THE EMERGENCE OF AI INTEGRATION IN RADIOGRAPHY: INSIGHT FROM A STUDENT'S PERSPECTIVE

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ABSTRACT

Background & Objective: The incorporation of artificial intelligence (AI) systems into the field of radiography has sparked significant interest and prompted extensive discussions about the core responsibilities of radiographers. This research seeks to explore the perspectives of student radiographers concerning the potential effects of AI on their careers by assessing current workflows and pinpointing specific areas where AI automation may be effectively implemented.

Key Findings: AI enhances precise isocentric positioning, automates the verification of referrals, and validates clinical indications that contribute to improved image quality. Radiographers develop versatility in patient care management, a fundamental element of their professional identity, while also gaining expertise in cross-modality and clinical adaptability. By integrating various AI modalities into the radiographic educational framework, students can gain insights into the substantial benefits of AI, which may help mitigate concerns about diminished employment prospects due to the reliability and adaptability of AI in radiography.

Conclusion: The use of AI in radiography poses several challenges that can be effectively managed through robust collaboration between AI experts and radiographers, enhancing adaptability.

Keywords: Radiography, Artificial Intelligence, Machine Learning, Deep learning, Imaging

INTRODUCTION

Radiography is a healthcare profession that requires skilled practitioners to possess advanced training and analytical abilities crucial for the processes involved in image acquisition (Hardy & Harvey, 2020)(Elshami et al., 2022).This expertise enables them to work in collaboration with medical radiologists to ensure the efficient management of patient care pathways and this versatility renders a radiographer essential, highlighting the important connection between radiographers and radiologists (Akpan et al., 2021). As a result, radiography has emerged as one of the most demanding programs in allied medical courses for individuals aspiring to build a career. Radiographers undergo specialised training to develop advanced competencies necessary for generating high-quality images, which are crucial for precise diagnosis, while also emphasising the importance of authentic patient care. The swift growth in technological advancements has greatly influenced patient diagnosis and treatment and has also transformed radiographic practices and the roles of radiographers. The evolution of technology has consistently impacted the field of radiography, leading to significant changes in practice as professionals adapt to new technological innovations and the enhanced imaging capabilities they provide. Recent advancements have particularly emphasised the incorporation of sophisticated machine learning (ML) algorithms and AI systems into the manoeuvres of equipment and the processes of image analysis (Chakraborty et al., 2024)(Malamateniou et al., 2021). Nevertheless, the degree to which these technologies impact practice is a subject that requires additional exploration. The global community is highly vigilant in observing the rapid progress in sophisticated ML and AI systems, which are designed to increase medical safety, optimise operational efficiency, conduct image analyses, and streamline treatment planning (Alowais et al., 2023)(Chhatrapati et al., 2022). As a result, it is imperative for radiographers and radiological technologists to become well versed in the wide array of potential utilisation of AI in medical imaging, thus empowering radiologists to deliver maximum benefits to patients.

This brief review seeks to offer insights derived from the perspective of a student radiographer concerning the present state of AI in radiography field, with an

emphasis on its influence in clinical practice, education, and research. Additionally, it will share observations and recommendations for potential developments aimed at those who are enrolled to the radiography profession. This review has been prepared based on a compilation of papers and assessments sourced from Scopus-indexed journals through Science Direct and Pub Med, along with similar reviews published in journals from leading publishers like Elsevier, MDPI, Springer, and Wiley & Sons.

THE ROLE OF A RADIOGRAPHER

Radiography has a rich historical background characterised by the advent of progressive ground-breaking technologies and tools. The development of erudite modalities that combine remote sensing with invasive methods such as ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), computed radiography, and digital radiography in clinical imaging highlight the credibility of diagnostic radiographers. Consequently, radiographers represent the largest segment of the workforce in clinical imaging departments, responsible for acquiring high-quality images of internal organs through the aforementioned technologies, as directed by different medical departments. These radiographic professionals are registered with the appropriate health care council and interact directly with patients, families, caregivers, and service users, playing a crucial role in patient care ("'Role of Radiology in a Multidisciplinary Approach to Patient Care': Summary of the ESR International Forum 2022," 2023). Their ability to acquire new skills and competencies reflects a dynamic and adaptable approach to their field. This further emphasizes their capability to evolve professionally, demonstrating a flexible and responsive methodology. This adaptability, combined with an expansion of practice scope and innovative service redesign, has resulted in a robust evidence base that highlights the numerous advantages of enhanced, advanced, and consultant roles for radiographers within the healthcare system. Therefore, the duties are varied and customised to address the unique requirements of their local settings and diagnostic radiographers employed in healthcare organisations are

required to perform multiple tasks in their day today activities (Makanjee et al., 2023).

Radiographers utilise a range of scientific approaches from various disciplines and incorporate advanced technologies, combined with an extensive understanding of critical elements in medicine and surgery, to develop precise protocols that prioritise patient care in the process of accurate imaging. To deliver genuinely person-centered care, it is essential for diagnostic radiographers to have a thorough understanding of diverse clinical presentations and various patient experiences (Antwi et al., 2021)(Kammies & Archer, 2022).This in-depth knowledge is vital for addressing the biopsychosocial needs of each individual, ensuring that patients are fully informed when consenting to imaging procedures, and customising care to meet specific circumstances. Furthermore, they must be adept at managing and adapting patient pathways in response to a wide range of trauma and medical conditions (Ross et al., 2024). Concurrently, they hold the obligation to uphold radiation safety protocols for both patients and their fellow colleagues.

THE APPLICATION OF AI WITHIN THE DOMAIN OF RADIOGRAPHY

AI embodies the intrinsic potential of machines cultivated through programming and various coding languages and supported by comprehensive human education (Ding & Makanjee, 2024)(Xu et al., 2021) .AI is primarily employed in radiographic devices, including automatic exposure control and personalised dose delivery systems designed for individual patients(Davenport & Kalakota, 2019)(Hovenga & Atalag, 2024). Its application is particularly advantageous in assessing patient positioning and offering guidance that corresponds to the specific radiographic protocols necessary for each patient. AI has shown exceptional precision and sensitivity in identifying anomalies in images, which could enhance the detection and characterisation of tissue-related disorders. At present, a variety of research projects are dedicated to the accurate assessment of AI imaging in terms of diagnostic precision, specifically by calculating sensitivity and specificity, while

some studies emphasise outcomes that are clinically significant (Oren et al., 2020)(Pinto-Coelho, 2023).

However, a key difference is found in the ability of modern AI systems to automate a broader spectrum of advanced cognitive functions. Therefore, it can be argued that a more rigorous standard of diligence and evidence is necessary before these systems are implemented. Notably, although the literature has examined the effects of AI in specialised imaging fields such as mammography, and ultrasound, there is still a considerable lack of evidence concerning features that project radiography and cross-sectional imaging (Hricak et al., 2021).

The incorporation of AI into radiography profoundly alters the roles of radiographers in both the current landscape and future scenarios. It is essential for radiographers to maintain a flexible mind set and be willing to learn new knowledge, skills, and techniques. Radiographers must assess the merits, risks and of AI integrated methods, as well as their possible implications for their professional duties and future areas of education and research. The radiography community ought to evaluate the merits and demerits of AI in generating high-dimensional images that facilitate straightforward diagnosis and procedures. Radiographers are tasked with evaluating the oversight of AI operations to guarantee safety and to convey precision to healthcare professionals and service users. Furthermore, radiographers must have the capability to evaluate and confirm the intricate decisions made by advanced AI systems (Hosny et al., 2018) . This ensures a safety mechanism in instances where AI may not perform as expected while also enabling them to recognise, value, and leverage the advancements that AI can offer.

A significant challenge emerges from the contrast between the definitive results yielded by sophisticated traditional radiographic examinations and the capacity of AI to detect alterations in imaging patterns that may not be readily apparent to human observers (Najjar, 2023). Furthermore, there may be instances where treatment recommendations are provided even in the absence of any identified abnormalities through conventional imaging methods. This inconsistency at the patient level can result in confusion and a potential erosion of trust, underscoring

the necessity of the emerging role of a wide spectrum of skills in image analysis (Pesapane et al., 2018) . Additionally, such situations may raise concerns about medical liability, including issues related to misdiagnosis or the possibility of unnecessary surgical interventions, especially if artificial intelligence becomes the dominant standard of care. It is quite mandatory to instil confidence in the public, especially among healthcare professionals, that the purpose of AI is not to supplant radiographers. Rather, a radiographer utilising AI may attain higher levels of productivity compared to one who does not leverage this technology (Aldhafeeri, 2022).

PRELIMINARY EVALUATION AND ASSESSMENT SCHEDULING

A fundamental responsibility of radiographers is to involve with patients throughout the entire process of their imaging procedures, including before, during, and after the examinations. AI can assist in confirming patient identification records through interactions with the Electronic Health Record (EHR) (Nashwan & Hani, 2023). The capacity of AI in accessing, integrating, and synthesising information from multiple patient data sources surpasses that of human radiographers, thus offering prospects for improved efficiency. However, the vigilance and meticulous oversight of radiographers are crucial for safeguarding the accuracy of patient electronic health record data and for ensuring uniformity in decisions made by AI system (Alanazi, 2023).

Additionally, the rational understanding of radiographers is essential in coordinating different imaging modalities. Incorrect patient positioning, especially non-isocentric alignment, may result in reduced image quality and, in the case of CT scans, an elevated radiation dose to the patient (Graef et al., 2022)(Al-Hayek et al., 2022). Consequently, the ability to make prompt decisions in critical situations, following the provision of appropriate patient care, is an essential aspect of a radiographer's responsibilities. Additionally, intelligent systems hold promise for optimising contrast volumes and injection rates on the basis of individual patient parameters, as well as the potential to eliminate the need for contrast altogether through synthetic contrast enhancement, thereby aligning with the principles of

personalised health care. In the realm of treatment planning, AI technologies facilitate the planning of treatment areas by automatically segmenting tumours and customising radiotherapy doses, ultimately increasing patient care and minimising the risk of unintended treatment effects.

PROSPECTS FOR RADIOGRAPHERS

The field of radiography has a longstanding tradition of embracing new technologies and has continually accepted change, particularly when these innovations are supported by evidence indicating enhanced patient outcomes and resonate with radiographers' dedication to providing superior care (Woznitza et al., 2020). Although qualitative research demonstrating widespread clinical impact remains scarce, the rapid pace of change and technological progress in the realm of AI indicates that AI integrated solutions will be widely accepted. As a result, radiographers should be equipped to welcome the new prospects presented by these advancements, while consistently sustaining the core professional principle that prioritise care of patients.

EVALUATION OF THE EFFECTIVENESS OF THE AI SYSTEMS

All automatic systems are required to comply with quality control protocols in accordance with established regulations to guarantee their efficient and orderly functioning in radiography(Holm T, 1986). As a result, there will be an increased obligation for radiographers to execute regular audits and assessments of the outcomes and decisions produced by AI image evaluation systems. A certain proportion of all AI assisted cases will likely require some level of post decision verification or critical review to evaluate the system's sensitivity, specificity, efficiency and accuracy. Radiographers should get hold of this opportunity to take charge of the practice and establish systems for reviewing and auditing human image interpretations against AI outputs. However, to effectively spearhead and develop such initiatives, radiographers must have an in-depth technical knowledge of the operations and functionalities regarding AI systems. Consequently, the establishment of educational programs and continuing professional development

(CPD) is highly essential to facilitate the progress of the radiographer workforce and their susceptibility to incorporate new AI-enabled services, which is to be regarded as the first priority. The foremost issue at hand is the transformation in the ethical dimensions that serve as the foundation of radiography.

ETHICAL CONCERNS OF RADIOGRAPHY PROFESSIONALS WHILE USING AI IN MEDICAL IMAGING PROCESS

AI can only be considered responsible if it complies with established ethical standards, which are underpinned by specific regulations and guidelines. The ethical dilemmas associated with AI in the healthcare domain are complex and often revolve data privacy, fairness and equity in both design and outcomes, accountability in the decision-making process, and transparency. It is imperative for the radiographers to commence the development of ethical guidelines and practices for AI at this critical juncture. The purpose of these guidelines is to promote applications that emphasise patient care while simultaneously protecting against the misuse of radiological data and algorithms for commercial gain, particularly in the absence of these essential qualities. Developing regulations, standards, and codes of conduct aimed at supporting ethical AI requires a thorough analysis of the related challenges, along with suitable considerations.

The incorporation of AI into radiography introduces a novel aspect characterised by improved diagnostic accuracy, increased operational efficiency, and the capacity to manage extensive volumes of imaging data. A thorough analysis of ethical considerations is needed in radiography due to its substantial implications for the public domain and its deep effects on patient care. Furthermore, a well-defined strategy is necessary for the formulation and execution of policies related to ethical practices at the national level. Consequently, radiographers must address ethical practices while implementing AI technologies, serving as vital members of healthcare teams tasked with acquiring and analysing medical images. Understanding their perspectives on the ethical implications of AI is essential to ensure the responsible and patient-centered use of these innovations (Wong et al., 2019) (Pinto dos Santos & Baeßler, 2018). The ethical implications associated with

the integration of artificial intelligence in radiography reflect those found in the wider context of healthcare AI applications, yet they are distinctly framed within the specific field of medical imaging. A significant issue is patient confidentiality, as AI algorithms are tasked with processing and analysing sensitive medical images (Char et al., 2018).

The incorporation of AI in radiography presents intricate challenges in data management, that include several critical aspects, notably the imperative of safeguarding privacy. These challenges encompass the protection of patient information, the maintenance of concealment for sensitive data, and the resolution of significant concerns surrounding data ownership. If not meticulously managed, the risk of algorithmic bias may result in inconsistent diagnostic results, adversely affecting patient care and worsening existing inequalities in the healthcare system. Furthermore, AI systems often operate as opaque entities, thus prompting concerns about accountability and transparency. A comprehensive survey conducted among radiographers in the Middle East and India highlighted the necessity for training in various aspects of artificial intelligence while also voicing concerns regarding job security and the applicability of radiology across diverse age groups and educational levels (Abuzaid et al., 2021) . Similarly, a study carried out in Saudi Arabia indicated a favourable attitude among radiographers for the integration of AI within radiology departments (Aldhafeeri, 2022). However, all participants raised concerns about the potential alterations in ethical practices, emphasizing the need for training programs, clear policies, and encouragement.

An extensive survey conducted across Europe revealed the successful integration of AI is essential for reaping the advantages of this emerging technology, which is fundamentally dependent on knowledge and trust (Rainey et al., 2021). The findings emphasised the importance of implementing responsible and ethical AI practices to foster a culture of safety and trust among healthcare professionals and patients. Furthermore, providing educational and training opportunities for medical imaging professionals to ensure a solid grasp of fundamental AI principles and their applications is crucial. The participants highlighted the need for collaboration among radiographers, radiologists, and other professionals to fully understand and

leverage the benefits of AI in medical imaging, underscoring that they encounter similar challenges and share common needs.

The ethical considerations surrounding AI technology developers and radiographers utilizing this technology for radiologists have been extensively analysed, focusing specifically on the ethical conflicts that arise between these two groups(Goisauf & Cano Abadía, 2022). This disagreement can be resolved through robust cooperation between AI experts and radiographers, enhancing adaptability.

RESEARCH AND PRACTICE IN AI

Research driven by radiography plays a crucial role in enabling radiographers to understand the implications of AI for their professional practice. As translational AI continues to evolve, there is a growing necessity for high-quality, prospective research initiatives that actively engage both patients and practitioners in the early stages of designing and developing AI solutions that are clinically relevant and address genuine needs in practice. Moreover, robust partnerships between the clinical, academic, and industry sectors are essential to support research in AI, which is driven by practical applications.

Education must evolve to become more agile, flexible, and responsive to meet the growing demands posed by the rapidly changing landscape of artificial intelligence. This can be accomplished through various approaches like implementing a modular course structure, integrating intercalated degrees, offering diverse specialization pathways within radiography, establishing formal internships as part of accredited modules, and providing funded AI apprenticeships, similar to the TOPOL digital fellowships introduced in the UK for NHS personnel (Kim, 2013). Additionally, it is essential to reassess and future-proof the frameworks for the knowledge, skills, and competencies of radiographers.

ACADEMIC ACTIVITY (EDUCATION, RESEARCH, STANDARDS)

The radiography workforce has exhibited some reluctance in accepting the impact of AI on workflows, processes, and services. This hesitation may be attributed to established service frameworks and the inherent adaptability of the profession in

response to continuous technological innovations. However, AI has emerged as a significant transformative element in healthcare, evolving in tandem with the sector's needs and calling for a more collaborative approach(Bajwa et al., 2021)(Bekbolatova et al., 2024) . The initial under appreciation of AI's potential effects has reduced involvement of the radiography profession in AI-related initiatives, including educational programs, research projects, and entrepreneurial activities (Hardy & Harvey, 2020).

Furthermore, student initiatives centered on AI in radiography are presently underway, exploring topics such as patient acceptance of new technologies, support for decision-making, patient safety, and implementation strategies. The radiographic community is eagerly anticipating the outcomes of these projects, accompanied by a significant concern regarding potential job losses and a decrease in available positions. The mounting number of conferences in medical imaging and radiotherapy are now featuring sessions on continuing professional development in AI or are focused entirely on innovations in this area. Different standards for AI in healthcare are underway by the British Standards Institute, different HEIs and NHS Trust consortia, sometimes with the contributions of radiographers (Sujan et al., 2023). It is high time to start establishing cornerstones for the future.

CONCLUSION

In summary, radiography is integral to medical diagnosis, treatment, and patient care, offering healthcare professionals essential insights for making informed decisions. The surge in demand for diagnostic imaging services during the pandemic has resulted in considerable challenges that necessitate prompt action, placing significant strain on the radiology workforce. This situation has led to shortages and increased workloads. To tackle these challenges and uphold high standards of patient care, it is essential to strengthen the workforce by attracting and retaining qualified radiography professionals, in addition to fostering education and specialised training in the field to align with international standards. This enhancement should encompass practical clinical experiences, access to advanced equipment and resources, and sufficient academic support and mentorship for

students. Addressing these concerns is imperative for the future advancement of radiography and will ultimately lead to improved patient outcomes and greater efficiency within healthcare systems globally. The emergence and proliferation of artificial intelligence in the field of radiography are poised to increase diagnostic accuracy and its ability to exclude particular conditions, as the initial diagnosis begins within the confines of the scanning rooms. Nevertheless, if AI algorithms are not sufficiently trained to differentiate between benign anomalies and significant lesions, the heightened sensitivity of imaging could lead to a greater occurrence of false positive results, along with confusing situations where AI-generated findings do not correspond with patient outcomes. The concerns of student radiographers hold significant importance and should be thoroughly addressed prior to the incorporation of curricula into existing radiological programs that incorporate digital technology. It is essential that they gain a comprehensive understanding of the advantages and disadvantages of machine learning, deep learning, and artificial intelligence to meet the necessary ethical standards in their clinical practice. This would further alleviate the concerns of student radiographers regarding job security and the restricted availability of radiographic positions. Such an environment would inspire them to grasp the advanced technologies through which they can make substantial contributions to the advancement of medical science.

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