









ORIGINAL ARTICLE

Australian perspectives on artificial intelligence in medical imaging

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Abstract

Introduction: While artificial intelligence (AI) and recent developments in deep learning (DL) have sparked interest in medical imaging, there has been little commentary on the impact of AI on imaging technologists. The aim of this survey was to understand the attitudes, applications and concerns among nuclear medicine and radiography professionals in Australia with regard to the rapidly emerging applications of AI. **Methods:** An anonymous online survey with invitation to participate was circulated to nuclear medicine and radiography members of the Rural Alliance in Nuclear Scintigraphy and the Australian Society of Medical Imaging and Radiation Therapy. The survey invitations were sent to members via email and as a push via social media with the survey open for 10 weeks. All information collected was anonymised and there is no disclosure of personal information as it was de-identified from commencement. **Results:** Among the 102 respondents, there was a high level of acceptance of lower order tasks (e.g. patient registration, triaging and dispensing) and less acceptance of high order task automation (e.g. surgery and interpretation). There was a low priority perception for the role of AI in higher order tasks (e.g. diagnosis, interpretation and decision making) and high priority for those applications that automate complex tasks (e.g. quantitation, segmentation, reconstruction) or improve image quality (e.g. dose / noise reduction and pseudo CT for attenuation correction). Medico-legal, ethical, diversity and privacy issues posed moderate or high concern while there appeared to be no concern regarding AI being clinically useful and improving efficiency. Mild concerns included redundancy, training bias, transparency and validity. **Conclusion:** Australian nuclear medicine technologists and radiographers recognise important applications of AI for assisting with repetitive tasks, performing less complex tasks and enhancing the quality of outputs in medical imaging. There are concerns relating to ethical aspects of algorithm development and implementation.

Introduction

While artificial intelligence (AI) and more recent developments in deep learning (DL) have sparked clinical and research interest in medical imaging (radiology and

nuclear medicine), a number of expert commentators, including Geoffrey Hinton, have predicted that AI would make radiologists redundant.¹ A more realistic perspective might predict a change in the way some tasks are performed.^{1–3} There has been little commentary on the

impact of AI in medical imaging on non-medical personnel like imaging technologists. Indeed, a number of AI tools directly impact the imaging technologist interface. With the changing AI landscape, there is a need to understand the perspectives of the imaging technologists with respect to challenges, role and opportunity of AI.

Hardy and Harvey⁴ identify acceptance of automated technology in radiography at the price of erosion of core skills; improved efficiency coming at the cost of increased workload and radiographer burnout. They raise concerns that the emergence of AI on top of these automations undermines the role and responsibilities of the radiographer. While it is conceivable that an AI system be designed that simply requires a “concierge” to direct the patient to the x-ray room for more basic procedures, this would be very difficult to implement outside the near perfect outpatient and for more complex imaging procedures. A more realistic threat to radiographers is the triage capability of AI on the role of interim reporting.

A qualitative survey of radiographer perspectives on AI in Africa reported positive attitudes toward the capabilities of AI but significant concerns related to implementation, job security, loss of skill bases and lack of awareness and education around AI in the workforce.⁵ This is a common theme in similar investigations where, for example, dental students felt they lacked the foundations to understand the application of AI in their profession but were open to learn to capitalise in opportunities to improve care.⁵ A survey of medical students in the United Kingdom indicated that 49% were less likely to pursue a career in radiology due to AI.⁶ Nonetheless, the survey also revealed medical students felt AI in their education would benefit their career (89%) and that students should receive AI training (78%).

In medical imaging, AI and DL are likely to drive a shift toward improved patient care and less likely to negatively impact on the roles and responsibilities of our people. AI and DL are likely to have an impact on imaging technologists responsible for data curation and stewardship where there is potential for role expansion in data management and data science. AI is part of the medical imaging landscape now and will be a growing part tomorrow. AI in medical imaging is unlikely to replace imaging technologists; but imaging technologists with AI capability are likely to displace those without AI capability at some point in the future. The challenges (legal, ethical and implementation) are being learned in parallel to development and application of AI. It is essential, therefore, to better understand the perceptions and perspectives of radiographers and nuclear medicine technologists to mitigate implementation issues associated with AI, ensure safe application and meet the workplace

and training needs of the professional workforce.^{7,8} This information is necessary to provide informed strategic planning for professional bodies and the higher education sector. The aim of this survey was to understand the attitudes, applications and concerns among nuclear medicine and radiography professionals with regard to the rapidly emerging applications of artificial intelligence.

Method

The anonymous survey was an online SurveyMonkey survey instrument with invitation to participate circulated to members of two professional bodies; the Rural Alliance in Nuclear Scintigraphy (RAINS) and the Australian Society of Medical Imaging and Radiation Therapy (ASMIRT). The online survey instrument allowed flexible and widespread access for completion in privacy and at a convenient time for participants. The online survey was open for 10 weeks in the third quarter of 2021. There were no specific control arms although the structure of questions included control questions that could be used as a reference point for the medical imaging based context. For example, rating questions around aspects of AI in imaging were supplemented by rating questions relating to AI applications in general life. Comparison was also made between the two professional groups (nuclear medicine and radiography) to provide a pseudo control arm for one another.

While participants were recruited by membership invitation of RAINS and ASMIRT, it was not anticipated that full membership will have participated. No exclusion criteria were applied as all members are part of the “perspective” crucial for improved understanding. Inclusion criteria was a willingness to complete the survey. The inclusive nature of the survey for membership made power calculations and sample size calculations redundant. The survey invitations were sent to members via email and as a push via social media accounts. A three week window was open for responses. At the end of the three week window a social media reminder push was performed with a second seven week window. After this, data collection was closed. There were 19 questions inclusive of demographic information and scaled responses relating to perception about attitudes and applications of AI. All information collected was anonymised and there is no disclosure of personal information as it was de-identified from commencement, making it non-identifiable data. The survey had institution ethics approval from the Charles Sturt University Human Research Ethics Committee.

The survey was modelled on previously developed instruments^{5,6,9–12} and adapted/enhanced by using multi-disciplinary feedback. The survey instrument was

informed by evidence and feedback from internal and external stakeholders. The survey was designed to be thorough while minimising time commitment of busy practitioners. Piloting of the survey among the academic group allowed refinement with respect to content and face validity before implementation.

Data analysis included descriptive statistics of all variables and distributions determined for scale-based survey items. Students *t* test, group ANOVA *F* test, and Chi square analysis were used to evaluate the statistical significance of differences in the data. Radar analysis was used to demonstrate grouped rating comparison. Participation bias was expected to shape the results but the inclusivity and importance of diversity in the data collection mean that the results will be valid as a representation of perspectives of the target groups.

Results

The mean time for completion of the survey was 12 minutes and 22 seconds among the 102 respondents. Peak response rates were associated with week one of data collection followed by the week of the reminder social media push. The typical respondent was female nuclear medicine technologist aged 25–44 years with 11–20 years experience working in the private sector in NSW with patient care or clinical duties. Table 1 summarises the demographic information of the respondents. The mean years of experience was 19.0 years with a range of zero to 47 years and a median of 18 years.

With respect to the degree of automation respondents were prepared to accept in their own lives (Fig. 1), there was a higher degree of acceptance of automation in pre-imaging patient management and in treatment than there was for the production and analysis of medical images themselves. There was an interesting higher degree of acceptance of autonomous heart surgery than there was for a general practitioner consultation or chest x-ray. There was also greater value for AI in roles that are manual and repetitive more so than tasks that require decision making and logic (Fig. 2). Not surprisingly, education in AI was considered important for those working in medical imaging but not for patients or the public (Fig. 3, top) and there was a significant disparity between the level of AI expertise respondents had (Fig. 3, bottom left) and the level of expertise they would like to have (Fig. 3, bottom right). Despite enthusiasm for AI in medical imaging, respondents indicated a high level of concern across a range of issues (Fig. 4). Contrary to the remit of the Australian Health Practitioner Regulatory Agency (AHPRA) / Medical Radiation Practice Board of Australia (MRPBA), 72.6% of respondents indicated they should be responsible for developing guidelines for

Table 1. Demographic data of respondents.

Variable	Number (%)
Gender	
Male	35 (34.3)
Female	66 (64.7)
Did not identify	1 (1.0)
Age (years)	
18–24	3 (2.9)
25–34	30 (29.4)
35–44	29 (28.4)
45–54	18 (17.6)
55–64	20 (19.6)
65+	2 (2.0)
Employment	
Private practice	45 (44.1)
Private hospitals	18 (17.6)
Public hospitals	29 (28.4)
Academic institutions	6 (5.8)
Students	2 (2.0)
Retired	1 (1.0)
Other	1 (1.0)
Location	
New South Wales	38 (37.6)
Victoria	22 (21.7)
Queensland	22 (21.7)
Western Australia	6 (5.9)
South Australia	5 (4.9)
Tasmania	4 (3.9)
Australian Capital territory	2 (2.0)
International	2 (2.0)
Role	
Nuclear medicine technologist	61 (59.8)
Radiographer	36 (35.3)
Both NMT and radiographer	1 (1.0)
Student NMT	2 (2.0)
Student in radiation therapy	1 (1.0)
Nuclear medicine physician	1 (1.0)
Work function	
Clinical / patient care	87 (85.3)
Management	5 (4.9)
Education	5 (4.9)
Research	2 (2.0)
Retired	1 (1.0)
Student	2 (2.0)
Years of experience	
0–5	16 (15.7)
6–10	18 (17.6)
11–20	31 (30.4)
21–35	25 (24.5)
36+	12 (11.8)

implementation of AI in medical imaging practice although most respondents indicated some level of shared responsibility among the professional bodies. There was similar variability of shared responsibility for errors occurring from AI implementation with the developers and commercial vendors perceived as holding the highest

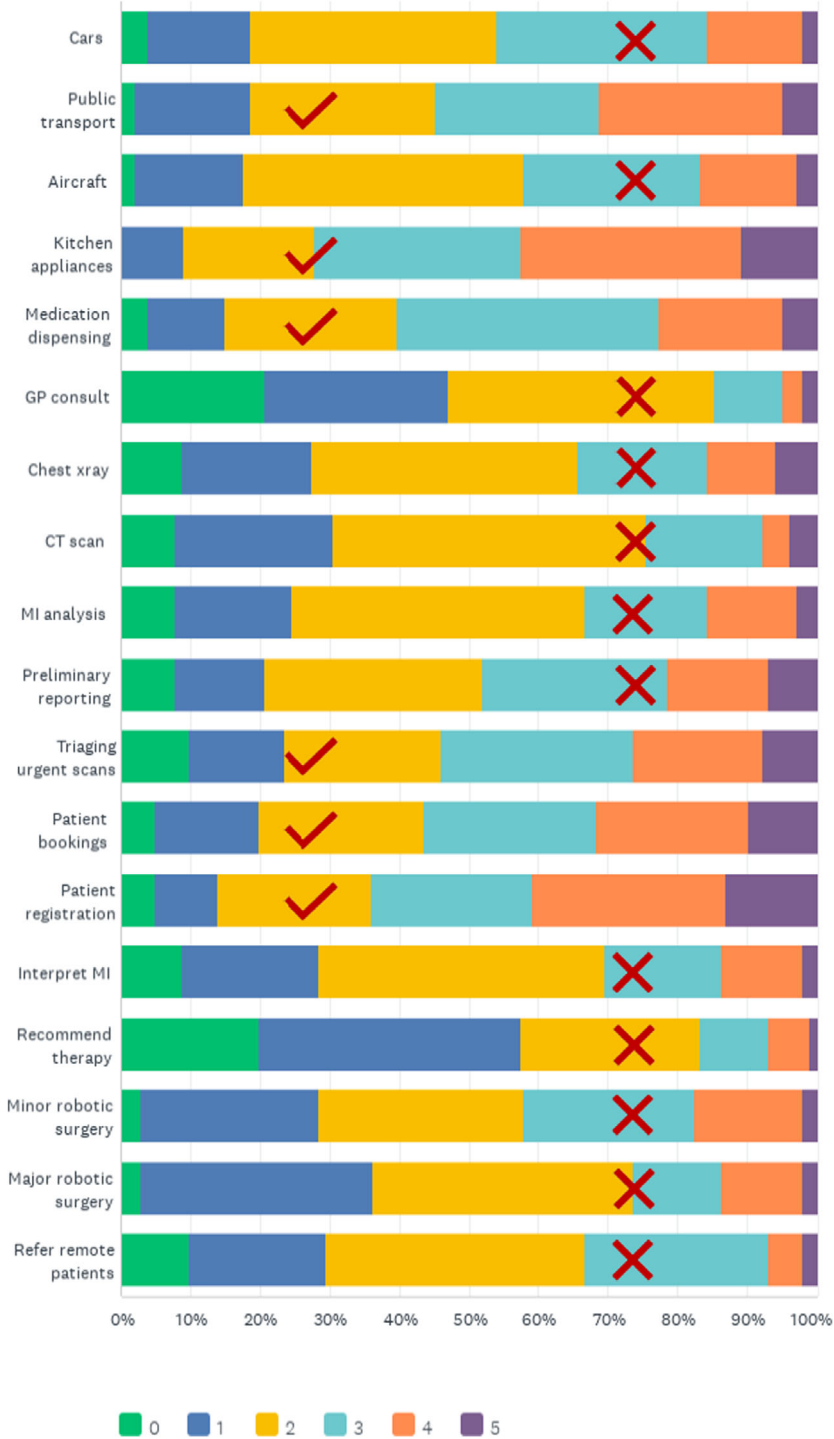


Figure 1. The degree of automation respondents were prepared to accept in their own lives. 0 = no automation; 1 = assistance for human in control; 2 = partial automation with human engaged; 3 = conditional automation with human ready but not required; 4 = high automation with optional human input; 5 = full automation. The red tick indicates those variables where respondents indicated greater acceptance of AI in their lives (cumulative total of category 0, 1 and 2 less than 50%) and red crosses where there was lower acceptance (cumulative total of category 0, 1 and 2 greater than 50%).

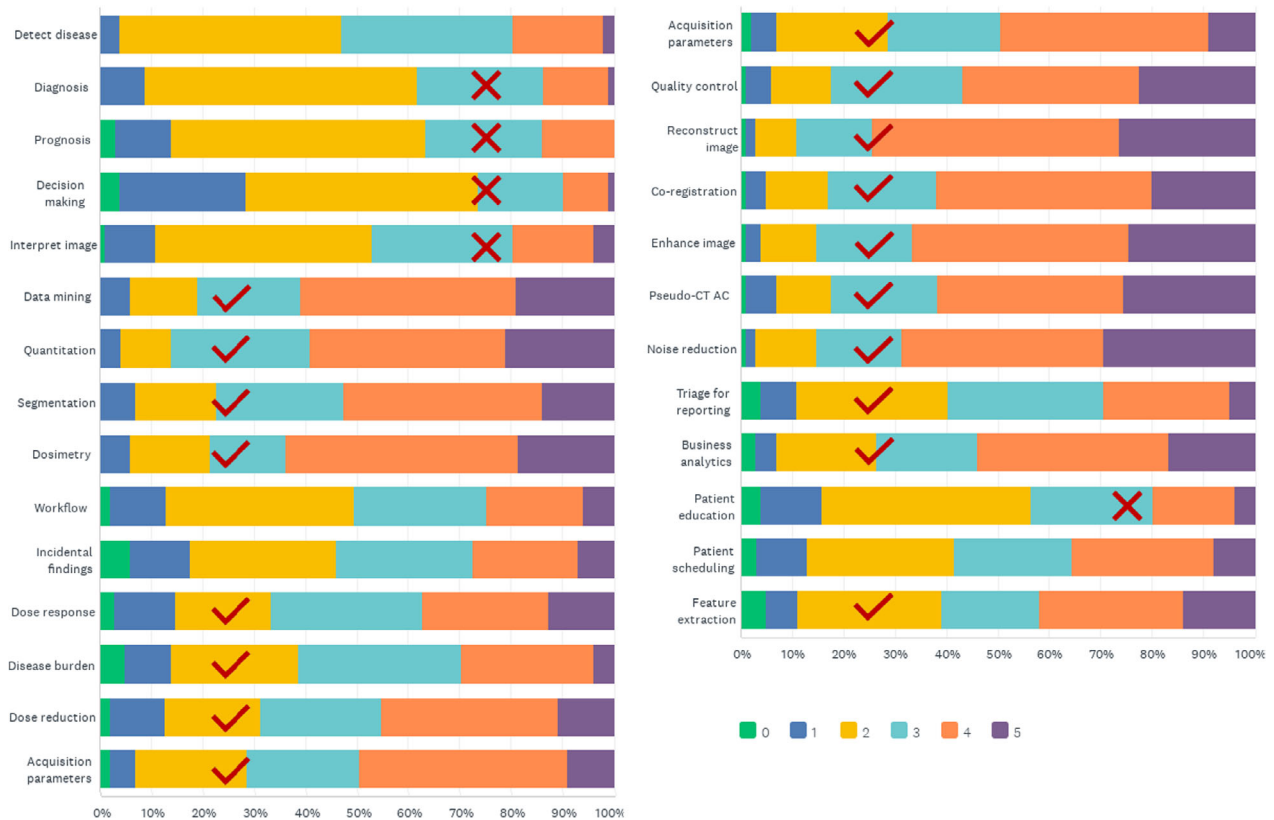


Figure 2. The perception of the role AI will play in clinical questions over the next 10 years. 0 = no role; 1 = AI assistance for human in control; 2 = AI augmentation or support for human activities; 3 = AI automation with human ready but not required; 4 = human augmentation with human supervision of AI; 5 = AI autonomy. The red tick indicates those variables where respondents indicated had a greater role for AI over the next 10 years (cumulative total of category 0, 1 and 2 less than 50%) and red crosses where there was lower anticipated role (cumulative total of category 0, 1 and 2 greater than 50%).

responsibility (70.3% and 73.3% respectively). Integrating AI algorithms with existing software applications was the most supported way (68.6%) for implementation in clinical practice followed by integration with image display (15.7%). Less than 15% of respondents indicated any certainty about their departments readiness for AI implementation with 58.4% expressing confidence that their department was not prepared for AI implementation.

Those respondents aged 25–34 years had a statistically significant higher support for the role of AI in medication dispensing than all other age groups ($P = 0.015$). There were no other statistically significant variations among the variables based on age and there was no statistically significant relationship between years of experience across any of the variables. Excepting performing a computed tomography (CT) scan, triaging urgent scans for reporting, patient registration and therapy recommendations, there were statistically significant increases in support for the role of AI to

automate all tasks in life ($P < 0.05$) for males over females. There was no gender based statistically significant differences for any other variables although there were variations in the mode responses between genders. Specifically, men recorded higher mode scores (2.8 versus 2.2) for acceptance of AI in their lives (Fig. 5 top) while women had greater concerns (2.8 versus 1.9) for AI implementation (Fig. 5 bottom).

There were no statistically significant differences for any variables based on where the respondent was employed (private practice, private hospital, public hospital etc), location (state) or work function (clinical, education etc). There was also no statistically significant difference for any variables between nuclear medicine technologists / scientists and radiographers. There were, however, some variations in the mode response between radiographers and nuclear medicine technologists (Fig. 6) with nuclear medicine technologists generally seeing a slightly greater role of AI over the next 10 years than radiographers (3.3 versus 3.0), although radiographers

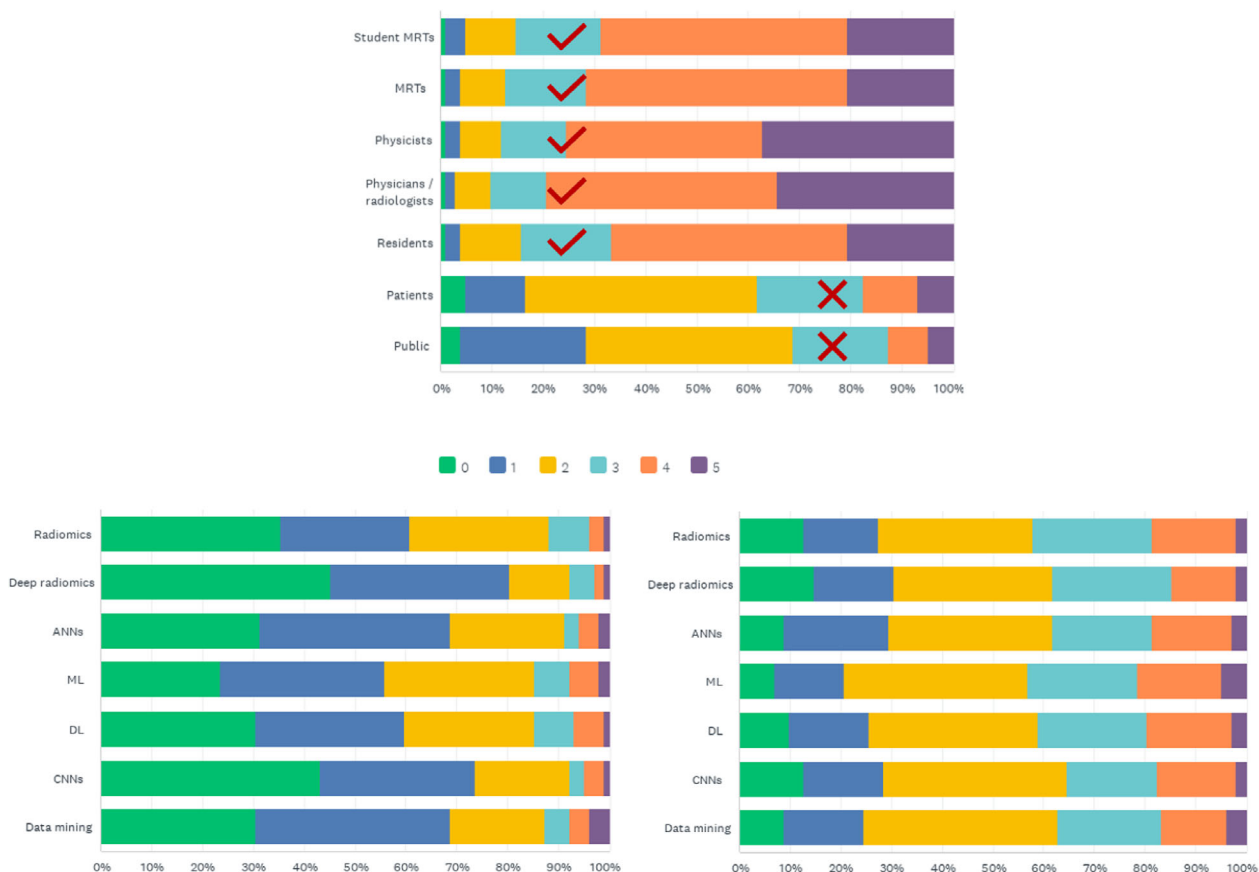


Figure 3. Top, how important AI education is for those in the pipeline. 0 = not important; 1 = minimal importance; 2 = some importance; 3 = important; 4 = very important; 5 = essential. Bottom left, how respondents ranked their own current understanding of AI. Bottom right, how respondents rated their desired understanding of AI. 0 = no understanding; 1 = minimal understanding; 2 = some insight; 3 = competent; 4 = proficient; 5 = expert. The red tick indicates those who respondents indicated priority for AI training and red crosses where there was lower priority.

tended to see specific rather than general applications. Conversely, radiographers had slightly greater concerns (2.7 versus 2.4) for AI implementation.

Discussion

The degree of automation respondents would consider in their own lives provided some interesting insights (Fig. 1). The control questions demonstrated a general lack of support for automation for higher order tasks (e.g. motor vehicle and aircraft) but a high degree of acceptance for mundane tasks (e.g. kitchen appliances). This might reflect concerns associated with safety but could reflect, in part, a preference for autonomy and / or control. This position is then reflected in the medical scenarios with support for lower order tasks (e.g. patient registration, triaging and medication dispensing) but less supportive of high order task automation (e.g. surgery and image interpretation). In Ireland, radiographers and

radiation therapists demonstrated resistance to AI for patient facing roles (confirming patient consent and identification, explanation of risks and benefits of examinations) and in final image interpretation.⁹ While safety is clearly an element of this preference, preferences also reflect autonomy of clinical responsibilities. This may reflect some concern about whether automation will lead to human redundancy. These contrasting views reflect previously published data that reported 64.2% of radiographers in Ghana are concerned about AI integration in medical imaging but 80.8% remain eager to embrace AI in their professional future.¹⁰ Interestingly, males generally were more receptive to the lower order, less career threatening tasks than females but for the higher order tasks there was closer gender agreement (Fig. 5).

Not surprisingly then, there was a perception that there is low priority for the role of AI in higher order tasks (e.g. diagnosis, prognosis, image interpretation and

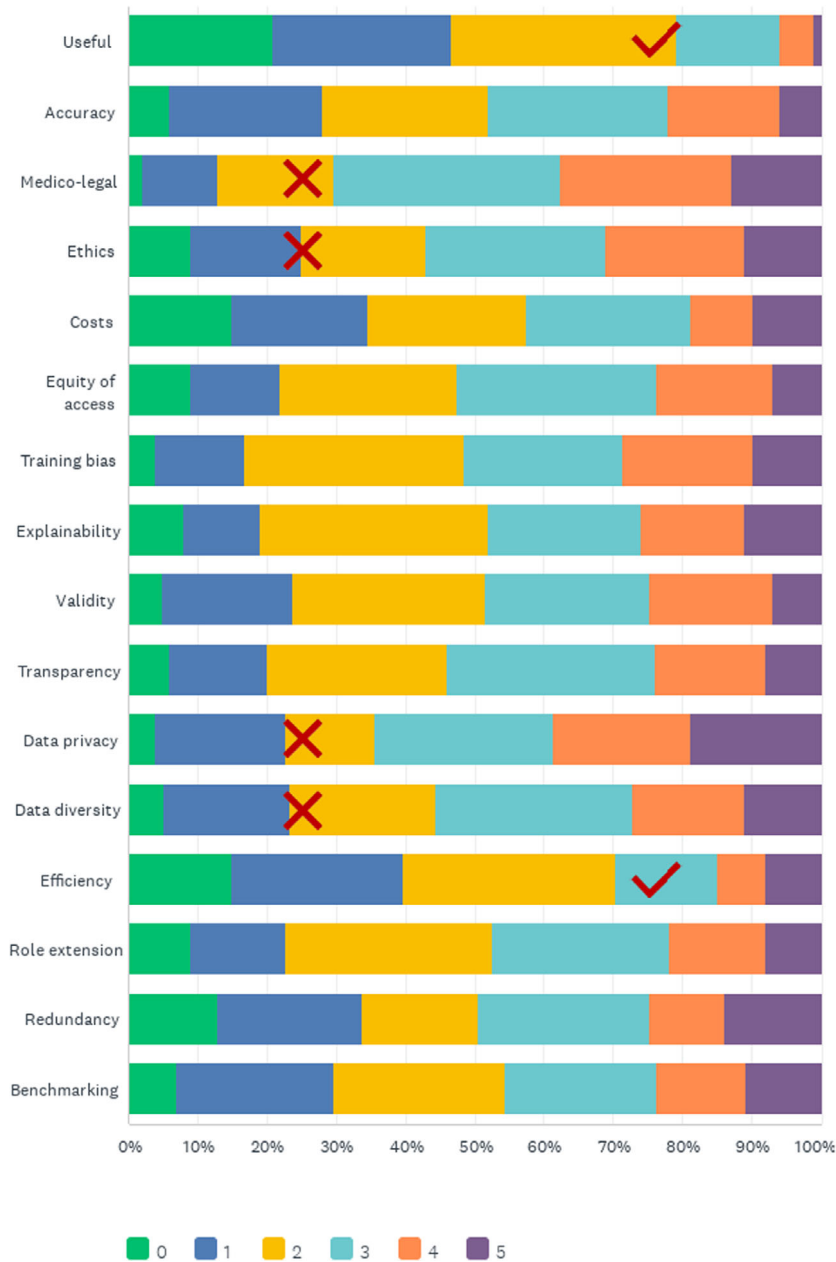


Figure 4. How respondents rated the extent of their concerns of AI. 0 = no concern; 1 = slight concern; 2 = mild concern; 3 = moderate concern; 4 = significant concern; 5 = extreme concern. The red tick indicates those variables where respondents indicated lower levels of concern about AI implementation and red crosses where there was high concern.

decision making) and high priority for those applications that automate complex but menial tasks (e.g. quantitation, segmentation, image reconstruction) or improve image quality (e.g. dose reduction, noise reduction and pseudo CT for attenuation correction). These findings are concordant with reports that 82.8% of radiographers feel AI would be an assistive tool to ease their workload¹⁰ and certainly the priority tasks identified

fit that scope. In another study, MRI technologists anticipated that AI could improve MRI protocol selection (91.8%), reduce the scan time (65.3%), and improve image post-processing (79.5%).¹¹

Perhaps the biggest barrier around AI in medical imaging at this juncture is the lack of education and understanding. The language itself is often misleading and AI is somewhat a misnomer with it being neither artificial

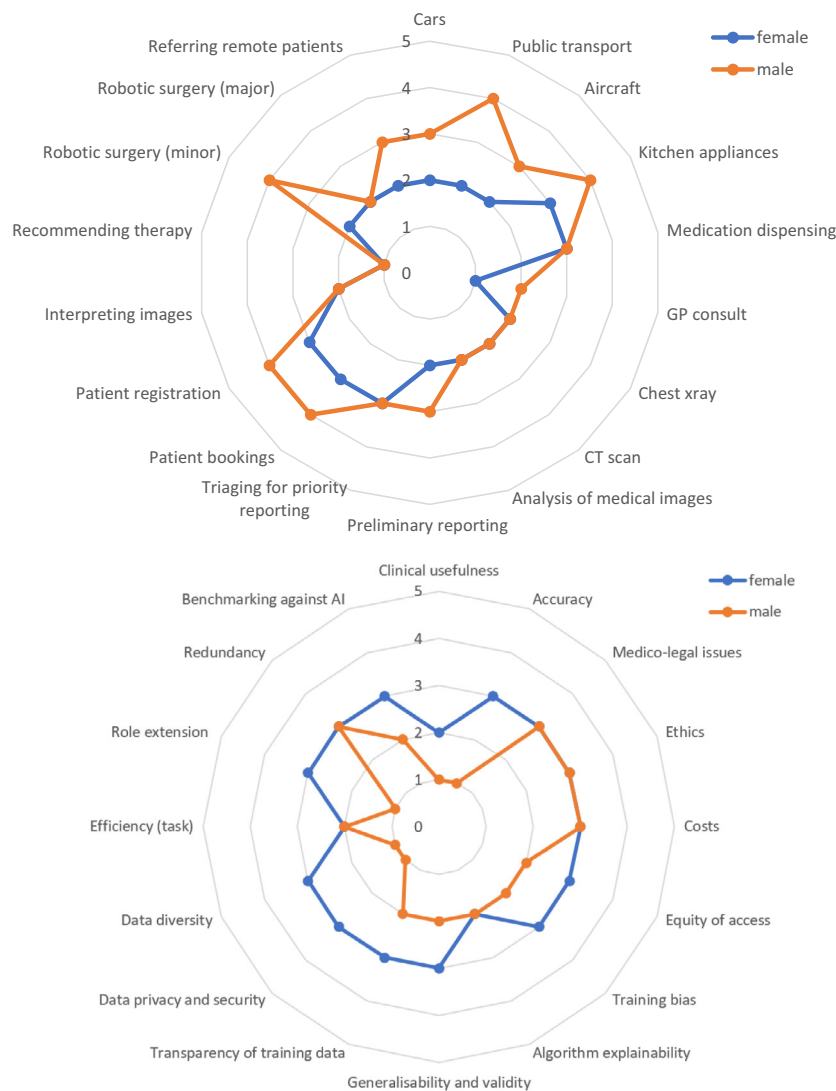


Figure 5. Top, radar plot of female versus male mode responses to willingness to have AI automate aspects of their lives. Bottom, radar plot of female versus male mode responses to concerns about AI implementation.

nor intelligent. Thus, expectations and understanding of what AI is often confusing. The use of machine learning, deep learning, expert systems and intelligent imaging certainly provide greater clarity for specific tools/applications, and perhaps there is scope to replace AI with a more intuitive term like “engineered learning”. In a survey of radiologists, more than 30% considered their AI knowledge below average with less than 5% considering it excellent.¹² For the nuclear medicine technologists and radiographer respondents in this survey, more than 60% of respondents reported lower than par understanding of AI (Fig. 3). While there was no change in respondents current understanding to their desired understanding of AI for those already expert, 40% of

respondents indicated that their desired level of understanding was competent or better. Several reports have highlighted the importance of AI education in increasing its use, optimisation and implementation among medical imaging practitioners.^{11,13,14} While AI education was broadly considered an essential part of the training of the medical imaging workforce, respondents were equally strong of the view that there is no need for patients or the general public to have that insight. Of course, some insight is required among patient groups in order to adequately gain informed consent.

There continue to be a number of concerns with respect to implementation of AI in medical imaging. As summarised in Figure 4, medico-legal, ethical, diversity

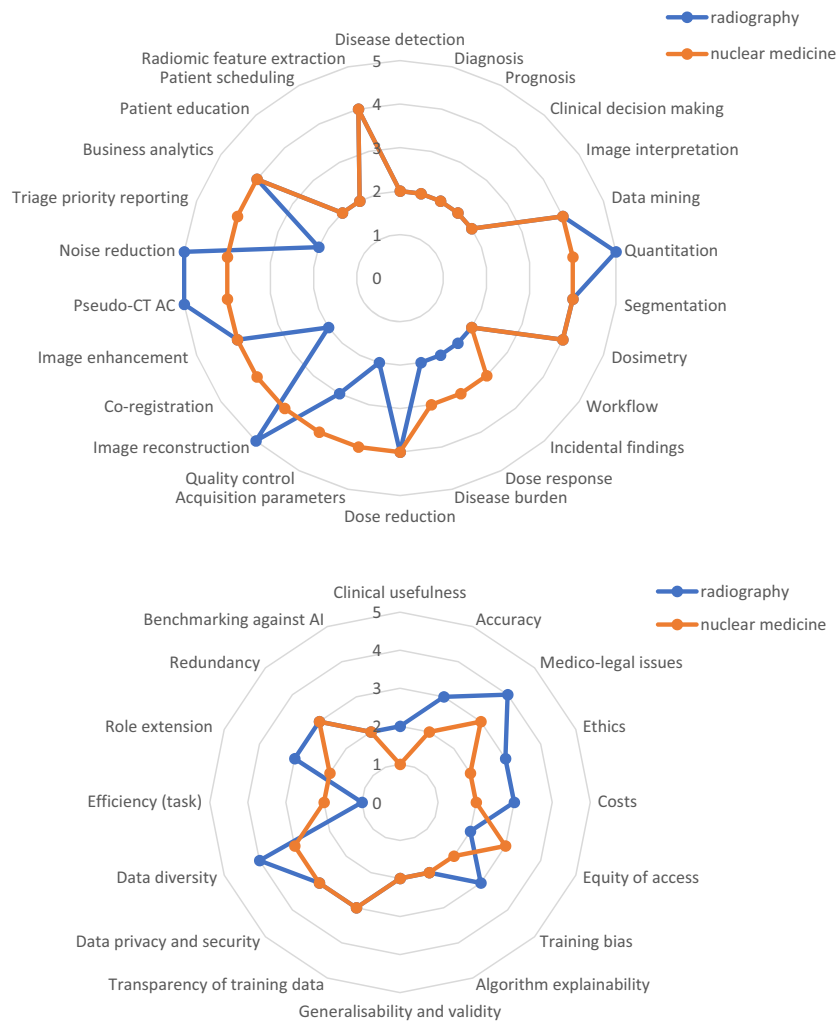


Figure 6. Top, radar plot of radiographer versus nuclear medicine technologist mode responses to opinions on the role AI will play over the next 10 years. Bottom, radar plot of radiographer versus nuclear medicine technologist mode responses to concerns about AI implementation.

and privacy issues posed moderate or higher concern while there appeared to be no concern regarding AI being clinically useful and improving efficiency. Considering mild concerns, redundancy, training bias, transparency and validity were all of concern. Interestingly and perhaps consistent with the previously discussed acceptance of lower order AI augmentation, males had lower levels of concerns than females excepting redundancy, medico-legal and ethical concerns (Fig. 6). Similarly, a survey of radiologists identified data diversity, data privacy, liability and transparency are primary concerns of AI in medical imaging although changes or work force needs (redundancy) was not identified as a concern.¹² Among radiographers, only 23.2% of respondents indicating role redundancy was an issue and 45.1% with privacy

concerns in the Ghana survey.¹⁰ A broader healthcare survey reported concern over privacy in AI among 80% of respondents and redundancy concerns due to AI by just 10% despite 79% feeling AI would be useful in their work function.¹⁵ Among radiographers, data security and role redundancy (job security) remain primary concerns with AI implementation.⁵ There are no definitive entity respondents identified as being responsible for developing appropriate use guidelines or liability resulting from error. While 70% put error responsibility on the developers and commercial vendors, almost 50% also attribute responsibility to the users. The risk of liability may limit AI adoption and, indeed, drive a model of standard care plus augmentation with a human in the loop selecting case by case when AI is integrated. Nearly

70% of respondents indicated AI should be integrated into existing software packages and another 16% integrated into existing image displays which may make it more difficult to determine when AI has contributed to an output. Nonetheless, only 15% of respondents indicated their clinical departments were ready for implementation of AI. Responses represent the neophyte stage of AI in medical imaging and a follow-up survey in several years would provide an interesting contrast.

The application of AI in radiography varies from nuclear medicine and, indeed, the rate of developments also varies. On one hand, AI has been a central part of the nuclear medicine landscape for decades without using that nomenclature. On the other hand, recent developments in deep learning algorithms have emerged more broadly and more rapidly in radiology than nuclear medicine. One might expect some variation in responses among radiographers and nuclear medicine technologists. There were no such differences with respect to receptiveness to AI automation in their own lives. There were, however, significant variations among the opinions of nuclear medicine technologists and radiographers on the role of higher order AI applications over the next 10 years (Fig. 6). This may reflect the relative importance of each of those advancements for application in each discipline. Generally, radiographers had higher levels of concern for data diversity, role extension, accuracy, medico-legal issues, ethics, training bias and costs (Fig. 6). These differences may reflect either increased radiographer experience with AI implementation or broader documentation of such issues in discipline specific journal publications and conference presentations.

There were a number of limitations of this study. The first was the poor response rate among the two professions. This is likely to reflect ambivalence resulting from the very early stage of development and lack of significant implementation of DL in the clinical environment. It may result in participation bias where respondents have increased investment or interest in the AI domain. The results do not reflect that with the majority of respondents self-assessing their level of understanding around AI as below par. Consequently, the results are considered to reflect a snapshot of actual industry perspectives. The radar analysis, while interesting, reflected the mode of responses for ordinal data and, thus, even with differences, does not reflect statistically significant trends. This is balanced by the reported analysis using statistical testing. While the data reflects an accurate snapshot of the perspectives of nuclear medicine technologists and radiographers in Australia at the time of data collection, it is recommended that the survey be repeated in 5 years (half way through the 10 year project role gleaned in the

survey) when a greater degree of clinical implementation of AI algorithms has taken place. Further, a focus group using a qualitative approach would benefit a richer understanding of the perspectives associated with both clinical implementation of AI in medical imaging and the concerns associated with that implementation.

Conclusion

Australian nuclear medicine technologists and radiographers recognise a number of important applications of AI for assisting with repetitive tasks, performing menial tasks and enhancing the quality of outputs in medical imaging. Concurrently, there is a heightened sense of concern relating to ethical aspects of algorithm development and implementation. While Australian radiographers, nuclear medicine technologists and their clinical departments, at this time, are not generally prepared for AI roll-out, there is an appetite to develop the requisite knowledge and skills for that preparedness.

Conflicts of Interest

There are no funding or conflicts of interest to declare.

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