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Impact of artificial intelligence on clinical radiography practice: futuristic prospects in a low resource setting

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ABSTRACT

Current trends in clinical radiography practice include the integration of artificial intelligence (AI) and related applications to improve patient care and enhance research. However, in low resource countries there are unique barriers to the process of AI integration. Using Ghana as a case study, this paper seeks to discuss the potential impact of AI on future radiographic practice in low-resource settings. The opportunities, challenges and the way forward to optimise the potential benefits of AI in future practice within these settings have been explored.

Some of the barriers to AI integration into radiographic practice relate to lack of regulatory and legal policy frameworks and limited resource availability including unreliable internet connectivity and low expert skillset.

These barriers notwithstanding, AI presents a great potential to the growth of medical imaging and subsequently improving quality of healthcare delivery in the near future. For example, AI-enabled radiographer reporting has a potential to improving quality of healthcare, especially in low-resource settings like Ghana with an acute shortage of radiologists. In addition, futuristic AI-enabled advancements such as synthetic cross-modality transfer where images from one modality are used as a baseline to generate a corresponding image of another modality without the need for additional scanning will be of particular benefit in low-resource settings.

The urgent need for inclusion of AI modules for the training of the radiographer of the future has been suggested. Recommendations for development of AI strategies by national societies and regulatory bodies will harmonise the implementation efforts. Finally, there is need for collaboration between clinical practitioners and academia to ensure that the future radiography workforce is well prepared for the AI-enabled clinical environment.

Keywords: Artificial intelligence, low-resource settings, Ghana, radiography, machine learning

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Introduction

The practice of radiography is highly reliant on technology and thus current innovations and advancements are contributing significantly to the quickly evolving profession. The transition from manual film processing, through to the phase of automatic processing and to the most recent use of digital daylight image processing is an example of such changes due to technological advancement.[1] These technological advancements revolutionised the practice of clinical radiography, particularly, with the introduction of cross-sectional imaging modalities like computed tomography (CT) and magnetic resonance imaging (MRI). Current trends in clinical radiography practice include the integration of artificial intelligence (AI) and related applications to improve patient care and enhance research in the field.[2,3] In low resource settings with unique challenges including healthcare infrastructure inadequacies, a discussion relating to the future impact of these modern innovations on clinical radiography practice is necessary.

Using Ghana as a case study, this paper aims to discuss the futuristic impacts of AI on clinical radiography practice.

AI usage in clinical radiography practice in Ghana

The benefits of AI notwithstanding, very little activity is reported of AI implementation and usage from the clinical radiography setting in most low resource countries. In Ghana, the areas of radiography practice that have seen some form of AI implementation are in image processing/reconstruction (aimed at reducing image artifact), dose optimisation and diagnosis of tuberculosis (TB) and recently for COVID-19 detection. The epidemiological distribution and prevalence of TB in Ghana is nearly four times the World Health Organisation (WHO) average.[4] The government therefore employed a commercially developed AI tool - Computer-Aided Detection for Tuberculosis (CAD4TB) (https://www.delft.care/cad4tb/) in an attempt to improve disease diagnosis especially within highly affected regions of the country. This system automatically detects TB on chest imaging systems that have CAD4TB installed using AI approaches.[4] The computer-Aided Detection for COVID-19 (CAD4COVID) (https://www.delft.care/cad4covid/) AI software was also introduced in response to the COVID-19 pandemic to help triage suspected COVID-19 patients from the populations. Both CAD4TB and CAD4COVID operate through a similar technical pipeline by employing AI approaches in the generation of heatmap scores ranging between 0 and 100 to indicate the extent of abnormalities. These observed abnormalities are then quantified as a ratio or percentage of the total lung that is affected.[5]

In terms of dose optimisation and image processing, almost all latest CT and MRI scanners have AI systems that reduce poor iso-centering. In particular, integrated technical specifications (e.g., positioning sensors) that detect specific landmarks on the patient's body surface in relation to the area of interest for a scan series and adjust the positioning (i.e., automatically moves the table) such that the majority of the scanned anatomy is located at the isocentre.[6] This helps to optimise patient dose. Other algorithms in a few of the

equipments in Ghana are the systems that allow the automatic selection of optimal protocol for a specific modality based on a given condition. Moreover, some automatic exposure control (AEC) systems used in CT operate on the principles of machine learning in the selection of an optimal tube potential and current. Of note, some of the latest equipments, mostly located in the major cities (and within private facilities) of the country have certain operations based on the convolutional neural network (CNN)-based deep learning approach to optimise image noise.[7] In addition, some ultrasound machines have AI software, which create multi-parametric reports and automates the analysis and quantification of cardiac imaging parameters. Moreover, the radiotherapy treatment planning systems in Ghana also use CNNs to produce auto-segmentation when showing organs that might be at risk while the available linear accelerators have AI-incorporated algorithms that automate the movement of some parts to ensure precision. With the important role of AI in the health sector, and the increasing demand for quality healthcare delivery including clinical imaging in low resourced countries, it is anticipated that many AI-integrated equipment modalities will eventually find their way into these settings in the very near future.

Challenges of AI usage in clinical radiography practice in Ghana

The introduction of AI in Ghana and most low resource countries is faced with challenges including the lack of necessary legal frameworks for implementation and monitoring, lack of knowledge and commitment from the various authorities, lack of financial resources to acquire appropriate AI tools and qualified personnel to utilise and manage these tools for maximum benefit. Of note, Ghana and most other developing countries are still challenged by limited resources.[8,9] Thus, the very low imaging equipment to the population ratio, especially when considering specialised modalities like CT and MRI[8,9] makes it unlikely for the required investments for AI-specific equipment implementation.

AI is heavily dependent on fast, reliable, and affordable internet. Ghana like most low resource settings is faced with the challenge of unreliable internet bandwidth quality which is mostly available only in major cities and relatively expensive.[10] Governments have over the years made attempts at improving the internet connectivity in the country, but enough progress has not been made even though Ghana is considered to have one of the best internet connectivity ratings in Africa[10]. In most low resource settings, it is known anecdotally that governments have over the years not invested the required resources in healthcare generally and radiography in particular. The radiography infrastructure is quite expensive and because these countries have resource constraints, equipment's are almost always very sparsely distributed when they are available and in most cases are not the most modern.[8,9] The pace of development of relevant technology is so fast that by the time low resource countries procure a certain technology it might have become obsolete. Previous reports indicated that radiographers feel that poor equipment maintenance culture might not make AI a sustainable technology for Africa.[11] This finding agrees with that of other studies on medical equipment infrastructure and management from across the West African sub-region.[9,12,13,]

In Ghana and most low resource countries, there are still many equipments that are not digital and/or in very poor functioning state. [9,12,13] Many African countries are still using

conventional radiographs with wet-image processing techniques. In such settings, the integration of AI into clinical radiography practice is almost impossible. It is only recently that Ghana as part of the TB control program with Delft acquired 52 digital x-ray equipments for distribution in mostly district hospitals and other healthcare facilities.[4] Most hospitals in these countries do not have electronic patient records, hard copies of radiographs are still printed as part of the clinical care pathway. It is therefore difficult for such facilities to make use of AI technology without the necessary investments in AI-related infrastructure.[14] Interestingly, even in the few hospitals with fully digital equipment, electronic health records are not linked with any other hospital.

Moreover, the lack of inclusion of AI theories, applications and techniques in radiography curriculum coupled with the lack of experience with AI tools continue to widen the knowledge gap about AI tools in Ghana and most low resource countries.[11,15] In a recent study[16] of Ghanaian radiographers, as high as 82.8% of the respondents indicated they lacked knowledge about AI. Most of the respondents have not seen any or learnt about AI and so they could only imagine its applications to clinical practice. With any new technology, some people would have various misgivings about it. Thus, the lack of knowledge and misgivings have the tendency to breed misinformation and lack of understanding about the AI tool. The religious beliefs of some people in Africa make them think that anything "super technology" is evil. Some radiographers were of the view that AI tools are a necessary evil and are prone to mistakes just like humans.[16] Education would be needed to empower end users of AI tools in low resource countries including Ghana.

Importantly, AI comes with its own legal and data protection complexities. These issues will require a robust legal framework that will ensure patients' data is adequately protected to avoid regulatory breaches as much as possible. The legal framework will also ensure that data is only used for the purposes for which it was acquired, and only authorised persons have corresponding access to certain levels of information. The major challenge in Ghana and most low resource countries is that, although, there may be some form of legislation on general data protection, nothing exist in relation to AI and policy implementation has always been a challenge.[17] This is known by most citizens and most are therefore very reluctant to provide information.

More so, cyber security is very important in the era of AI because of possible cyber-attacks by hackers. It is important that patient data is fully secured to minimise or eliminate the possibility of data breaches from hackers. To achieve enhanced cyber security, it is required to have the necessary security infrastructure in place which is non-existent in most low resource countries. Ghana has recently just passed the Cybersecurity ACT 2020 with the mandate to set up a National Cyber Security Centre, to be responsible for the development and implementation of a national policy and strategy on cybersecurity.[18]

Botwe and colleagues[16] in a study that assessed the perspectives of Ghanaian radiographers on the integration of AI into medical imaging concluded that the participants showed a general awareness of AI and believed it will improve and ease their work, however they were concerned about possible job losses, AI related errors, security of data, lack of

technical expertise, threats of cyber security and high equipment cost. These trends were replicated in a follow-up Africa-wide study[12,15]

Potential future AI applications in radiography practice

While it is unlikely that direct human interaction will be completely taken over by AI tools, there are aspects of these interaction that will be affected. Activities like vetting of referrals, verification of patient identity via electronic health records and assessing clinical history and matching it with the modality requested are potential areas AI tools could be used.[19] AI tools do have the potential to access data from multiple sources much faster and more accurately than a human and as such it is reasonable to expect that it is cost saving, efficient and more preferred. However, there might still be the need for the radiographer to have an oversight responsibility over the AI tools employed to ensure patient records have not been corrupted[1]. Additionally, the radiographer's role includes accurate positioning of patients in all imaging examinations. Of note, previous reports[19, 20,] on isometric positioning of patients for CT and MRI indicate the possibility of automation of this procedure which is a traditional radiographer role. Although, this is already happening, it is on a very limited scale, currently. There is also the possibility of contrast volume being determined by AI tools based on patient parameters[21] and in some cases contrast media could be eliminated altogether by AI systems by introducing synthetic contrast enhancement approaches.[22]

Moreover, radiographer reporting is well established[23-25] with positive outcomes.[26,27] It is envisaged that AI-led radiograph triaging may soon render radiographer reporting redundant; this is indeed captured in literature.[28] If AI-led image triaging becomes widespread and clinically viable, what becomes of reporting radiographers? AI presents a great potential in medical imaging and especially for low resource settings like Ghana, where there are no reporting radiographers and very few radiologists within the healthcare system. AI could be used in image interpretation across most of the country where there are either no radiologist or very few of them. There is a possibility of cost reduction, increased productivity, and increased accuracy.[29-32] There are early indications of the possibility of synthetic cross modality transfer, such that an MRI image could be generated from a CT scan image and vice versa,[33] thereby eliminating the need for a second scan altogether. This will be a boost to quality healthcare delivery in low resource countries like Ghana where very few facilities have both CT and MRI, and there would no longer be the need to purchase separate CT and MRI units thereby saving scarce resources that could be used in other areas within healthcare.

Opportunities for radiographers in the AI era

Topol[34] has predicted that every clinician, be they a consultant or a specialist or a paramedic, will soon be required to use AI and deep learning applications in their professional practice. This period is one of uncertainty for many professions in healthcare and there has been some level of speculation that some professions like radiology could be replaced by automation and AI tools.[35] AI also presents with it numerous opportunities and as to whether one profession will become redundant or not will depend on how willing and

ready that profession is ready to take up the opportunities presented by AI. Indeed, roles will change, skillsets that were once very essential might no longer be needed and the ability and willingness of any profession to learn new skillsets and take up new responsibility will largely determine how relevant the profession will be going forward.[36] Whilst radiographers and other healthcare professionals in Ghana and most low resource countries will be tempted to believe that the introduction of AI in clinical radiography practice is in the distant future, urgent plans are required to prepare the radiography workforce in order not to be overtaken by events. AI tools are already creating good opportunities for some radiographers in low resource settings to positively influence the patient management pathway.[11,15,16] The CAD4TB installed in Ghana in particular, is changing how radiography is practised in facilities which have these software tools incorporated in their x-ray equipments and related accessories. Far from the norm at various imaging facilities in Ghana, radiographers now do not have to physically keep radiological images of suspected TB patients and carry them to radiologists for comments which take between 3 days to a week or more to complete. Some radiographers are now trained while others are being trained on how to read pathological heatmaps of TB and COVID-19 using specialised software and communicate results to the referring clinicians through virtual platforms in real time. This is reducing the time spent by patients and improving care at the imaging departments. In addition to that, radiographers are serving as first line managers of the AI tools at the radiology departments to ensure effective operation. In these settings, they are engaging in AI-assisted preliminary image interpretation (including reporting incidental findings) as core parts of their role. Thus, the AI tools are extending the roles of radiographers and creating new prospects in medical imaging practice in a low resource setting.

Moreover, there is the need to periodically audit the reports being generated by the AI systems and this is one area radiographers could be engaged in. Auditing of these automated clinical AI tools will serve the purpose of establishing the sensitivity, specificity, and accuracy while serving the additional purpose as a peer reviewer. Against this background, urgent critical infrastructural developments and training/education will be required for all radiographers especially those in developing countries to embrace these futuristic changes.

Additionally, radiographers will still have to provide the human interface for patients as AI tools have still not developed to the point where this activity is no longer required. The current IR(ME) regulations[37] clearly places the ultimate responsibility of the acquisition and processing of medical imaging in the hands of the radiographer regardless of the level of automation. It is unlikely this will change anytime soon. It is therefore the responsibility of the radiographer to provide radiation protection education to the patients and take steps to ensure the patient is always protected.[37] Again, the radiographer led AI-supported reporting is a cheaper alternative when compared to a single radiologist, especially for high volume examinations or modalities like chest radiography, CT lung and mammography screening. It is therefore imperative that radiographers develop and implement plans for radiographer-led AI-supported reporting services in low resource setting like Ghana that is bedevilled with huge imaging backlog and inadequate personnel.[9,38].

The way forward

Given the fast pace at which technological innovations are occurring in healthcare and particularly in medical imaging, it is understandable that some radiographers are concerned about their level of knowledge to keep active in clinical practice.[11,15,16] Unfortunately, one common trait of radiographers in Ghana is the penchant of underestimating their power , to influence decision making in the workplace. The unique position of radiographers, ensures they understand the way technology and innovation impacts both the patient and the flow of work volumes.[39-41] Radiographers in Ghana turn to act unconcerned and when decisions are taken that affect them then they shout the loudest. Radiographers must depart from this attitude and ensure that their voice is heard throughout the process from procurement, vendor demonstration, implementation and conducting required research to inform practice and policy.[42] The Ghana Society of Radiographers (GSR) and similar professional bodies must as a matter of urgency develop an AI strategy to guide future implementation and practice monitoring activities. Societies like the European Federation of Radiography Societies (EFRS), Canadian Association of Medical Radiation Technologists (CAMRT) and the Society and College of Radiographers (SCoR) are taking steps to ensuring that their membership is abreast with AI.[43,44] They have set up a subcommittees and special interest working groups to provide education, develop policies for their members on the usage of AI applications in radiography practice.[43] Awareness creation and capacity building must be of prime importance to all professional bodies and societies and particularly those in developing countries like Ghana considering the relatively poor awareness of these latest developments.

It is important that radiographers take steps to learn the intricacies of AI in healthcare. More importantly, the GSR and similar professional bodies across low resource countries should outline their strategy towards AI. Obviously, membership will be looking up to their respective professional bodies to give them leadership, position papers and direction.[43,45] It is also crucial that radiographers demand that any tool that will be suggested for implementation will ensure a healthy balance between efficiency and well-being of both patients and staff.[45]

Critically, there is the urgent need for collaboration between radiographers in clinical practice and academia. There is also the need to ensure that the educational curriculum is reviewed to include advanced information technology (IT) and AI skills to reflect the changing times[1]. Higher education will do the profession a lot of good if the next generation of radiographers are adequately trained in AI and IT skills. Higher education institutions in collaboration with employers and professional societies should organise continuous professional development (CPD) programs for radiographers already in clinical practice to update their skills[1]. This will ensure they stay relevant within the ever-changing profession.[1]

It is important that strategic partnerships are created between clinical practice, academia, and industry to ensure AI tools developed are relevant to the profession and keep academia in the loop on what is being developed so that in educating the next generation of radiographers, AI is factored into their curriculum. This synergy will ensure the profession is well placed with regards to usage and implementation of AI applications.

Lastly, if radiographers are not to be left behind with AI, then conscious efforts must be made to invest in AI related research. Other countries are investing heavily in AI and low resource countries cannot afford to be left out. Investments in AI related research rose from $80 million in 2016 to a projected value of over $500 million dollars in 2019.[45,46] Whilst it is unreasonable to expect Ghana, a low resource country, to invest such huge sums of money into AI related research, it is important that Ghana begin to invest in research. Moreover, there would also be need for more research to be conducted in low-resourced settings to empirically develop data to further understand the AI usage, challenges, potential future AI applications and opportunities for radiographers.

Conclusion

Artificial intelligence has come to stay, radiographers equipped with clinical, analytical and research skills should be harnessed to ensure the safe and ethical use of AI. As professionals we must accept AI, embrace it, learn it and own it. The profession of radiography must be positioned strategically to play key roles in the introduction and management of AI to ensure that practitioners can direct how it is implemented. AI will take up some roles played by the radiographer and improve upon efficiency, speed, and accuracy but there will always be the need for the indispensable element of human support and interaction. Radiographers should ensure they make inputs because if they don't, this AI ship will still sail, maybe just not in our preferred direction.

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