Radiography xxx (xxxx) xxx

Contents lists available at ScienceDirect

Radiography

journal homepage: www.elsevier.com/locate/radi

Artificial intelligence: The opinions of radiographers and radiation therapists in Ireland

M.-L. Ryan [a, *], T. O'Donovan [b], J.P. McNulty [a]

[a] Radiography and Diagnostic Imaging, School of Medicine, University College Dublin, Ireland
[b] Discipline of Medical Imaging and Radiation Therapy, School of Clinical Therapies, University College Cork, Ireland

ARTICLE INFO

Article history:
Received 26 April 2021
Received in revised form
5 July 2021
Accepted 24 July 2021
Available online xxx

Keywords:
Artificial intelligence
Education
Medical imaging
Professional issues
Radiation therapists
Radiographers

ABSTRACT

Introduction: Implementation of Artificial Intelligence (AI) into medical imaging is much debated. Diagnostic Radiographers (DRs) and Radiation Therapists (RTTs) are at the forefront of this technological leap, thus an understanding of their views, in particular changes to their current roles, is key to safe, optimal implementation.
Methods: An online survey was designed, including themes: role changes, clinical priorities for AI, patient benefits, and education. It was distributed nationally in the Republic of Ireland via the national professional body, clinical management, and social media.
Results: 318 DRs and 77 RTTs participated. Priority areas for development included quality assurance, clinical audit, radiation dose optimisation, and improved workflow for DRs and treatment planning algorithm optimisation, clinical audit, and post processing for RTTs. There was resistance regarding AI use for patient facing roles and final image interpretation. 27.6% of DRs and 40.3% of RTTs currently use AI clinically and 46.1% of DRs and 41.2% of RTTs anticipate reduced staffing levels with AI. 64.9% of DRs and 70.6% of RTTs felt AI will be positive for patients, with the majority promoting AI regulation through national legislation. 86.1% of DRs and 94.0% of RTTs were favourable to AI implementation.
Conclusion: This research identifies priority AI development and implementation areas for DRs and RTTs. It thus highlights that DRs and RTTs should be involved in development of AI tools that would best support practice, and that clearly defined pathways for AI implementation into these key professions requires discussion so that optimum use and patient safety can ensue.
Implications for practice: Understanding opinions of AI has significant implications for practice, for ensuring optimal product development, implementation, and training, together with planning for potential DR and RTT role changes.

Introduction

Having adapted to substantial changes throughout their professional history, perhaps the most significant change is imminent for Diagnostic Radiographers (DRs) and Radiation Therapists (RTTs). Artificial Intelligence (AI) is set to change relationships between humans and their work, offering significant opportunity for medical imaging.[1] DRs and RTTs represent core groups affected by AI development. A paucity of evidence exists on their understanding and education in AI, together with their professional opinion on where AI developments are best focussed.

The International Society of Radiographers and Radiological Technologists (ISRRT) and the European Federation of Radiographer Societies (EFRS) provided a position statement on AI for the professions.[2] Guidance is provided in a number of areas, namely safe and optimal use of AI, education, and appropriate development of AI tools. Impact on the professions is expected - to date, the extent of this remains unknown and no clear strategy on engagement is

* Corresponding author.
E-mail addresses: marielouise.ryan@ucd.ie (M.-L. Ryan), theresa.odonovan@ucc.ie (T. O'Donovan), jonathan.mcnulty@ucd.ie (J.P. McNulty).
(M.-L. Ryan), (T. O'Donovan), (J.P. McNulty)

https://doi.org/10.1016/j.radi.2021.07.022

evident. The ISRRT and EFRS acknowledge that AI should enhance professional roles, but without ongoing engagement with DRs and RTTs, this may not happen optimally.

Botwe et al.[3] have explored this area in Ghana, and whilst a positive attitude towards AI is noted, there are concerns around job security, AI-related errors, and knowledge gaps. These apprehensions were also reported in a Canadian study investigating AI impact in radiation oncology.[4] These issues were somewhat echoed in an American Society of Radiologic Technologists (ASRT) survey, where most respondents had some trust issues with AI features but did not foresee impacts of staffing.[5]

Exploring these issues in a European context is key to safe, informed progression in this exciting field. This research focusses on Irish DRs and RTTs, which is noteworthy as Irish DRs and RTTs do not currently have advanced practice roles in place,[6] which may influence their opinions on AI development. The research aimed to develop a comprehensive understanding of Irish DR and RTT perspectives on AI in medical imaging, namely focussing on key areas that the ISRRT and the EFRS address-training, AI tool development and impact on professional practice.[2]

Methodology

A survey was developed which included 34 questions to ascertain quantitative and qualitative data. Survey development considered question structure, appropriate response choices and the arrangement of the survey. Open- and closed-ended questions were used. The survey was distributed using the online software Survey Monkey®. Bias is a pervasive problem in questionnaire design thus question wording was kept unambiguous and concise. Some technical jargon was used appropriate to the population. Leading and sensitive questions were avoided.[7] The study adhered to requirements of the authors' university ethics committee.

The survey was in seven sections: demographic data; current knowledge and interest in AI; AI applications in clinical use and areas for priority development; potential role impact; patient impact; AI development, regulation, testing and ethics; education in AI; future perspectives. To enhance validity, the authors used aspects of questions from similar which allowed for study comparison.[3,5] Further questions and answer choices were derived from extensive literature in AI technology and clinical use.[4,9–19]

The population were Irish DRs and RTTs. The survey was distributed via the national professional body, the Irish Institute of Radiography and Radiation Therapy (IIRRT), by advertising the study details to their members, together with direct requests to all services managers nationally (n = 76) and promotion through social media channels. A pilot was conducted with a sample of the population, where a 10-min completion time was estimated. DRs completed the survey over a four-week period in September 2020 and RTs over a two-week period in November 2020. Reminders were issued on social media posts only.

Descriptive statistics were employed to describe results of closed question. Open questions were coded through a thematic analysis to discover patterns and develop themes and to achieve a deeper understanding of the data.[8]

Results

Demographics

There were 395 respondents (Table 1). According to the March 2021 Irish CORU registration statistics, this represents 12.2% (318/2598) of registered DRs and 16.2% (77/476) of registered RTTs. Most respondents were aged between 25 and 35 years and distributions across job titles were similar between both groups (Fig. 1). DRs mainly worked in University Teaching Hospitals and RTTs in Private Teaching Hospitals (Fig. 1).

93.3% (n = 263) of DRs and 96.1% (73) of RTTs indicated they understood the term AI, however this was self-stated. Fig. 2 shows levels of agreement in terms of AI understanding in everyday life and awareness of AI applications in professional contexts.

Respondents were asked where they would prioritise AI development and where they feel AI is inappropriate. Highest ranked results are displayed in Table 2.

Areas suggested for AI development in open questions for DRs included referrer alerts for unexpected findings; alert system for patient specific issues (allergies, infection control etc); automated clinical indication selection; automated anatomy labelling; training; image quality analysis; improve efficiency of administrative processes; patient dose records; staff rostering based on skill mix. Suggestions by RTTs included combination of AI with 3D printing; training; improved efficiency of administrative processes; quantifying post treatment parameters of interest e.g. offline review - geometric uncertainties; automated treatment summary plans.

Respondents noted that AI is currently being used (Fig. 3). DR examples included voice recognition, radiation dose tracking, real-time remote vendor assistance, piloting automatic reporting (particularly for query stroke and lung nodules), automated protocol selection and post processing in CT and MRI, automated X-ray tube positioning. RTT examples included auto-contouring, dose optimisation in treatment planning and in CT, automatic image registration software for image guided radiation therapy (IGRT), motion management during treatment delivery, radiomics and quality assurance.

Respondents' opinion on potential professional role impact is displayed in Table 3.

Thematic analysis revealed the primary professional issues for DRs was concern that technical skills would be lost and the aspiration that AI should reinforce the DR role. Other areas noted were that DRs will always have a key role in patient care, that AI paves the way for role development in other areas but conversely, concern was noted that AI may negate the requirement for DRs reporting. These themes were reflected for the RTT profession, revealing RTTs will always play a primary role in patient care, concern about technical skills and the need for RTTs to use AI to complement their current role.

Anticipated impact on staffing levels is noted in Fig. 4. 46.9% of DRs and 38.2% of RTTs felt AI will create new specialised roles, whilst 33.6% of DRs and 45.6% of RTTs felt this should be subsumed into current roles.

Patient impact

A majority in both professions anticipated a positive impact on patients due to AI (64.9% for DR and 70.6% for RTT). Feelings on whether patients should choose whether AI is used as part of their examination or treatment is displayed in Fig. 5.

Development, regulation, testing, ethics

Opinions around ethics were varied – a majority felt they would have ethical concerns about AI implementation (47.6% for DR and 46.3% for RTT). Responses regarding responsibility for regulation are noted in Fig. 6.

77.5% of DRs and 76.1% of RTTs noted it was extremely important that the professions are involved in AI application development. 75.7% of DRs and 88.0% of RTTs had moderate or full trust in AI applications.

Table 1
Demographic detail of respondents.

	DR	RTT
Number of participants	318	77
Age Groups	**% (n)**	**% (n)**
under 25 years	10.8% (31)	21.1% (16)
25–34 years	37.5% (108)	44.7% (34)
35–44 years	31.6% (91)	25.0% (19)
45–54 years	14.6% (42)	9.2% (7)
55 years and older	5.6% (16)	0% (0)
Job Titles (respondents could select more than one answer)	**% (n)**	**% (n)**
Basic Grade Radiographer/Radiation Therapist	28.8% (83)	31.6% (24)
Senior Grade Radiographer/Senior Radiation Therapist	32.6% (94)	38.2% (29)
Clinical Specialist	23.3% (67)	22.4% (17)
Radiography Services Manager/Radiation Therapy Services Manager	10.1% (29)	6.6% (5)
Lecturer or Clinical Educator	4.5% (13)	2.6% (2)
Industry Specialist	1.7% (5)	0.0% (0)
Other	4.5% (13)	6.6% (5)
Years Qualified	**% (n)**	**% (n)**
5 years or less	18.7% (52)	37.3% (28)
6–10 years	18.3% (51)	20.0% (15)
11–15 years	18.7% (52)	18.7% (14)
16–20 years	16.9% (39)	13.3% (10)
21 years or more	27.3% (84)	10.7% (8)

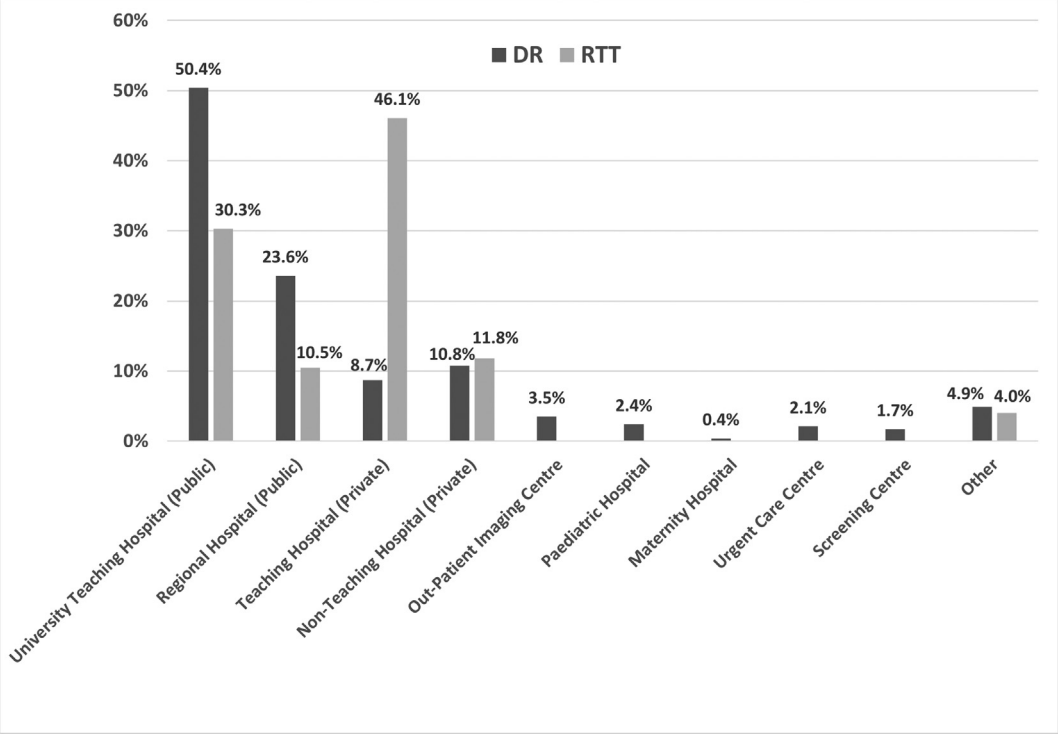

Figure 1. Place of work of the participating Diagnostic Radiographers (DR) and Radiation Therapists (RTT).

Education

19.6% of DRs and 28.36% of RTTs had completed formal education in AI (Table 4). 74.5% of DRs and 70.1% of RTTs were interested or very interested in learning about AI. Opinions on timing of education is in Fig. 7, with level of information recorded in Fig. 8.

Finally, the majority of both professions noted a 6–10 year (36.6% for DR and 44.7% for RTT) timeline for AI to be prominent in departments. 86.1% of DRs and 94.0% of RTTs were favourable or somewhat favourable to AI implementation.

Discussion

Unquestionably, AI will have a significant impact on medical imaging and radiation oncology, thus the importance of understanding current attitudes.[15] Consistent with medical imaging literature, there is a positive attitude towards AI implementation.[20] Whilst a majority self-stated awareness of AI in everyday life (89.7% for DRs; 90.7% for RTTs), less were informed on professional AI applications (75.2% for DRs; 68.4% for RTTs), perhaps because it is a reasonably new phenomenon in imaging and therapy, whereas has been prevalent in everyday life minimally for the last decade.

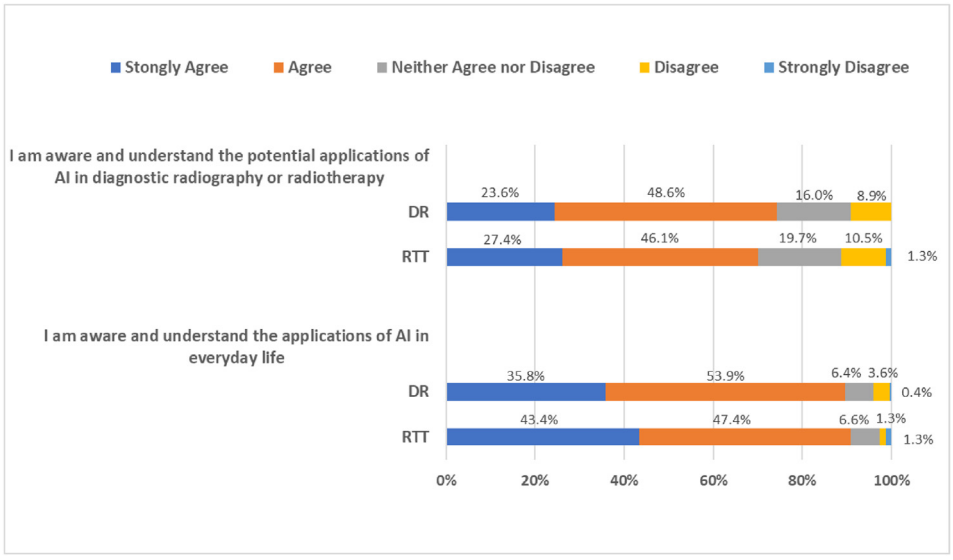

Figure 2. Level of agreement of participating Diagnostic Radiographers (DR) and Radiation Therapists (RTT) with their 'Understanding of AI in everyday life' and 'Awareness of AI in their professional contexts'.

Table 2
Areas identified by participants as AI development priority areas and areas identified where AI development is not appropriate.

Areas for priority AI development (highest ranked opinions)			
DR		RTT	
Priority Area	% Respondents	Priority Area	% Respondents
Automated quality assurance on equipment	67.1%	Treatment Planning: Optimisation Algorithms for treatment planning.	61.11%
Improved and faster automatic post processing in cross sectional imaging.	61.0%	Treatment Planning: Auto segmentation contouring tools for treatment planning.	56.94%
Automated clinical audit on areas such as radiation dose, image quality etc.	53.3%	Audit: Automated clinical audit on areas such as radiation dose, image quality etc.	50.00%
Radiation dose optimization, for example patient specific doses.	45.5%	Treatment: Real-time tumour motion estimation using respiratory surrogate via memory-based learning.	45.83%
Scheduling and streamlining of appointments.	43.9%	Pre-Treatment: Improved and faster automatic post processing in cross sectional imaging.	43.06%
		Treatment: Assisting in selection of "plan of the day" for adaptive RT.	43.06%
Areas where AI development is not appropriate (highest ranked opinions)			
DR		RTT	
Priority Area	% Respondents	Priority Area	% Respondents
Image interpretation for final patient results	48.40%	Treatment: AI applications for patient consent.	47.22%
Automated process for patient consent.	40.70%	Treatment: Automated process for confirming patient identification.	27.78%
Automated process for confirming patient identification.	38.60%	IGRT: Assistance in interpretation and clinical decision making- final result.	25.00%
Aid in explanation of risk/benefit of examinations to patients.	24.80%	Post-Treatment: Patient support: connecting new patients with previously treated patients who can provide insight into their experience.	25.00%
Clinical decision support tool for the appropriate justification of examinations	20.70%	IGRT: Assistance in interpretation and clinical decision making- immediate preliminary result.	16.67%

A thought-provoking point was the correlation between responses from both professions in most areas, which confirms a collective approach may be possible from the Irish professional body and education providers. This correlation has not been fully explored previously and thus requires further consideration.

Applications of AI

Both professions were not fully supportive of AI use for patient facing activities including confirming consent (40.6% of DRs and 47.2% of RTTs not supportive) and patient identification (38.6% of DRs and 27.8% of RTTs not supportive). This is not surprising, however literature has suggested other pre-examination roles that may use AI such as confirming clinical indications.[15]

To date, AI development has focussed on image interpretation.[15] A curious finding is that 48.4% of DRs and 25% of RTTs do not think AI is appropriate for final image interpretation. This is debated in the literature, where professional feeling is image interpretation should remain a human task[9] with AI supports such on workflow management as urgent exam prioritisation[9,13] which is echoed in medical students' and radiologists opinions.[16,21] One could suspect there is concern around AI affecting DR/RTT advanced practice, which is particularly interesting for this Irish population, who do not currently hold advanced practice roles. It could be argued that AI may facilitate advanced roles, by making simpler processes efficient. This is evident in radiation oncology literature where AI showed potential to improve efficiency along the radiotherapy pathway with the use of auto-contouring[22] (auto segmentation) of

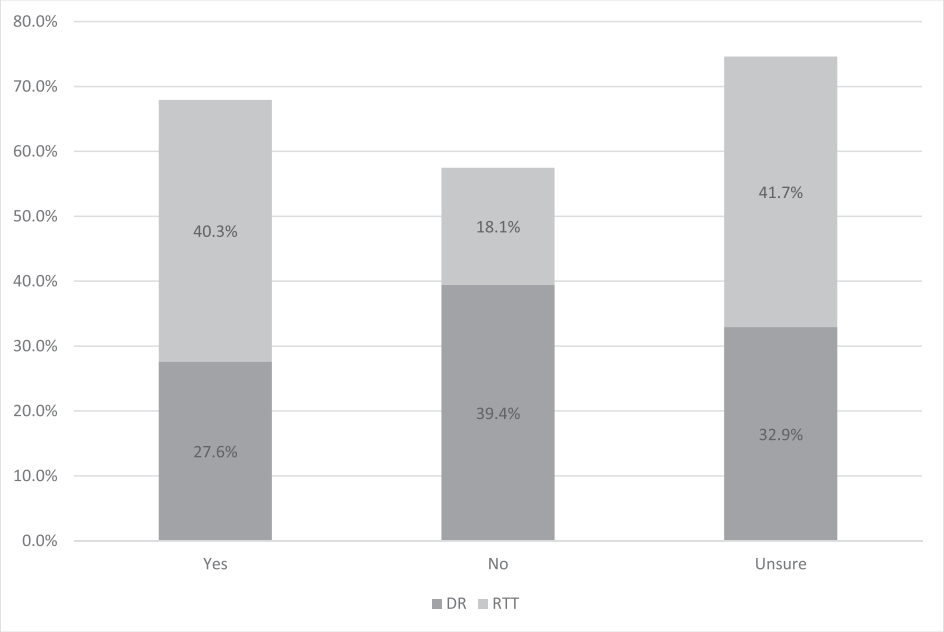

Figure 3. Current use of AI.

Table 3
Impact on the role of the diagnostic radiographer (DR) or radiation therapist (RTT).

With the implementation of AI …	Strongly Agree		Agree		Disagree		Strongly Disagree		Undecided	
	DR	RTT	DR	RTT	DR	RTT	DR	RTT	DR	RTT
Opportunity to redefine the radiographer's/radiation therapist role	24.6%	19.1%	40.5%	47.1%	9.1%	10.3%	1.7%	2.9%	24.1%	20.6%
Revolutionise radiography/radiation therapy practice	22.4%	25.0%	40.1%	51.5%	8.6%	2.9%	2.2%	0.0%	26.7%	20.6%
Enhance the quality of the service provided by the radiographer/radiation therapist	23.7%	25.0%	46.6%	54.4%	8.2%	2.9%	1.3%	1.5%	20.3%	16.2%
Provide an opportunity for more research	29.7%	42.7%	51.3%	44.1%	2.6%	1.5%	0.9%	0.0%	15.5%	11.8%
Reduce stress/burnout for radiographers/radiation therapists	19.8%	14.7%	24.6%	33.8%	16.0%	16.2%	3.5%	4.4%	36.2%	30.9%
Radiographers/Radiation Therapists could be completely replaced by machines	3.0%	4.4%	9.1%	11.8%	39.2%	30.9%	40.5%	45.6%	8.2%	7.4%
Impact the profession negatively dur to machine 'takeover'	17.7%	16.2%	28.5%	26.5%	24.1%	19.1%	3.0%	5.9%	26.7%	32.4%
Allow radiographers/radiation therapists to focus more on patient communication and less on technical aspects	7.8%	8.8%	41.4%	39.7%	19.4%	29.4%	5.2%	8.8%	26.3%	13.2%
Promote a poor perception of radiographers/radiation therapists due to help with machines	26.7%	20.6%	32.3%	26.5%	19.4%	23.5%	3.5%	14.7%	18.1%	14.7%
Result in reduced recruitment of radiographers/radiation therapists	19.8%	22.1%	32.3%	32.4%	22.4%	11.8%	4.3%	10.3%	21.1%	23.5%
No effect on the role of the radiographer/radiation therapist	2.2%	0.0%	3.9%	4.4%	38.8%	35.3%	38.8%	44.1%	16.4%	16.2%

organs at risk and knowledge-based treatment planning.[17,18] Work is required to ensure medical imaging professions are supportive of AI's role in image interpretation going forward, aligning with DRs and RTTs expectations of advanced practice.

Support for AI use in QA and clinical audit was evident. 95.9% of DRs and 80.6% of RTTs consider automated equipment QA a medium or high priority and 89.8% of DRs 88.9% of RTTs consider automated clinical audit a medium or high priority. This is clearly a potential focus for research and industry, however, is contradicted in literature which suggests radiologist time could be freed up by AI to support quality improvement.[14] Regular QA and clinical audit is time consuming, thus having automated processes and result generation could be a very appealing use of AI. Indeed, radiation dose optimization and audit are suggested as core functions where AI could prove useful.[2,9]

DR and RTT role

Internationally, there are discussions regarding possible changes in the DR/RTT role with AI implementation. The ISRRT and EFRS support this, by observing how the DR/RTT role could be enhanced, and patient care maximised.[2] From a UK perspective, Hardy and Harvey (2019) note that the discussion about the impact of AI on the radiographer's role has been quiet, but there is no doubt it will change.[15] Participants in an ASRT survey disagree that the DR/RTT role will shift with AI implementation, which contrasts with the current work and European perspective.[5] DR and RTT professional roles vary globally, therefore differing opinions are expected.

In this study, concern was evident that with increasing use of 'machines', negative perceptions could be drawn on the professions. Goldberg and Rosenkrantz (2018) reviewed the social media perspective, and a negative viewpoint was not apparent.[23] However, Copppola et al. (2020) noted that radiologists anticipate issues with poorer professional reputations.[16]

There was no strong agreement for a less technical role (41.4% agree/19.4% disagree for DRs; 39.7% agree/29.4% disagree for RTTs). In contradiction to responses on changing professional roles, a majority indicated that with AI implementation, staffing levels would reduce (46.1% for DRs; 41.2% for RTTs) and new specialised

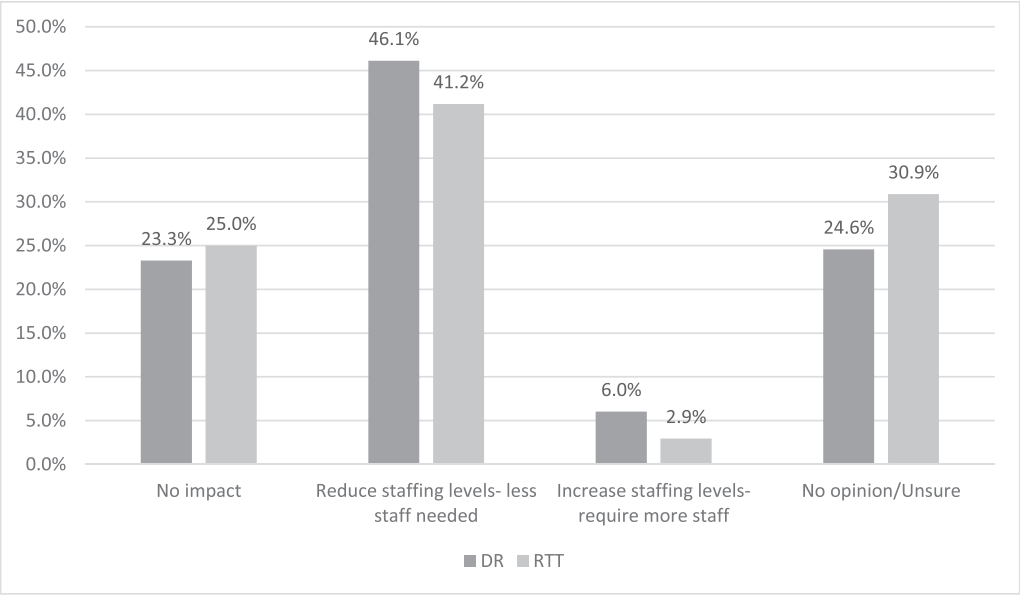

Figure 4. Anticipated impact on staffing levels.

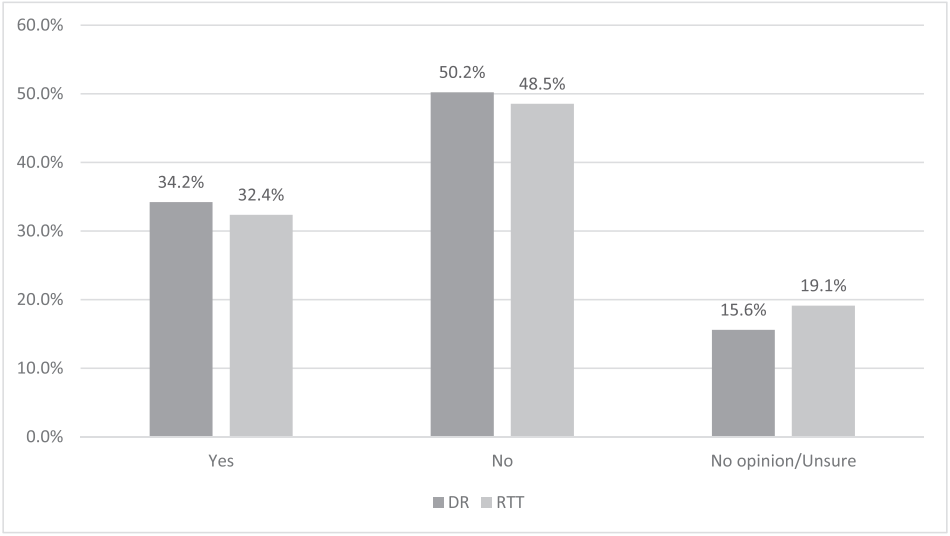

Figure 5. DR and RTT opinion on whether patients should have a choice on AI use as part of their examination.

roles would be required or integrated into current roles. Previous research noted radiologists did not anticipate changes in staffing levels, and roles may expand.[14,24]

A pertinent question is whether AI will take over DR and RTT roles entirely. Whilst unlikely, Hardy and Harvey (2019) address the issue in cross sectional imaging, where AI will likely help automate the DR role significantly, thus potentially reducing roles and responsibilities.[15] Conversely, the ISRRT and EFRS note potential exists for role expansion for the professions,[2] but how this is going to happen has not yet been mapped out and is becoming urgent as AI technology is beginning to filter into clinical departments (Fig. 3).

Impact of AI on the patient

65% of DRs and 70.6% of RTTs felt AI would be positive for patients. Most respondents felt patients should have no option as to whether their examination or procedure is fully or partly machine controlled. This seems rational, as a technical understanding is important for an informed choice. Currently patients do not have a choice around technology, but ethically is this important to review? Practical implications to support this would require consideration and engagement with patient advocacy groups is essential going forward.

Regulation of AI

A majority (94.7% for DRs; 100% for RTTs) felt it was extremely or moderately important to be involved in AI development. Responses to AI regulation were varied, with a majority favouring national legislation. This is mirrored by the ISRRT and EFRS who recommend lobbying for updated legislation to maximise AI benefits[19] and scope of practice consideration at national level.[2]

Key ethical issues are professional trust on data generated from technology, potential associated bias and patient privacy and

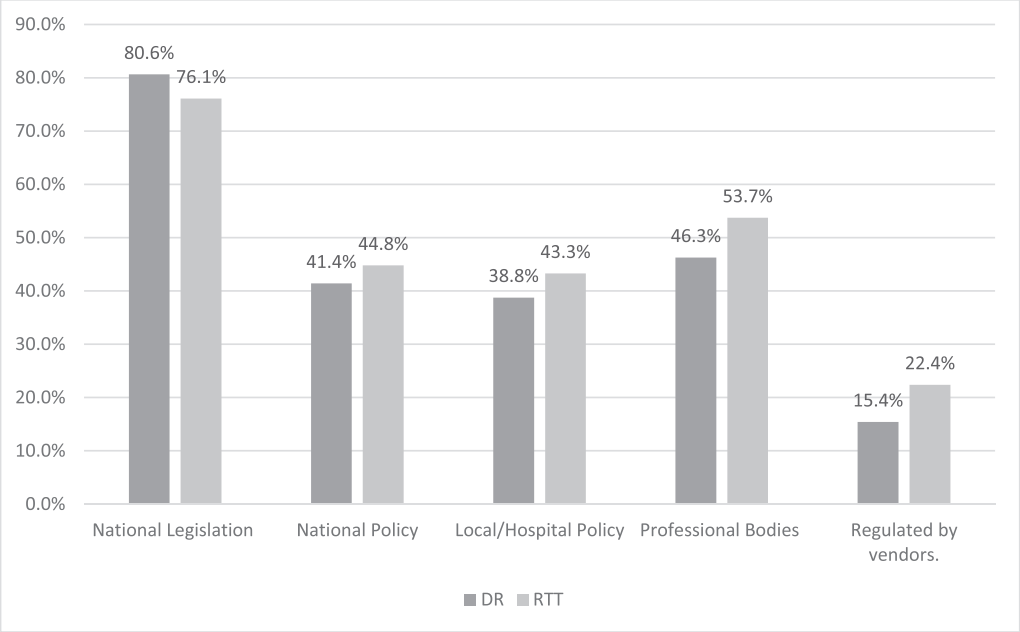

Figure 6. Responsibility for AI regulation.

Table 4
Type of training completed in AI.

	DR	RTT
Face to Face training	26.3%	24.5%
Online	26.3%	31.6%
Local hospital/in house training	26.3%	28.6%
CPD training	21.1%	27.6%
Postgraduate qualification	21.1%	39.8%
University/College education	42.1%	55.1%
Personal reading/online searching	47.4%	38.8%

confidentiality.[25] Indeed, overall responsibility for diagnosis is a significant medico-legal issue.[9] If AI does more technical work, as a profession, we need to confirm where responsibility lies.

Education

The European Society of Radiology (ESR) emphasise the importance of AI education, especially implementation into practice, in future training curricula.[9] The ISRRT and EFRS, and the European Society for Radiotherapy and Oncology (ESTRO), highlight that DRs

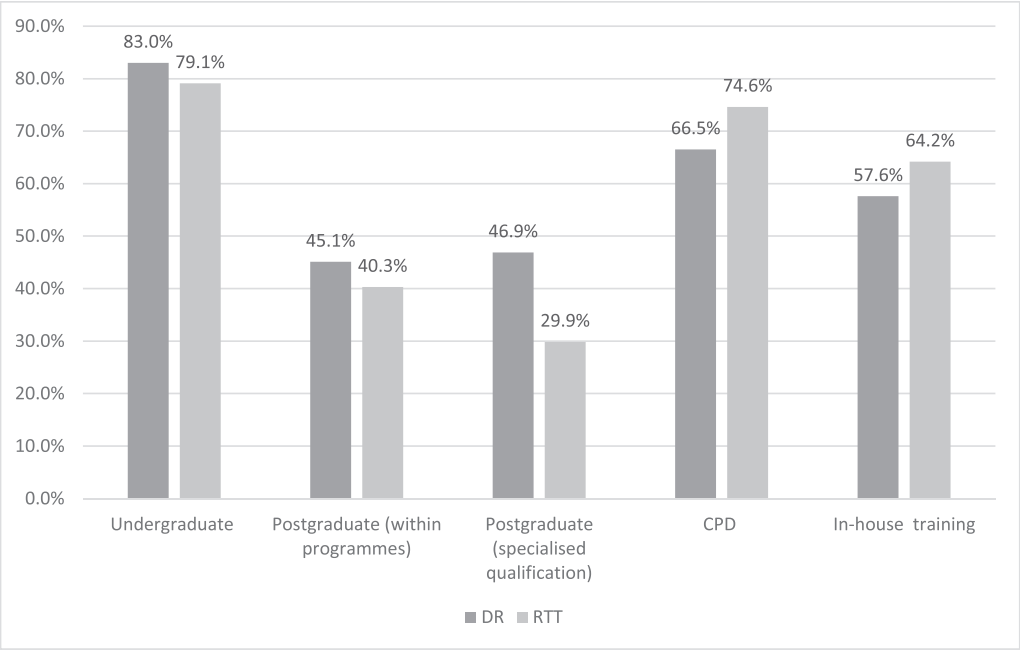

Figure 7. Timing of AI education for the professions.

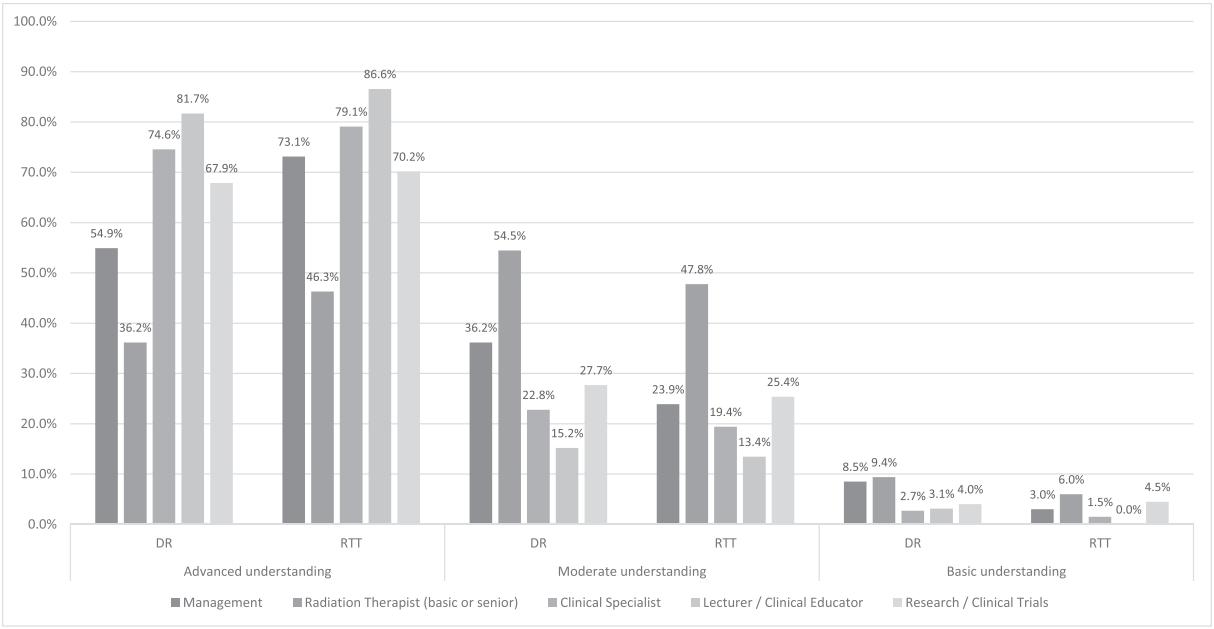

Figure 8. Level of information of AI by role.

and RTTs should be educated, with consideration at European Qualifications Framework Levels 6 and 7.[2,26] In this study, just 19.6% of DRs and 28.36% of RTTs had completed any kinds of formal education, confirming that AI education is in an embryonic stage.

There are upcoming challenges for educators to integrate AI learning into programmes for the wider medical community.[24,19] It is an acquired skill to learn collaborative working with AI driven semi-automated processes.[9]

Consistent with other studies, most respondents were interested in AI education,[4,22] although it is accepted that the respondents are likely those that have some appreciation of AI, resulting in potential bias. It is imperative to investigate the non-respondents who may not have an understanding and are perhaps more in need.

Conclusion

It is acutely important that this substantial advance in practice is controlled, planned, and executed to the highest quality. The evidence presented in this study shows an overall positive attitude to AI, with role specific priority areas for implementation and an urgent requirement for appropriate education. The AI industry is moving quickly, and this study highlights that the professions must prepare and adapt at the same speed. Ultimately, this is a time for movement and leadership, so AI acts as an enabler of best practice, efficient use of resources and clinical safety.

Conflict of interest statement

None to declare.

Acknowledgements

We thank all respondents who took the time to complete this survey.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.radi.2021.07.022.

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