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Professional implications of introducing artificial intelligence in healthcare: an evaluation using radiation medicine as a testing ground

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Abstract

Aim: This study will evaluate radiation medicine professionals' perceptions of clinical and professional risks and benefits, and the evolving roles and responsibilities with artificial intelligence (AI). *Methods:* Radiation oncologists (ROs), medical physicists (MPs), treatment planners (TP-RTTs) and treatment delivery radiation therapists (TD-RTTs) at a cancer centre in preliminary stages of implementing an AI-enabled treatment planning system were invited to participate in uniprofessional focus groups. Semi-structured scripts addressed the perceptions of AI, including thoughts regarding changing roles and competencies. Sessions were audiorecorded, transcribed and coded thematically through consensus-building. *Results:* A total of 24 participants (four ROs, five MPs, seven TP-RTTs and eight TD-RTTs) were engaged in four focus groups of 58 minutes average duration (range 54–61 minutes). Emergent themes addressed AI's impact on quality of care, changing professional tasks and changing competency requirements. Time-consuming repetitive tasks such as delineating targets, generating treatment plans and quality assurance were thought conducive to offloading to AI. Outcomes data and adaptive planning would be incorporated into clinical decision-making. Changing workload would necessitate changing skills, prioritising plan evaluation over generation and increasing interprofessional communication. All groups discussed AI reducing the need for TP-RTTs, though displacement was thought more likely than replacement. *Conclusions:* It is important to consider how professionals perceive AI to be proactive in informing change, as gains in quality and efficiency will require new workflows, skills and education.

Introduction

Technology has always been, and remains, at the heart of contemporary radiation medicine (RM) practice. As artificial intelligence (AI) technology is increasingly being introduced into all aspects of society—from personal assistants to driverless cars—RM is a natural target for its application in healthcare.

AI encompasses the ability of computer systems to perform tasks that are regularly attributed to intelligent beings, such as human reasoning, and the ability to generalise and learn from past experience.[1] There has been significant research and development work in recent years regarding the potential of RM AI strategies, such as automation of treatment planning,[2] but little attention has been paid to the impact on the professionals who provide care delivery. Popular media has raised the issue of the impact on the workforce, anticipating that some jobs will soon be replaced entirely by computers,[3] but consideration of the impact of AI on those who provide care is essential, including the evolving provider perceptions regarding risks and benefits of shifting roles.

The paucity of empirical research or meaningful academic enquiry into the socio-behavioural aspects of implementing AI suggests a gap in positioning AI to be integrated successfully in healthcare. Constructs in complex intervention theory, specifically in normalisation process theory,[4] provide a valuable lens through which to explore the relationship between innovation and practice evolution as would be expected with the integration of AI technologies in RM. It can illuminate how professions would be best served by approaching change as is heralded by AI. From another angle, professional identity theory is useful in the downstream consideration of how professions equip themselves to adapt to the new roles and workflows identified through preparing for innovation.[5,6] With a high level of identity threat found to lead to poor team performance,[7] it can be hypothesised that elements of the

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normalisation process could be impacted by professional identity, challenging the success of the intervention.

This study sought perceptions in RM regarding implementation of a novel, automated radiation treatment planning computer (TPC) system. By gaining insight to the opportunities, barriers, and concerns regarding AI as perceived by those who will be most affected by its implementation—radiation therapists (RTTs), medical physicists (MPs) and radiation oncologists (ROs)—implementation of AI strategies can be approached most responsibly as a complex intervention, and professions can work proactively to prepare for it and maximise its potential.

Methods

Qualitative method

Uniprofessional focus groups were employed to generate a broad preliminary picture of the perceived implications of introducing AI in RM for each of ROs, MPs and RTTs. Focus groups were selected rather than individual interviews as they afford the opportunity to highlight areas of agreement and debate within each profession, providing a richer exploration of emergent themes.

Study setting and population

A single, urban, academic cancer centre with novel experience in piloting AI technology served as the study setting. The organisational culture was the one that championed innovation and willingness to engage in change. A TPC with automated tools and the capability to support AI was in the process of being implemented through a phased roll-out using a train-the-trainer model. This served as the reference AI strategy, though discussion was not limited to this specific technology. The foundational element of this TPC was being employed for the treatment of some disease sites at the time of the focus groups, though no actual AI elements or add-ons to the software were yet being employed. Departmental engagement in related innovations suggested that staff were exposed to academic discussion of future potential of AI strategies.

All RM professionals involved in the technical delivery of radiation therapy (RT) care at this centre were considered for inclusion (ROs, MPs and RTTs). As per professional designations in Canada, RTTs included treatment planning (dosimetry). For our purposes, we separated treatment delivery radiation therapists (TD-RTTs) and treatment planners RTTs (TP-RTTs). An information letter tailored slightly for each professional group was sent by a single investigator via departmental email distribution lists. One reminder was sent after one week. Individual reminders were also sent to a small subgroup of professionals of each group who were believed by investigators to hold potentially differing but representative views on the topic at hand, encouraging participation.

Data collection

Each 1-hour session was facilitated by the principal investigator with a second investigator present as notetaker. Focus groups were semi-structured, employing a script of six questions with supporting probes. An introductory script was read at the start of each session to present the topic. Questions then addressed participant perspectives on benefits and drawbacks of AI technology in RM, predictions about evolution of their practice and that of others in light of AI, and anticipated impact on skills and competencies necessary for their profession.

All groups were audiorecorded with participants' permission. This study was granted Research Ethics Board exemption by the Institutional Review Board of the University Health Network.

Data coding and analysis

Audiorecordings were transcribed and analysed iteratively by two investigators and discussed regularly with the broader research team. Coding and identification of themes were performed manually using highlighting in a standard word processor. Provisional thematic categories were identified throughout data collection by the way of constant comparison method (aligning newly emerging data with categorisation of earlier data, and iterative modification of groupings based on saturation of individual themes). Further refinement of themes was based on concurrence between investigators, which was achieved through independent review of aggregated data and group discussions.

Results

Four focus groups were conducted, one for each professional group. This included eight TD-RTTs, seven TP-RTTs, four ROs and five MPs, for an average of six participants (range 4–8). In the RO group, one participant engaged remotely over videoconferencing. All participants held staff positions; no trainees participated. Focus groups were an average of 58 minutes (range 54–61 minutes) in duration.

There were three main areas of conversation, each relating to perceptions of AI technologies: impact on quality of care, impact on tasks and workflow and impact on scope of practice and competencies of the relevant professions.

General perceptions of impact on care

A common perception of AI was that it would improve quality of care. Participants mentioned efficiency, availability of new and accessible data, value to clinical decision-making and potential advances in facilitating higher precision and complexity of care.

Gaining efficiency in practice with the implementation of AI strategies was framed in value to both patients and professionals. TP06 noted that 'all things being equal, if patient throughput is increased, then it's a good thing', reducing patient wait times. Others acknowledged that time-savings in certain clinical areas, particularly relating to mundane but time-consuming tasks such as contouring and planning, would allow more focus on 'high touch' (RT02) or value-added tasks, final plan evaluation, managing complex patients and non-clinical responsibilities.

MPs were, in particular, cognizant that the more standardised practices necessary to implement AI would lead to better data. Both ROs and MPs valued that this could subsequently be fed back into the AI system to support more systematic clinical decision-making. MP02 suggested that AI would provide 'a greater opportunity for some of us to catch weird things in a plan […] the computer is helping to draw the attention to some relevant features'. As summarised by RO02, in terms of big data's impact on informing decisions:

> '…if you look at what AI is able to do, it basically needs data to chew over. It needs data. So healthcare is one of the very silos where we have mountain loads of data just trapped. In our films, in our x-rays, in our

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notes, it's just text and it's all there, you just need some way to mine all that out. That would be invaluable.'

Finally, the efficiency in practice and the computing power afforded through AI were seen, particularly by the two RTT groups, as enablers of complexity that could improve care. Specifically,

'all that computing power really did was give us a set of tools and made our work even more complex than it's ever been before. So we're able to open the door to… do things we'd never have considered before, and do them in a shorter time frame than we ever thought was possible'—(TP06).

There were a number of potential downsides to AI quality acknowledged by participants, such as the concept of AI as an untested and unverifiable 'black box', though MPs tended not to raise these concerns. RO01 worried that

'… someone has to know what has gone into the AI models and what's going into the machine learning… because, you know, crap in crap out… there's a lot of algorithms and black box, and some of them are crap even though it looks good'.

TP-RTTs tended to focus on the risks of adopting novel techniques, facilitated by AI, before evidence supported their use. They suggested that caution should be employed until the data produced supports the value to patients and their care.

Impact on tasks/workflow

Aligning with the perception that AI would increase efficiency in certain areas of practice, there was also the belief that time saved by AI in certain areas would facilitate focus on other areas. In some cases this was noted to be tasks or roles that always existed but that could not be afforded the necessary time (i.e., patient care). In other cases, it would relate to being able to do more of something if it took less time to do it in the first place (i.e., adaptive re-planning). While there was some overlap, participants tended to envision different impact on each professional group.

Treatment planners

In all groups, the first point that came to mind was the impact on TP-RTTs of reduced treatment planning time per plan. Discussion of the subsequent impact was framed by many as an impact on the very nature of the profession, but also concerned the novel focus facilitated by offloading the manual elements of treatment planning. As AI technologies were seen to execute the 'task-based' elements of basic planning, computers would do the 'heavy lifting, [with] a few people still doing the manual, classic stuff' (RT07). 'We'll have to take on more complex tasks. Like probably those types of plans that are more complex, that require somebody thinking about what are we actually trying to achieve with this plan' (RT05).

MP02 noted a similar perception:

'…it's going to be the planners [who are most impacted] because they use the planning system all day long… and the computer will be doing that. And the planner's job will be plan evaluation and maybe integrating it a little bit with the longitudinal considerations for the patient treatment'.

This was reiterated by a treatment planner, suggesting a shift in focus towards adaptive treatment, 'But what happens tomorrow? And the second day? And the third day? That's where your planning skills would shift, in introducing adaptation. Not the initial plan' (TP01).

Radiation therapists

The RTTs were the most attuned to the connection between the faster treatment planning and a resultant increased implementation of adaptive re-planning, not strictly an AI strategy. As well as serving as a gatekeeper for flagging the need for re-planning, they suggested that higher volumes of more accessible toxicity data, mined through machine learning, would better equip them to provide timely interventions regarding side effects. One TD-RTT (RT08) framed their changing role as follows:

'[when] talking to patients about their side effects… if we're doing dose accumulation and we're like 'yup, your esophagus has now hit the dose that we know you're going to feel something and oh, you're having difficulty swallowing….' You know? And we can communicate that…'

Radiation oncologists

The perspective on how the daily workflow of ROs would change with AI was primarily discussed by the two RTT groups, with ROs suggesting only that they could focus on other priorities, such as that,

'we don't want to be doing stuff like contouring if the machine can do it for us. I mean I want to be able to use my time more efficiently in the most high-value activity. So you know - dealing with patients… looking over plans' (RO02).

Expanding on the notion that adaptive planning would increase with AI technology implementation, RTTs raised the potential for a shift in responsibilities for ROs, primarily that 'they're going to have to be on the unit a lot more, especially for making decisions about delivering [treatment]' (RT08).

Medical physicists

Attention to the changing tasks of the MP was only noted by the MP focus group itself, which focussed on the impact on quality assurance. It was noted that the volume of chart-checking tasks would likely increase as the number of plans increased (with adaptive planning), but also that increased automation of the rule-based and repetitive aspects of these tasks would allow greater focus on evaluation of more complex plans and decision-making. One physicist noted the benefit in this, that

'sometimes I feel like maybe I'm struggling with checking all of the routine stuff…I would hope that I don't have to spend that time there and I could use my expertise and focus on that extra conversation… maybe we have time then to figure out how to push that further with time that we don't necessarily have to invest now'—(MP05).

This represented a common view that the relative time spent on quality assurance would not ultimately be reduced. A discussion within the MP group highlighted this:

MP01: We can spend time in different places.
MP04: I don't think that will speed up our process of checking plans, unfortunately, but I think it will….
MP04: Right. SO I think that's probably it.
MP05: It can change the conversation we have about the plans, maybe? To something that maybe could focus on stuff that….
MP04: …actually matters! Focus on actual quality!

Impact on professions

Discussion of the impact on professions concentrated in two areas: the professions themselves, and the education and competencies required in light of AI. The two RTT groups anticipated

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changes to the nature of their profession. TP-RTTs debated whether fewer treatment planning positions [full-time equivalents (FTE)] would be required, noting a general but perhaps unfounded fear of job loss.

> 'That's the buzz that's going around, that we're going to need less, and that's freaking out a lot of people, but with the technology there, our jobs are going to change into something else, but they're not going to go away'—(TP01).

An RO and a TD-RTT echoed the concerns about the fewer TP-RTT FTE with the introduction of automation. Both noted that the computer would subsume the bulk of the tasks performed by planners, but planners went further to say that roles could be displaced by AI, or evolved in response to its introduction, rather than replaced.

TP01 suggested the need for all RTTs to be open-minded to accommodate the need to change, suggesting: 'This is big. It is moving fast, and we all have to learn different ways of doing things. We all have to be… flexible'. For RTTs, it was felt that changes to their role with the introduction of AI would lead to making fuller use of their scope of practice. RT06 framed it as follows:

> 'I think it would broaden the horizon… So you're involving more, everything that we're trained to do…. What we all train and learn for, we will use. Which I think really is a good way to go'.

Those at the front line of treatment delivery also expect to become gatekeepers to adaptive re-planning. To evaluate the appropriateness of the current treatment plan, they would need to build on foundational dosimetry knowledge to 'have an increased level of planning literacy to engage with the plans and the treatments in a different way' (TP06). This would also introduce the need for the RTT to act increasingly as a clinical decision-maker.

> 'Role expansion – if AI could help us make clinical decisions. Like adaptive re-planning, if we have therapists and also an AI machine telling us we need to re-plan… when all the other indicators are there… it would be nice if we could use it that way going forward in our profession. There's an opportunity there'—(RT07).

A unique element of the discussion in the RTT groups was advocating that they be involved in guiding the introduction of AI, rather than passively accepting new roles or the elimination of jobs. RT05 worded it as a potential 'turning point for the profession'; needing to create 'the opportunity to drive that change… to be at the forefront of that… and improving those processes'.

The need for new competencies and education required for this was also discussed for ROs and MPs. They were thought to require a strong appreciation for harnessing newly available data to guide clinical decision-making for adaptive planning. As noted by MP04,

> 'I think clinical decision-making. If we're doing more adaptation, there will be a lot of questions like when to adapt, what to adapt, things like that. I think AI will help with that, but ultimately they're the ones making clinical decisions…I think now we just say 'oh at 40 Gy we take off the bolus' or, you know 'we rescan'. …. So… it will be a bit of a paradigm shift and [ROs] have to also get used to that. That will apply to their training as well, because right now I don't think a resident would know how to do these things. It's not in their training, in their curriculum'.

One physicist, MP05, raised the possibility of MPs needing to interact more regularly with patients at the treatment unit, given the propensity for AI to impact on treatment decision-making. This would require patient care considerations, not currently a focus in their training.

The risk of losing certain knowledge and skills related to treatment planning was also a concern, in that,

> 'with more automated planning…. the fear is if we don't teach the next generation the concepts, they're going to have no idea if they encounter a problem, how it's supposed to be fixed…. You need to be able to troubleshoot'—(RO03).

Finally, all groups referred to needing to be equipped with an understanding of the principles, functionalities and limitations of AI, in order to work responsibly with it in the clinical context. Some argued for the benefit of an appreciation of basic coding, the principles of big data and machine learning and/or related algorithms. TP06 referred to this as 'technology literacy'. More specifically, from RO01, 'You need to have more awareness of automation and computers and algorithms and possible solutions', and from TP01,

> 'you need to learn the basics. Just like coding… and understanding what's going on, so that you have… the tools…. You don't need to know how the car works, exactly, you just need to know the general thing'.

It was also acknowledged that this knowledge could instead come in the form of a new role in the team; someone with a strong background in AI, coding and informatics, to act as a liaison.

Discussion

Complex interventions in healthcare are those changes to delivery of care that involve several interacting elements that must all be coordinated for the intervention to be successfully and sustainably implemented.[8] As AI is developed and implemented in various facets of healthcare, an impact on those at the front lines of care is unavoidable, but has been poorly considered to date. Normalisation process theory helps to distill the behavioural elements of complex intervention from other elements, focussing on the action necessary to effect change.[4]

Participants in this investigation suggested that there is an acknowledgement of both emergent opportunities and challenges for their professions in implementing AI. Many of these were thought to involve changing roles and responsibilities as AI subsumes some traditional tasks and generates the need for new ones to be undertaken. As focus would shift to more complex cases and more informed decision-making, new competencies and workflows would be required. While not discussed explicitly in this investigation, the process of defining these would require coordination between professions, referred to within normalisation process theory as interactional workability, the first of the four constructs of collective action.[4,9] Interprofessional collaboration in defining new roles has previously been shown to be an essential element of integrating new RM technologies such as CT-Simulation[10] and image-guided RT.[11] Redistributing knowledge and acquiring new skills, such as was mentioned by therapists in order to flag the need for adaptive re-planning, speak to relational integration, as users of the new technology seek joint agreement as to how accountability to new roles will be built through training.

Negotiation of new roles and workflows, in light of a technology that will infiltrate significantly into traditional boundaries of practice in many areas, can challenge professional identities. Participants in this investigation tended to anticipate changes in a

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positive light, but as volunteers from a uniquely innovation-friendly institution, they are not necessarily reflective of the general feelings within their professional communities. Both the physics and therapy groups, however, reflected on divergent views of professional colleagues—fears of professional obsolescence, focus on tasks lost to AI rather than opportunities made available and reluctance to embrace new skills.

Professional identity theory concerns how individuals 'categorise and differentiate themselves from members of other professions'.[6,12] Influenced by traditionally siloed education and socialisation, an individual's sense of professional identity can be heightened in times of change.[5] If proposed change involves reconsideration of professional roles, in particular where it might be perceived as devaluation of established skills or contributions, professional groups could feel threatened.[5–7] Although such threats were not reported directly in this investigation, participants' acknowledgement of their existence merits further investigation in exploring considerations of AI implementation.

As argued especially by the TD-RTT participants in this investigation, engaging professionals in guiding and informing the changes related to integration of AI might serve to allay concerns regarding the future of the related professions. Given the paucity of academic reflection on the impact of AI in this regard, professions may be well-served by equipping themselves to advocate for where they could contribute to a new AI-supported model of care. Engaging in interactional workability in this proactive way could reduce the sense of threat to professional identity perceived to be of concern to many in RM.

Conclusion

AI-related tools are changing work practices in medicine today. Staff trained in the absence of these tools form complex views on their value and impact. The introduction of AI strategies in RM will necessitate changes in practice that will have ripple effects into many aspects of care, requiring professional groups to adjust their roles in response. In order to most responsibly plan for such a complex intervention, it is critical to consider these professional groups and their training needs in terms of technology literacy and new workflow models, empowering them to engage in leading the change.

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