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Radiation therapist perceptions on how artificial intelligence may affect their role and practice

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Abstract

Introduction: The use of artificial intelligence (AI) has increased in medical radiation science, with advanced computing and modelling. Considering radiation therapists (RTs) perceptions of how this may affect their role is imperative, as this will contribute to increasing the efficiency of implementation and improve service delivery. **Methods:** A peer-reviewed anonymous survey was developed and completed by 105 RTs between April and June 2021. The online survey was distributed via the Medical Radiation Practice Board of Australia and the Australian Society of Medical Imaging and Radiation Therapy newsletter as well as professional networks. The survey gained perceptions of the impact of AI on radiation therapy practice and RTs roles within Australia, and data were analysed using quantitative data analysis and thematic analysis. **Results:** Automation is used throughout radiation therapy practice, with 68% of RTs being optimistic about this. The majority (63%) had little to no knowledge of working with AI and 96% would like to learn more including the underpinnings of AI and its safe and ethical use. Many (66%) perceived AI would affect their role, including increasing their skillset and reducing mundane tasks, whereas others (23%) perceived it would reduce job satisfaction by increasing repetition and limiting their problem-solving ability. AI was perceived to impact the patient positively (67%), increasing efficiency and accuracy of radiotherapy treatments; however, it could depersonalise patient care. **Conclusion:** RTs perceive embracing AI in radiotherapy has the potential to advance the profession and improve the service to patients. If AI is implemented with sufficient training for greater understanding, and management uses these benefits to improve patient care, rather than replace RTs roles, then overall any negatives will be outweighed by the benefits.

Introduction

Chronic illnesses are a challenging burden, with an ageing population.[1] There were an estimated 151,000 cancer diagnoses in Australia in 2021, with 49,000 deaths.[2] Radiation therapy provides effective treatment for cancer, with 74,200 courses being delivered between 2018–19 within Australia alone,[3] highlighting that improvements to the radiation therapy service would be beneficial.

Artificial intelligence (AI) and machine learning (ML) algorithms can enable enhanced personalised treatments through automation easing the medical radiation professionals (MRPs') workload.[4] AI uses computerised systems performing tasks ordinarily carried out by humans and refers to the intelligence achieved by computer systems, falling into three subcategories including ML, representation learning (RL) and deep learning (DL).[5]

The term AI and automation are often used interchangeably with automation referring to computers doing a task without human intervention using data fed into a system. AI takes the use of complex algorithms to a new level allowing computers to learn without explicit programming through automatic extraction and analysis of complex data.[5] AI is increasingly utilised in medical radiation science (MRS) with advanced computing and modelling,[4] supporting advancements in treatment decision making,[6] adaptive radiotherapy (ART),[7] treatment workflows and quality assurance (QA).[6,8]

Artificial intelligence can improve clinical decision support through ML-enhanced treatment prediction outcome models,[4] providing evidence-based, outcome-orientated treatment pathways for patients. AI can improve safety and quality in CT simulation by predicting tumour motion[4] and improving image registration via improved computational efficiency[6] and treatment planning. Standardising treatment planning using ML algorithms enables plans to be produced based on the predicted attributes of historical plans, improving efficiency.[4,6] Further treatment planning improvements include ML algorithms automating organ segmentation by analysing images and providing a likelihood segmentation map, which speeds up the segmentation process.[7] This reduces the bottleneck in the treatment workflow, increasing time for human interaction and efficient treatment delivery.[9] AI is also used in multiple aspects of quality assurance (QA)[7] where there are various combinations being adapted striving for 'machine-creates and machine-verifies' workflows.[4]

Artificial intelligence can improve consistency and quality, moving radiation therapists (RTs') attention away from manual tasks to developing and evaluating radiation treatments,[9,10] which still require human intervention.[4] The introduction of AI has not come without challenges, with AI being considered a 'black box'. Anxiety exists around how AI may impact job roles, including AI displacing roles[10,11] or 'dumbing down' the workforce, reducing RTs' ability to problem solve, impacting patient safety and quality treatment delivery.[12] Concerns have been raised about job security, job satisfaction and loss of skills[13] as well as organisation disruption.[11,13]

Little evidence exists about AI and the perceptions of RTs' and the support needed for safe use of these technologies. This must be explored to realise the full potential of AI and to develop strategies for implementation, education and training for the current and future RT workforce. The aim of this study was to survey Australian RTs' perceptions on how AI may affect their role and the service they deliver to patients.

Materials and Methods

Study design

A pragmatic decision was made to use an online survey for all participants to maximise the population reach, reducing bias and increasing internal validity.[14] Development of the questionnaire drew on a scoping literature review and was discussed with RT experts, ensuring questions were appropriate; important in self-generated research.[15,16] The survey was piloted by three MRS experts, with feedback acted upon, providing a degree of face and content validity,[17] increasing the opportunity for meaningful answers, to expand the depth of the research.[18]

Carefully considered questions aided accurate encoding of the survey, guarding against miscommunication.[15,16] A direct structured questioning strategy was brief, relevant, unambiguous, specific and objective aiming to gain quantifiable and generalisable answers.[15–17] Close-ended and open-ended questions collected qualitative data in sufficient quantity, adapting a triangulation methodological strategy.[18] Concurrent method triangulation combining overview and insight questions enabled participants to expand and contextualise responses, gaining rich data,[19] resulting in well-validated, substantiated findings.[18,20]

Study population and sampling

This study was approved by the Sheffield Hallam University Human Ethics Committee (SHU Ethics/MC/310321). Intrusions on privacy were minimised with survey questions designed so participants were not identifiable through their responses aiding anonymity and confidentiality. This is important as radiation therapy is a small profession

A participant information sheet (see supplementary file S1: Participant Information Sheet.docx) provided clear information on expectations prior to completing the questionnaire (see supplementary file S2: Questionnaire.docx). Consent was gained in question one of the questionnaire and participants could close the questionnaire without submitting if they no longer wished to participate. Direct participant quotes are available to view in supplementary file S3 Direct quotes.docx for transparency.

The selection criteria for participants in the survey included Australian RTs' who currently perform RT practice in clinical sites and consented to completing the survey. By targeting RT networks, the sample was homogeneous in terms of a shared profession, yet heterogeneous in demographics, skill level and perceptions of AI.

Multiple methods of recruitment included an online survey link via the Medical Radiation Practice Board of Australia (MRPBA) and the Australian Society of Medical Imaging and Radiation Therapy (ASMIRT) newsletter. Participants were also recruited via professional networks, and a snowball strategy through Medical Radiation

Australia, the Australian Chief RT's group and the Australian Radiation Therapy Clinical Educators group on social media.

With a 95% confidence interval and 5% margin of error, the total sample size required for this study was 336, which would allow robust conclusions to be drawn. The sample was drawn from the total population of 2625, Australian registered RTs'[21] between April and June 2021. The study recorded 105 responses, which is lower than the estimated sample size, thus it increased the margin of error. The low response rate (31%) means that the results may not include all perspectives from practicing RTs'.

Data analysis

Quantitative data were analysed using Microsoft Excel v2109 (Microsoft Corp, Redmond, US) and expressed in percentages, charts and tables. Qualitative open-ended questions were coded in NVivo-12 software (QSR International, Melbourne, Australia) and analysed using reflexive thematic analysis (TA).[22]

TA was conducted in six phases by a single member of the research team (JO)[22] to identify main themes within the data, based on relevance to the research question and represented a patterned response, useful when analysing perceptions[23] providing a broader understanding of the context.[24] These included familiarising oneself with the data, generating codes, searching for themes, reviewing themes, defining and naming themes and then producing a report.[22] The TA was reviewed independently by a second member of the research team (MC), which improved the dependability and rigour of the coded data.

Results

Demographic information

All 105 RTs' who participated completed the survey, with the majority (65%) having >11 years clinical experience and proficient in multiple RT tasks presented in Table 1.

The data were organised into multiple codes, generating key themes, which were displayed in Figure 1.

Theme 1: AI implementation

Results demonstrated that automation is used in image reconstruction (59%) and fusion (61%), organs at risk (OAR) contouring (50%), plan set-up (27%), plan optimisation (49%), plan evaluation (25%), QA (20%) and image match analysis (50%), with the most manual task being target contouring.

Table 1. Participant demographics (n = 105).

Demographic	Frequency	Percent (%)
Gender		
Male	23	22
Female	81	77
Self-describe	1	1
		100
Years Practicing		
<5	19	18
5–10	18	17
11–20	35	33.5
>20	33	31.5
		100
Role		
RT	50	47
Senior RT	28	27
Management	15	14
Academic	7	7
Other	5	5
		100
Area of proficiency†		
CT Simulation	90	87
CT Fusion/Contouring	75	72
Dosimetry	82	79
Treatment	99	95
QA	73	70
Other	15	14
Skipped	1	1
Region distribution†		
Australian Capital Territory	2	2
New South Wales	28	27
Northern Territory	0	0
Queensland	23	22
South Australia	2	2
Tasmania	7	7
Victoria	10	10
Western Australia	39	37

†Participants may have responded with more than one answer.

Participants were optimistic about AI use (68%), attributed to increased safety, quality, efficiency and service improvement with one participant stating.

> *Radiation therapy is becoming increasingly complex. Without AI we will not be able to continue to improve the service, without becoming unproductive.* (82)

Few participants showed apprehension towards AI (7%) due to the fear of the unknown, ethical implications, increased expectations, safety issues, a lack of understanding and loss of skills, with 25% of participants having neutral feelings.

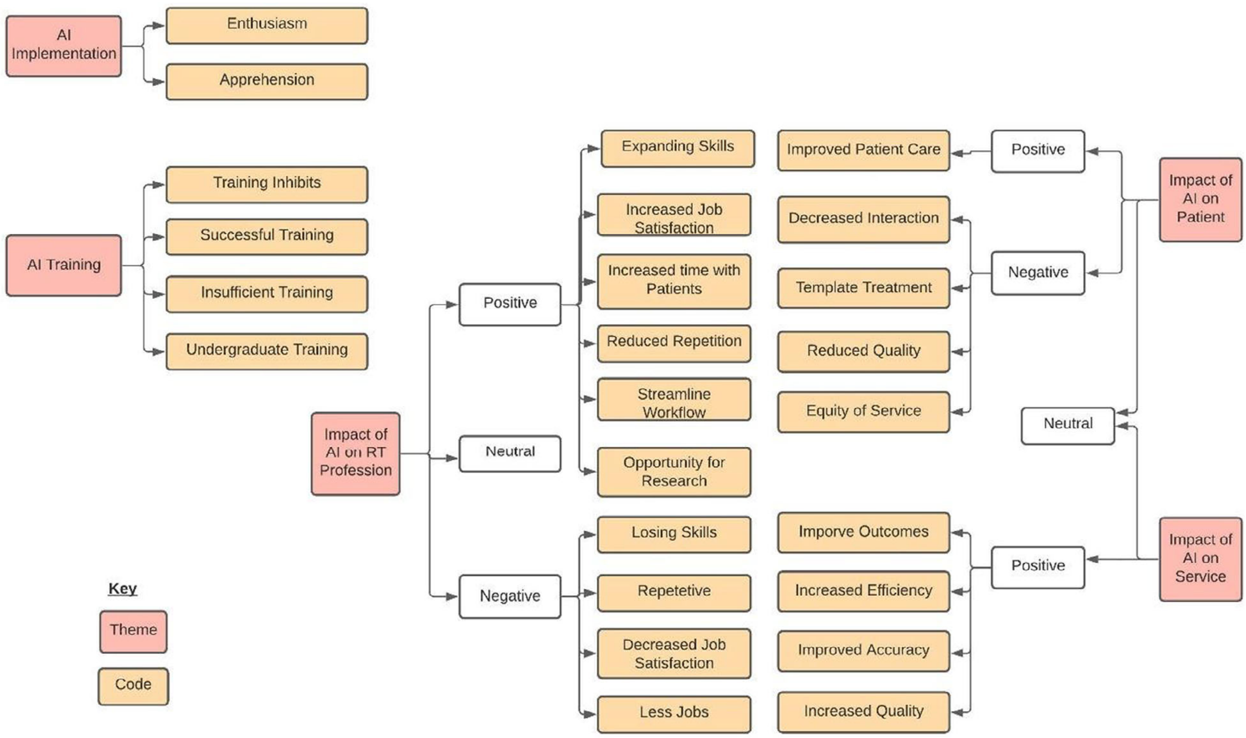

Figure 1. Thematic analysis map.

> *The potential is great; however, it is dependent on its implementation, scope of use and how trustworthy the results will be, the old adage of 'shit in, shit out' comes to mind.* (17)

Theme 2: AI knowledge and training

Knowledge

AI knowledge was limited amongst most participants (63%) (Fig. 2.), with 18% gaining this knowledge through university or work-based training (Fig. 3.).

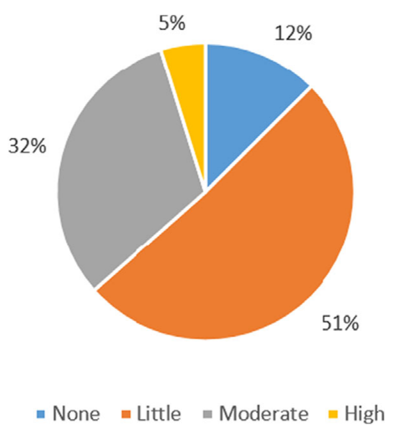

Figure 2. Level of knowledge that RTs had of AI in percentages (n = 105).

Some participants (27%) perceived sufficient training had been provided for safe and efficient AI use and 96% desired to know more, with one participant stating.

> *I said "no" but I'd be willing to learn more if the training wasn't too complex avoiding IT-language.* (50)

RTs' would like to learn more about clinical applications (95%), ethical implications (60%) and the

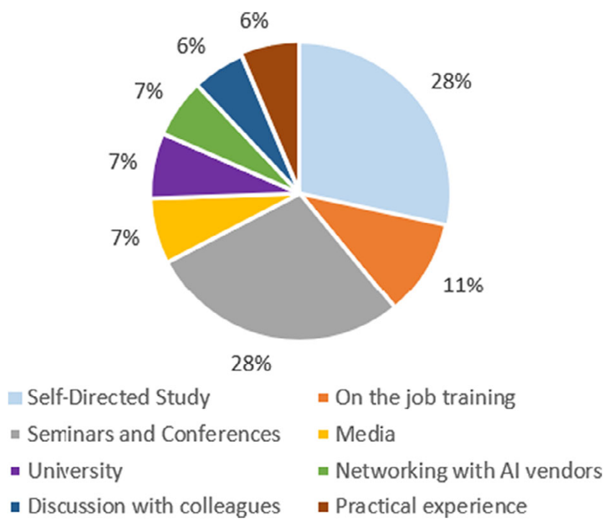

Figure 3. How participants gained their AI knowledge (n = 105).

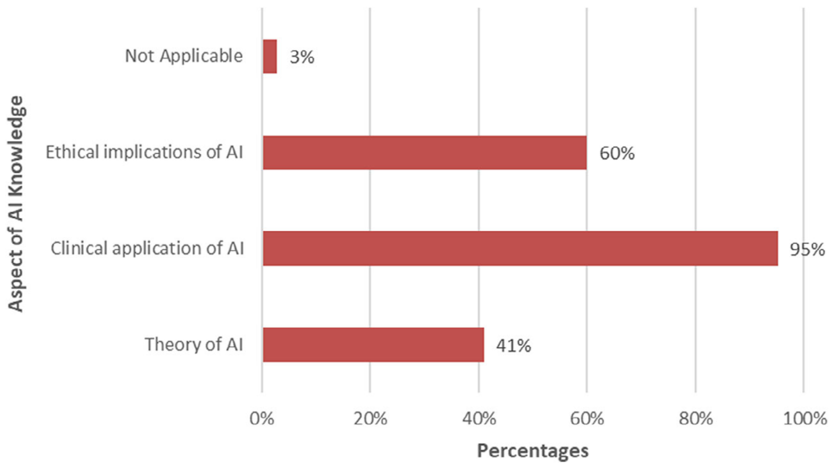

Figure 4. Aspect of AI, RTs would like to learn more about.

theory of AI (41%) (Fig. 4.), via online workshops, self-paced online material and face-to-face workshops.

A selection of what aspect of AI, RTs' would like to learn more include;

Building AI tools

> *The limitations of AI; what it could one day achieve, and what it would never achieve.* (24).

Regulators/ethics/safety

> *Ethics of allowing computer-based technology to adapt decision making techniques.* (55).

Application of AI

> *I like to be hands-on with my learning, so the application of AI is more interesting.* (4)

AI training

Participants commented a lack of time and resources inhibits training opportunities and whilst training may have been given, this does not guarantee competency. Participants suggest training should include the underpinnings of AI, safe use of AI, maintenance of algorithms and troubleshooting skills with associated competency packages.

Theme 3: Impact of AI on RT profession

Participants perceived that AI increases productivity more so than quality in most radiation therapy tasks (Table 2).

RT roles

Many participants (66%) perceived AI would affect their role, with 12% stating it would not and 22% were unsure. Participants stated AI would increase their skillset, providing opportunities for staff, patients and the radiotherapy service by implementation of daily ART, and

Table 2. Effect of AI on productivity and quality of common RT task (n = 105).

Radiation therapist task	Decreased quality (%)	Decreased productivity (%)	No change in quality (%)	No Change in productivity (%)	Increased quality (%)	Increased productivity (%)
Registration and reconstruction	0	0	26	22	63	69
Image fusion	0	1	26	22	63	67
OAR contouring	9	4	36	20	46	66
Target contouring	1	0	45	39	14	24
Plan set-up	3	0	41	22	39	64
Plan optimisation	6	0	26	10	54	77

advancing the profession. RTs' perceived AI would free up critical thinking time, increasing job satisfaction whilst reducing mundane tasks and with good management, time gained could be used for patient-facing tasks, research or continued professional development.

> *I believe it will decrease repetitive tasks allowing more time spent on training and advancing practice.* (105)

Others perceived RTs' would lose their clinical reasoning skills, to become 'button pushers' or QA computer operators, unable to detect errors and use professional judgement. Participants (23%) stated AI could lead to reduced job satisfaction, job security and could devalue experienced staff.

> *The quality is not the same as human intervention.* (99)

Neutral perceptions stated RT roles will adapt, attracting different people to the profession. AI has the potential if implemented successfully, to improve care, highlighting the need for a strategic implementation process, ensuring AI is not used to 'cut corners' making it inferior to current practices.

> *I believe implementation of AI will result in changes to current roles to adapt to new technology.* (61)

Theme 4: Impact of AI on the patient

Some (67%) perceived AI would improve the treatment pathway for patients, as RTs' can focus on patients or develop supportive roles. Others (5%) believed AI will have a negative impact on the patient; decreasing interaction with RTs', and patient service will become a people conveyor belt, with templated treatments and less personalised plans, decreasing service quality, whereas 28% had mixed feelings.

Theme 5: Impact of AI on service

Many participants (67%) stated AI would positively impact the service by improving outcomes (21%), increasing efficiency (40%), improving accuracy (11%) and quality (9%). Treatments are increasingly complex with technological advancements, and if carried out manually would limit availability. Several (60%) perceived AI could improve consistency, quality and efficiency, while decreasing human error, positively impacting the patient, the RT and the service.

The success of AI depends on its implementation, with participants stating if AI is safely implemented, it can benefit patients and increase precision. Research such as this, will aid in the implementation process, so perceptions of RTs' can be heard and hopefully acted upon, ultimately improving the service to patients.

Discussion

This study explored RT perceptions on how AI may affect their role. 105 RTs' completed this research with 77% female, comparable to the MRPBA registrant data (68.4%),[21] demonstrating a representative gender ratio was collected. Participants recruited had significant clinical experience, similar to a prospective cohort study carried out by Batumalai et al.[13] who examined radiation oncology professionals perceptions of automation in radiotherapy planning, whereby participants highlighted the need for continued education to ensure knowledge is not lost with automation, similar to this current study.

Most RTs' practicing in Australia are enthusiastic about AI use. Support and training are desired to reduce apprehension as AI is increasingly utilised. Training would preferably be via online workshops and self-paced material, including the underpinnings of AI, safe use of it, maintenance of algorithms, and how to effectively troubleshoot AI creations.

RTs' had mixed feelings on how AI may change their role and the impact it has on the patient and service. The perceptions of RTs' in this study provide a useful insight into the use of AI in radiation therapy, and how it may affect their role, with many RTs' using AI in practice alongside manual intervention.

Most participants (63%) had limited AI knowledge with many enthusiastic about learning more (96%), as they perceived AI would affect their role (66%). Confusion exists between AI and automation definitions amongst participants, with 63.5% of RTs' having limited or no knowledge of AI, despite using AI daily, potentially limiting its application to practice due to a lack of understanding. This highlights a need for improved education on AI use and its application in radiation therapy. These results were similar to Batumalai et al's[13] findings, whereby 24% of their MRS participants felt training and education in their department was sufficient, with the remaining 76% undecided or required further training, which is comparable to 63% of RT participants in this study having limited understanding. This further demonstrates a need for RTs' to gain underpinning knowledge of AI and its application, so advancement could develop faster. A potential theory of why confusion exists amongst RTs' could be because RT departments lacked transparency implementing new software 'behind the scenes,' limiting RTs' knowledge to day-to-day use only, preventing a depth of understanding and potentially limiting the scope of AI use in practice.

Most participants (96%) would like to learn more about AI, specifically clinical application, ethical implications and the theory of AI. This is supported by Chamunyonga et al.[6] in their review on considerations for future radiotherapy curriculum enhancement. Chamunyonga et al.[6] found effective training must include ongoing maintenance of algorithms, alongside, multi-disciplinary care and research, complemented with competency packages. This is further supported in a review paper by Vanderwinckele et al.[25] who looked at AI applications in radiotherapy and suggested recommendations for practice. They stated a multi-disciplinary team must have basic knowledge of AI, knowing the strengths and limitations, enabling safe implementation of AI models,[24] thus supporting what depth of knowledge would be useful to the participants in this study.

RTs would prefer AI training to avoid 'IT language', although, collaborative training would be beneficial including AI experts, researchers, software companies, radiation oncologists, RTs' and radiation oncology medical physicists (ROMP),[11] which was supported further by Chamunyonga et al.[6] who found RTs' or ROMPs' would be the preferred facilitators. French and Chen[26] concur in their invited commentary on preparing for AI, stating collaboration for training should occur across computer science and data analytics domains. Considering the results in this and other research discussed,[6,11,28] an ideal training programme would incorporate a multi-disciplinary collaborative approach. Concepts raised in this and previous studies,[6,9,10,11,13,25] align with the MRPBA[27] professional capabilities, which underpin the RT role. This highlights ethical implications, clinical applications and theory of AI would be imperative to include in a multi-disciplinary training programme.

The need for AI knowledge to be improved amongst RTs' is important with AI being increasingly utilised and, therefore, potentially affecting the role of the RT. The MRPBA recognise this in their position statement on AI, acknowledging that AI will be a significant element to the future of the MRS professions.[27] Many participants (66%) in this study believe AI will affect their role as was found in a study by Batumalai et al.[13] (83%). By using AI to its full potential, administrative tasks can be reduced and mundane processes automated, increasing efficiency[10,26] and job satisfaction, potentially leading to a shift in roles, 'making fuller use of RTs' scope of practice'.[10] Nevertheless, concerns were raised that AI will make the job repetitive and boring, and RTs' will 'become button pushers', consistent with Batumalai et al.'s[13] findings. However, some participants in this study felt AI would not affect the equilibrium of the RT profession, as roles will adapt, and RTs' will embrace AI to improve care. This perception would be beneficial to all as there is a greater demand on healthcare[26] with people living longer and more successful treatments. The workforce must become more efficient,[26] which is pertinent to keep up with the demand on the healthcare system and continue to improve the patients experience and safety.[28]

Many perceived AI would affect the patient's radiotherapy service positively (67%), with some having a contrasting view (5%) and 28% having mixed feelings. Participants believed AI should enable RTs' to deliver the best care to patients more easily; however, some perceive AI can decrease treatment quality. With improved efficiency by utilising AI applications further, specialised pathways could be implemented, and supportive roles developed. This could improve patient care and potentially increase the overall quality of service. Some perceived AI would have a neutral effect on the patient and service. If used appropriately, AI has many advantages to reduce the time from planning to treatment, highlighting the necessary quality and safety of the implementation process potentially enhancing the profession, not replacing it,[11,28] highlighting the need for improved AI knowledge and understanding with further exploration required.

RTs' as 'communicators and collaborators'[26] put patients' needs first with RTs' duties balanced between the technical and patient contact aspects of the profession. Maintaining this balance is a hallmark of the MRS profession,[26,27] with a need for the indispensable element of human support. The findings within this study support the need for a balance to be maintained, whilst further improving knowledge and increasing implementation of AI driven tasks to improve the service.

AI implementation and acceptance in practice could be improved with collaboration between RTs', industry experts and academics so the next breakthrough in RT advancement has the potential to be developed. It is imperative for the MRS profession to collaborate and improve their knowledge, so it can improve the quality of RT tasks at the same rate as the productivity. Change is upon us, and adaptation is required,[6] RTs' who prepare for and accept this change may prosper, career-wise, whereas those that do not could limit the opportunities AI could provide.[29]

Limitations

Some limitations are apparent in this study, with the main one being the sample size. A confidence interval of 95% with a 9% margin of error was achieved with a sample size of 105. This low response rate (31%) may limit the generalisability; however, data collected from those RTs' had great depth and quality, which is not so easily measured with statistics. The response rate may have been improved if it was conducted outside the COVID-19 pandemic, or if the survey completion timeframe was longer.

Another limitation was a slight overuse of open-ended questions, which made responses harder to analyse, due to the mass of responses and analysis required. Although time-consuming to analyse, this did expand the scope of this research, so considering this a limitation could be contradicted. Some of the open-ended questions could have been changed to Likert-type responses, which would have been quicker to interpret, although may not have gained the same level of depth of understanding. Enabling participants to provide their email addresses could have provided increased opportunity for follow-up. By not collecting correspondence information limited this opportunity and was another limitation of this study, which should be considered in future studies.

Conclusion

In conclusion, RTs' perceive embracing AI in radiotherapy could potentially advance the profession and improve the service to patients, changing the RT role and not replacing it. They perceive these benefits will outweigh the negatives, if AI is implemented with sufficient training, to enable RTs' to greater understand the potential benefits of AI, and management use these benefits to improve patient care rather than replace RT roles, so the quality of patients treatment can be improved at the same rate as productivity, whilst maintaining job satisfaction and retention amongst RTs'.

This study can inform multiple follow-up research projects including management perspectives on the implementation process of AI, and what they perceive are the training needs of employees. This study could also be replicated to include other MRS professionals to increase the scope of the research. Future directions could also investigate AI training options for MRS professionals in Australia and worldwide, as it appears there is a great demand for it with 96% of RTs wanting to learn more.

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Conflict of Interest

The authors declare no conflict of interest.

Ethics Approval Statement

This study was approved by the Sheffield Hallam University Human Ethics Committee (SHU Ethics/MC/310321).

Data Availability Statement

The survey questionnaire has been included in a supplementary file. Any other information required including a full list of participant responses are available on request.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Supplementary file S1: Participant Information Sheet.

Supplementary file S2: Questionnaire.

Supplementary file S3: Direct quotes.

