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ORIGINAL ARTICLE

A National Survey on the Awareness of Artificial Intelligence Technologies Among Radiation Oncologists-Turkish Society of Radiation Oncology Artificial Intelligence and Information Technology Group Study

Esra KORKMAZ KIRAKLI,[1] Şükriye Bilge GÜRSEL,[2] Eda YİRMİBEŞOĞLU ERKAL,[3] Durmuş ETİZ,[4] Enis ÖZYAR[5]

[1]Deparment of Radiation Oncology, Dr. Suat Seren Chest Diseases and Surgery Training and Research Hospital, İzmir-*Türkiye*
[2]Deparment of Radiation Oncology, Ondokuz Mayıs University, Samsun-*Türkiye*
[3]Deparment of Radiation Oncology, Kocaeli University, Kocaeli-*Türkiye*
[4]Deparment of Radiation Oncology, Eskişehir University, Eskişehir-*Türkiye*
[5]Deparment of Radiation Oncology, Acıbadem University, İstanbul-*Türkiye*

OBJECTIVE

We aimed to investigate the perception of radiation oncologists about artificial intelligence (AI), their current use of AI in clinical practice, and their expectations, concerns, and wishes in terms of the future of radiation oncology (RO) in the era of AI.

METHODS

An electronic survey was created.

RESULTS

A total of 108 radiation oncologists participated. One-fourth (24.3%) rated their knowledge of AI as very poor. The majority (94%) reported that they need training about AI. Most respondents (62.6%) indicated that they had never used any AI application. Nearly 90% reported that the introduction of AI would improve RO. Image analysis and target definition were identified as key benefits of AI in RO by 84% of respondents. The medical liability due to machine error and black box uncertainties was the greatest concerns. The need for clinical validation of AI applications, development of ethical frameworks, and medicolegal guidelines was identified as priorities before the implementation of AI in RO by 86%, 78%, and 68%, respectively.

CONCLUSION

There was a big gap in knowledge within our RO community. The enthusiasm to learn was high. AI applications have not been imposed much in clinical routine. Mostly, the participants felt optimistic about the introduction of AI. The top areas where AI was thought to be most useful in RO were reliant on imaging. The respondents were mostly concerned about the medical liability.

Keywords: Artificial intelligence; radiation oncology; radiotherapy; survey.

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Dr. Esra KORKMAZ KIRAKLI
Dr. Suat Seren Göğüs Hastalıkları ve Cerrahisi Eğitim ve Araştırma Hastanesi,
Radyasyon Onkolojisi Kliniği,
İzmir-Türkiye
E-mail: esrakorkmaz1@yahoo.com

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INTRODUCTION

Artificial intelligence (AI) is a computer science branch that tries to imitate human-like intelligence in machines using computer software and algorithms to perform certain tasks.[1] There is currently considerable enthusiasm for AI in healthcare.[2] Similarly, AI has the potential to revolutionize the field of radiation oncology (RO) since all steps of workflow in RO (patient evaluation, simulation, contouring, planning, quality control, treatment application, follow-up, etc.) have relation, to a greater or lesser degree to potential application of AI.[3]

Besides, areas of medicine that are most reliant on imaging will be amongst the first to be impacted by AI.[4] RO is one of the departments which rely mostly on imaging; the image analysis is a core work task for RO that has big data and must use the most advanced technology.[1] Therefore, AI algorithms have the potential to perform many functions in RO such as image segmentation, automatic contouring, treatment planning, dose optimization, treatment verification, and quality assurance.[1] As a result, AI in RO has been making more impact in recent years; there is a continuous flow of new published papers.[5] In contrast, only few studies have examined the radiation oncologists' perceptions on AI technologies. Since the personal perceptions of radiation oncologists' on AI would influence the integration of this technology into RO clinical practice, it's important to outline how radiation oncologists perceive this development in AI. As far as we know, there has been only one specific study in the field of RO on this subject, but it was not specifically dedicated to radiation oncologists.[6]

In this study, we conducted a national survey to ascertain radiation oncologists' perception of AI technologies, their current use of AI-based models in their clinical practice, and their expectations, concerns, and wishes in terms of the future of RO in the era of AI.

MATERIALS AND METHODS

A questionnaire was developed composed of 17 multiple choices, 9 Likert-scale, and 1 open-ended questions following the review of the current literature and feedbacks from the Turkish Society for RO (TROD)-AI and Information Technologies Study Group members. The first part composed of demographic questions, the following parts focused on the current knowledge and use of AI applications in clinical practice, perception of AI in RO, acceptable AI performance standards, and clinical workflows, perceived advantages, and concerns of AI technologies and preparedness for the future, respectively.

The study received approval from Dr. Suat Seren Chest Diseases and Research Hospital Ethics Board in June 2021. An electronic survey was created. The E-mail with the link of the survey to participate was distributed among TROD members through TROD in July 2021. The electronic informed consent was obtained from each participant online before survey commencement. The responses were collected in September 2021 and then analyzed using descriptive statistics. A copy of questionnaire has not been included in this paper, but the full version is available on request.

RESULTS

A total of 108 radiation oncologists participated in the survey. The respondents predominantly practiced in university (50%). The percentages of RO specialists, professors, associated professors, and attendees were 39%, 26%, 18%, and 8%, respectively. According to member registration informatics from TROD 22% of professors, 28% of associated professors, 10.5% of RO specialists, and 4.5% of attendees participated in the survey.

The Current Knowledge and use of AI in Clinical Practice

One-third of participants (33%) rated their knowledge of AI as below the average, and 24.3% as very poor, only 3% reported as excellent (Fig. 1). Most respondents (62.6%) indicated that they had never used any AI application in their practice (Fig. 2). Among users who provided details the used applications were as follows: automated organ at risk contouring (nine participants), treatment planning (seven participants), radiomics (two participants), imaging (one participant), adaptive therapy (one participant), simulation (one participant), and quality control (one participant).

Perceived Impact of AI on RO

Nearly 90% of respondents reported that the introduction of AI would improve the field of RO (Fig. 3). Almost half of participants (54.7%) estimated that the impact of AI in RO would be apparent in <5 years. Three quarters of radiation oncologists predicted that the workforce needs will be decreased (Fig. 4).

The top five areas where AI is thought to be most useful in RO were (1) image analysis, (2) target definition, (3) on-line adaptive therapy, (4) treatment planning, and (5) synthetic reconstruction (Fig. 5).

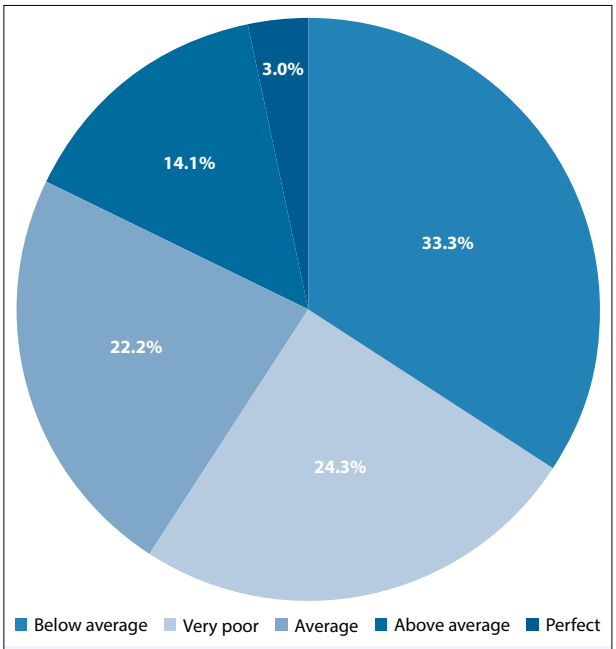

Fig. 1. Self-reported knowledge of artificial intelligence.

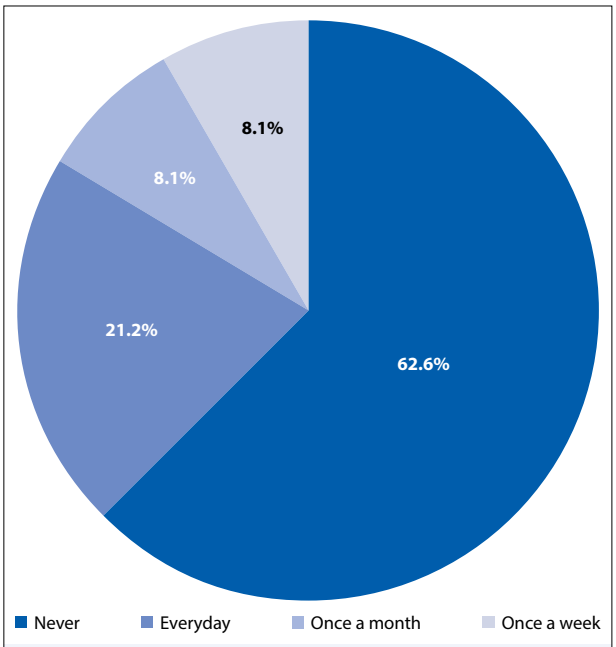

Fig. 2. The artificial intelligence use in clinical practice.

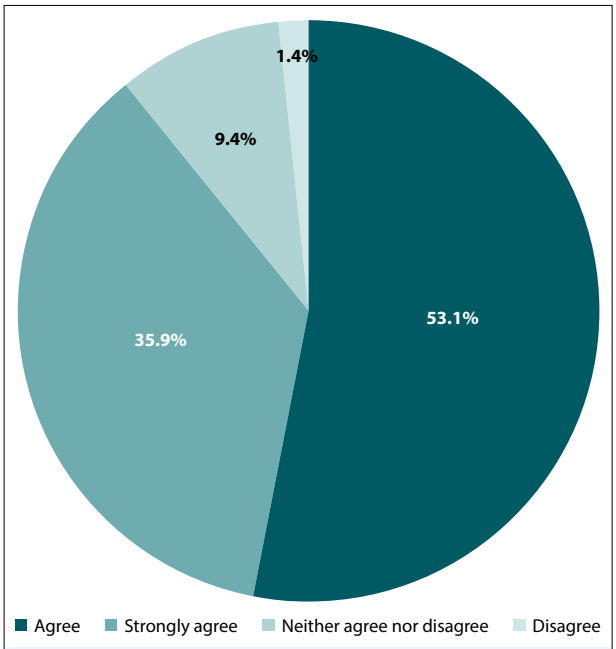

Fig. 3. Percentages of agreement with the statement 'the field of radiation oncology will improve with the introduction of artificial intelligence'

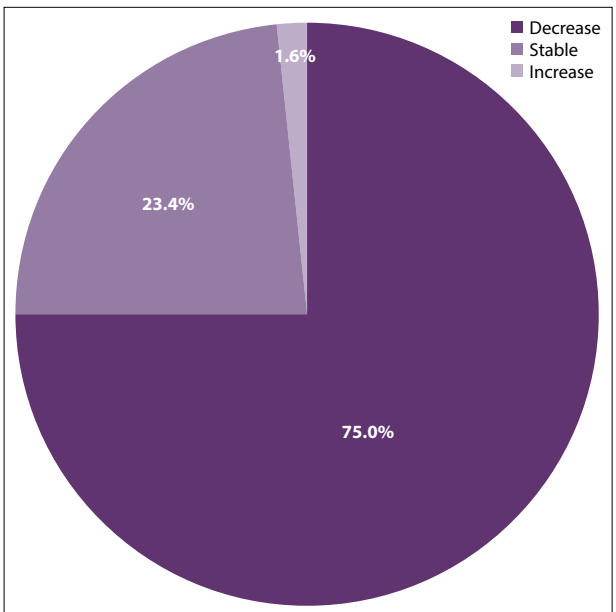

Fig. 4. Estimated impact of artificial intelligence on radiation oncology workforce needs.

Perceived Advantages and Concerns of AI

The top three expected potential advantages of AI were as follows: (1) more personalized and evidence-based treatment approach, (2) improved imaging quality, and (3) improved therapeutic gain (Fig. 6).

The top three ranked potential concerns about AI were (1) medical liability due to machine error, (2) black box uncertainties, and (3) ethical violation and negative impact on workforce needs (Fig. 7).

The radiation oncologists feel fear (2%), threatening (5%), anxiety (18%), confidence (27%), and hope (85%) about the future of RO in the new era of AI.

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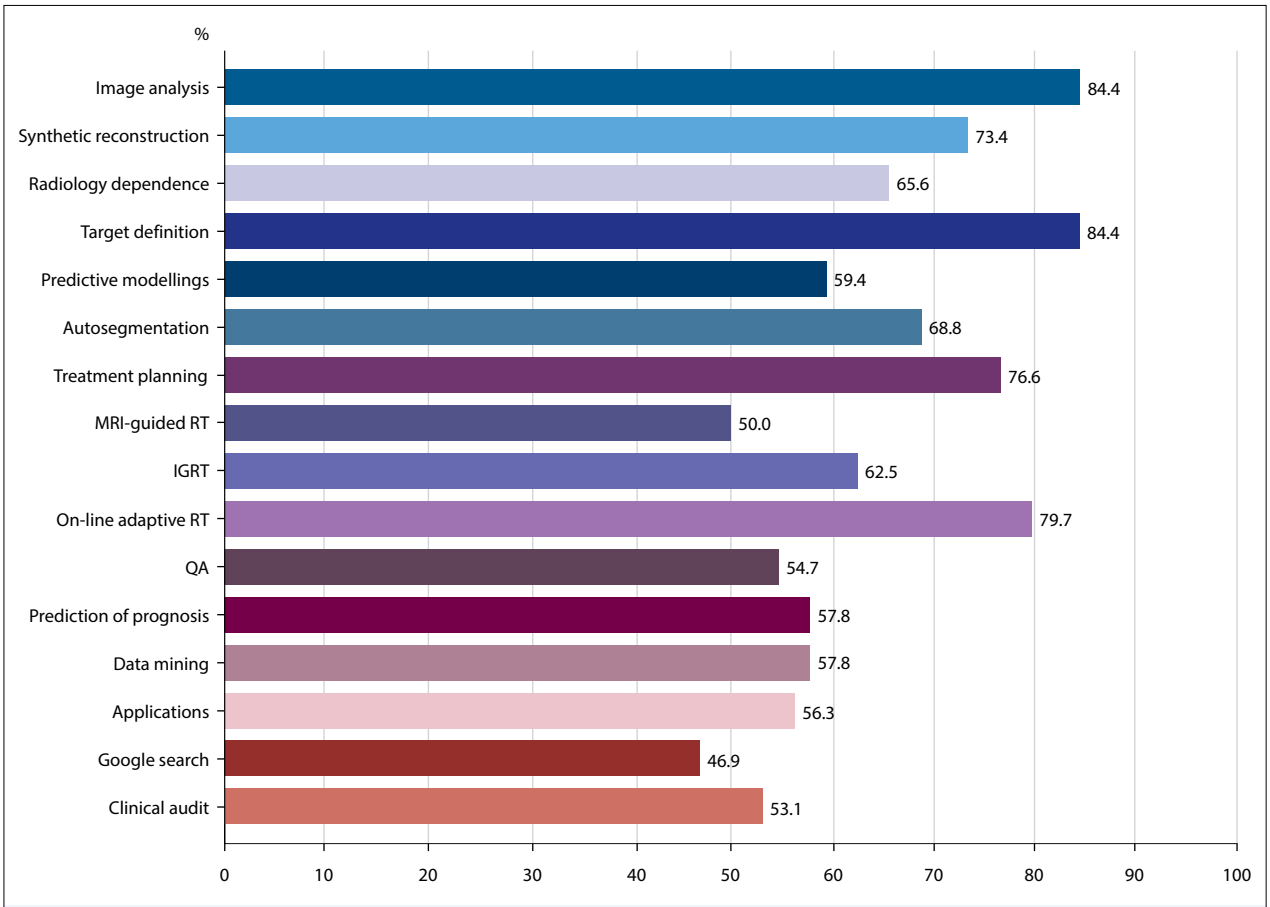

Fig. 5. The areas where artificial intelligence is thought to be most useful in radiation oncology.
MRI: Magnetic resonance imaging; RT: Radiotherapy; IGRT: Intensity modulated radiation therapy; QA: Quality assurance.

Acceptable AI Performance Standards and Clinical Workflows

To be able to have a place in clinical practice, 37.5% of respondents stated that AI applications would need to achieve performance that was superior to average performing radiation oncologist, 34.4% stated as equivalent to the best, and 22% stated as superior to the best (Fig. 8). When a hypothetical clinical workflow was proposed as follows: "In first step, all patient information undergo AI analysis and radiation oncologist subsequently evaluates both data about the patient and AI findings and then make a decision." Most of the respondents (76.6%) confirmed such a clinical workflow but 9.4% refused and 14.6% was unsure about it. Among clinicians who confirmed the hypothetical clinical workflow, while making a clinical decision; 62.5% would consider his/her own approach primarily, 32.8% would consider both his/her own and AI's approach equally, and 4.7% would consider AI's approach primarily.

Preparedness for the Future

Most of radiation oncologists (94%) reported that they need training and education about AI. The most preferred methods of education were as follows: regular sessions on understanding of practical implications of AI (78%), guidelines for the clinicians about latest developments (78%), fundamentals of AI (62.5%), and safety of these technologies in the context of global technology giants (53%). Furthermore, there was a demand for collaborative courses with technological companies (59%).

The reported needs before AI implementation in routine clinical practice were clinical validation of AI applications before being introduced into clinical practice (86%), development of ethical frameworks for AI implementation (78%), definition of responsibilities of clinicians (70%), and development of medicolegal guideline to set the responsibility if error has been made based on information provided by AI (68%).

Seventy 5% of respondents felt that AI applications would help and support doctors, 67% believed that it

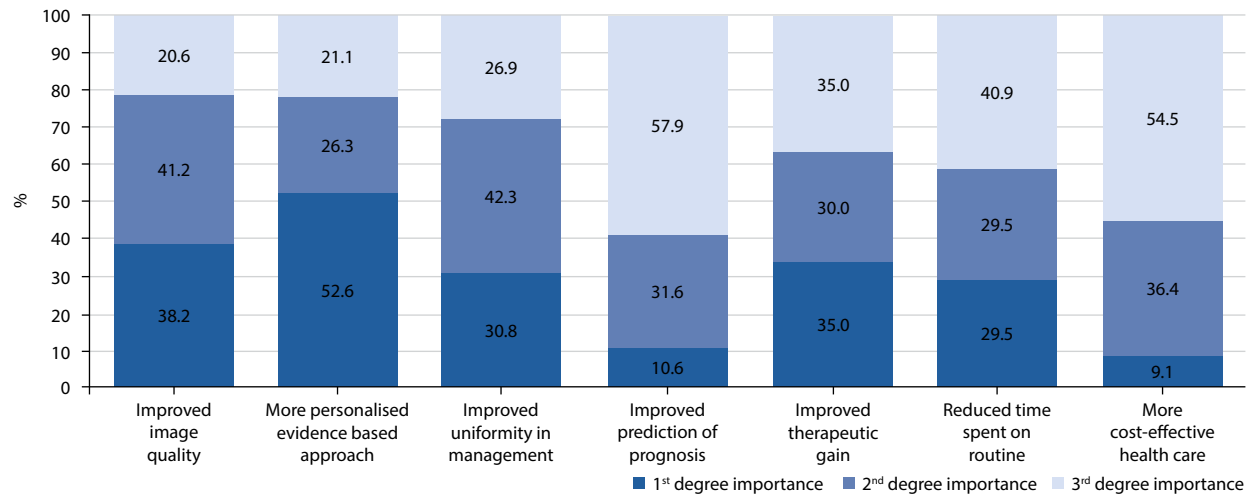

Fig. 6. Perceived advantages of AI.
AI: Artificial intelligence.

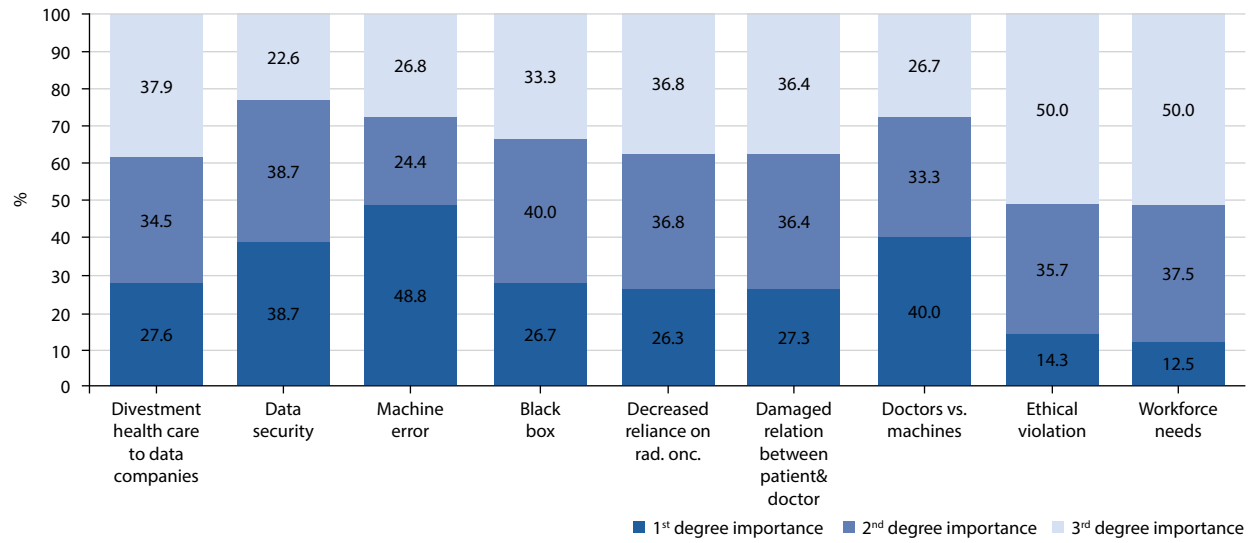

Fig. 7. Perceived disadvantages of AI.

would increase the doctors' performance, 57% implicated that those clinicians who use AI in their daily practice would have a positive impact compared to none users, 50% expected that the doctors would guide AI, 11% felt that AI would replace clinicians, and 5% believed that the income and welfare level of doctors would be better.

While 44% of respondents believed that AI will be directed by technological companies in the future, 43% believed that it would be directed in cooperation of clinicians and companies.

Instead of perceiving AI as a threat, the rate of radiation oncologists who think that they can actively shape and be part of this active transformation is 76%.

DISCUSSION

The survey was conducted to understand the perceptions of radiation oncologists about AI applications in RO, their current use of AI-based models in their clinical practice, and their expectations, concerns, and wishes in terms of the future of RO in the era of AI and might serve to guide the development of future research projects. To the best of our knowledge, this survey is one of the first of its kind; the respondents in our survey are very homogenous, is composed of only radiation oncologists. This study highlights the big gap in knowledge within RO community; however, the

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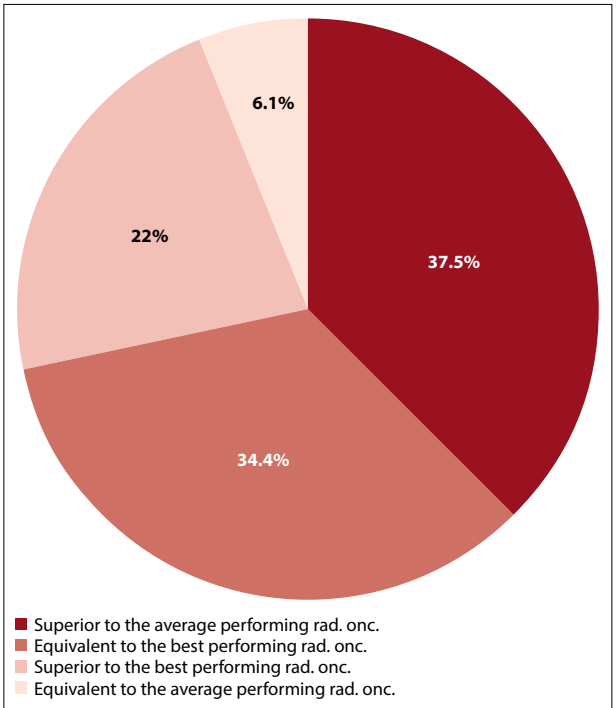

Fig. 8. Accepted artificial intelligence performance.

enthusiasm to learn was high. These findings were in line with two other surveys; a Canadian study on perception of AI among radiation oncologists, radiation physicists, radiation therapists, and radiation trainees reported that only 12% of respondents felt well with knowledge of AI, but 91% were interested in learning more. The other one is an Australian study on the use of AI in dermatology, ophthalmology, radiology, and RO, in which radiation oncologists reported their knowledge about AI as "average."[6,7] We assume that consideration of these knowledge gaps will be essential step for health-care systems, medical educators, professionals, and AI developers.

There was very low representation from RO attendees. The reason behind these results is not clear, but this finding might imply a need for rapid action to advance learning from earlier stages in their education for radiation trainees, representing the future generation of practitioners.

Considering the best method to learn AI algorithms, responses were in line with other surveys; the participants highlighted, mainly a need for regular training and education sessions about fundamentals of AI and latest developments.[6]

In the current state, the use of AI-based methods in daily practice is very low in our community. Low rates of clinical AI use by other disciplines have previously been reported, indicating that AI has not yet been widely adapted in clinics.[1,7,8] The most common application was mentioned as automated organ at risk contouring among users which are a similar finding with the literature.[7,9] However, it is possible that AI-based model use might be underrepresented in our survey such as this due to lack of visibility of algorithms that are deployed within imaging platforms and treatment plannings or interpretation of what constitutes AI. These results support our previous finding about the knowledge gap and warn us about the necessity to improve the awareness about AI.

Mostly, the participants felt optimistic about the introduction of AI applications into the field of RO. Most of the other surveys had similar positive sentiments; respondents indicated that most clinicians believed that AI technology would have a positive impact in their profession.[7,10,11] Our participants believed that AI would have positive advance mostly on personalized and evidence-based treatment approach.

The top areas where AI was thought to be most useful in RO were reliant on imaging. This finding is not surprising since the image analysis is a core work task for RO.[4,7]

Although three quarters of radiation oncologists predicted that the workforce needs will be decreased, the reduced reliance on clinicians was not the primary concern; it has the least first-degree importance when considering the potential disadvantages of AI. Accordingly, the rate of participants who considered that AI would replace clinicians was only 11% which was quite a different finding than the Canadian study that 34% of participants were afraid of losing their jobs.[6]

The respondents were mostly concerned about the medical liability due to machine errors and black box uncertainties which were a similar finding with the literature.[7] These disadvantages appear to be main obstacles to be overcome to make clinicians feel more comfortable with AI systems.

The adaption of AI technologies by radiation oncologists seems to be influenced by the level of performance of AI tools, because our respondents consider that AI systems should have error levels at least superior to the average performing radiation oncologist. Similarly, Scheetz et al. reported that their respondents had high expectations of AI performance also. Nevertheless, they seem mostly ready to adapt and cooperate with AI implementations in their clinical workflows.

Like any new technology, the need for clinical validation of AI applications, development of ethical frameworks, and medicolegal guidelines was consis-

tent priorities for clinicians before AI implementation into clinical practice. An urgent need for clarity regarding these concerns is obvious since legal, moral, and ethical considerations are increasingly challenging as technologies become more autonomous. If these concerns would be clarified in the near future this might help to decrease the anxiety among clinicians against AI systems. The methods of integration of AI systems into RO practice should be evaluated also.

Although the future of AI technology in RO is challenging to predict, we believe that we might have helped to improve the awareness of radiation oncologists about the integration of AI as a cooperative tool in RO profession in our country.

Limitations of the Study

The limitations of this survey warrant consideration. As a result of volunteer response bias, the results may not be broadly representative of the views of all radiation oncologists in our country and may not be generalizable to other countries. Moreover, there was low representation from RO attendees. The reason behind these results is not clear, but this finding might imply a need for rapid action to advance learning from earlier stages in their education for radiation trainees, representing the future generation of practitioners. Finally, the limitations on the scope of response options, due to design of survey, limit us about the comprehensive understanding of the perceptions of respondents.

CONCLUSION

The aim of our study was to understand the perceptions of radiation oncologists about AI applications in RO, their current use of AI-based models in their clinical practice, and their expectations, concerns, and wishes in terms of the future of RO in the era of AI. This survey highlights the big gap in knowledge within our RO community; however, the enthusiasm to learn was high. AI applications have not been imposed much in clinical routine. Mostly, the participants felt optimistic about the introduction of AI technology into the field of RO. The top areas where AI was thought to be most useful in RO were reliant on imaging. The need for clinical validation of AI applications before being introduced into clinical practice, development of ethical frameworks, and medicolegal guidelines was consistent priorities for clinicians before AI implementation into clinical practice. More studies should evaluate the best education methods on this subject and how to best implement them into training and education programs. Although the future of AI technology in RO is challenging to predict, we believe that we might have helped to improve the awareness of radiation oncologists about the integration of AI as a cooperative tool in RO profession in our country.

Peer-review: Externally peer-reviewed.

Conflict of Interest: All authors declared no conflict of interest.

Ethics Committee Approval: The study was approved by the Dr. Suat Seren Chest Diseases and Surgery Training and Research Hospital Ethics Committee (no: E-49109414-604-02, date: 11/08/2021).

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