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A Study on the Evaluation of Image-Guided Treatment Use in Radiotherapy Centers in Türkiye

Ahmet Murat ŞENIŞIK[1*]

[1] Altınbaş University, SHMYO Radiotherapy Program, Istanbul, Türkiye

Keywords

Radiotherapy

Image-Guided Radiation Therapy (IGRT)

Questionnaire

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Abstract

This study presents a preliminary investigation into the use of image-guided radiation therapy (IGRT) in radiotherapy centers in Türkiye, based on survey data. Radiation therapy technologists were administered a 67-item Internet-based questionnaire. The first five items focused on demographic data, while the remaining items pertained to IGRT applications in the clinics where the technicians worked. Statistical data of the answers obtained were used in SPSS 28.0. While evaluating the study data, descriptive statistical methods (frequency, percentage) were used. A total of 314 individuals participated in the survey, with 45.9% (n=144) being female and 54.1% (n=170) being male. The study focused on patients with stomach (20.6%), rectum (18.9%), prostate (17.6%), head and neck (14.5%), lung (14.3%), and breast (13.9%) cancers. It was observed that megavoltage (MV) ports (35.7%) were used more frequently during daily checks. It has been stated that 1-25 MV ports are drawn daily. This is followed by Cone Beam Computer Tomography (CBCT) and kilovoltage (kV) port checks. In our country, it is seen that important steps have been taken in IGRT and its use is quite common. It has been observed that the technical infrastructure and manpower in the clinics are sufficient. It is predicted that the development of systems that reduce the doses received by patients and employees with IGRT and the development of wage policies will increase the use of IGRT. We hope that this result will be supported by future large-scale studies. Although we think that the use of IGRT is at an adequate level, there are differences in practices between clinics. It is thought that the establishment of national protocols for the use of IGRT will be in favour of patients and technicians.

Cite

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Author ID (ORCID Number)

0000-0002-7781-3355 Ahmet Murat ŞENIŞIK

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1. INTRODUCTION

Image Guided Radiation Therapy (IGRT) is an imaging procedure that allows increasing target accuracy and precision by correcting anatomical and biological deviations applied during conformal radiotherapy (RT) (Nabavizadeh et al., 2016). IGRT allows the identification of the target and making small adjustments just before delivering radiation to detect the target and irradiate the correct location. This helps deliver radiation more accurately. In this way, fewer side effects and a more accurate treatment are provided. With IGRT, while the radiation dose is kept at a minimum level in the normal tissues adjacent to the tumour, high doses can be applied to the tumour. In this way, the success of radiotherapy can be increased (De Los Santos et al., 2013; Şenişik et al., 2022).

IGRT provides precise localization and monitoring of the tumour before and during treatment During treatment, however, bladder filling, peristalsis, or tumor movement may occur, requiring intrafractional monitoring. Respiratory or cardiac activity may also cause faster movements that affect treatment accuracy. Real-time monitoring of these movements requires a high temporal frequency (De Los Santos et al., 2013;

*Corresponding Author, e-mail: ahmet.senisik@altinbas.edu.tr

Bertholet et al., 2019). Imaging and tracking systems used to monitor the tumour and surrounding structures in detail can be called tumour tracking systems. Tumour tracking systems (TS) used in clinics are CT TS, US TS, Fiducial TS, MR TS, Respiratory monitoring system (RPM) TS, Surface TS, Cone Beam Computer Tomography (CBCT), Orthogonal TS, Xsight Spine TS.

Thanks to tumour tracking with real-time imaging, it helps to ensure that radiation beams are delivered correctly to the tumour in case of tumour movement caused by the patient's breathing or other internal organ movements. Meanwhile, it minimizes the risk of damaging healthy tissues (De Los Santos et al., 2013; Franzone et al., 2016; Lievens et al., 2020). Reducing the risk of unnecessary radiation exposure to healthy tissues and organs also minimizes possible side effects. By precisely targeting the tumour, higher radiation doses can be delivered while preserving critical structures, leading to improved treatment outcomes and reduced complications (Zelefsky et al., 2012; Kilburn et al., 2016; Fiorino et al., 2020). Thanks to these imaging methods, the treatment margin is minimized, and organ movements are considered, reducing the need for repositioning and readjustment during each treatment session (De Los Santos et al., 2013; Sun et al., 2017; Bertholet et al., 2019). Therefore, IGRT provides increased patient comfort and improved overall patient experience.

One of the important advantages of IGRT is that the treatment plan can be adapted with Adaptive radiotherapy according to the changes observed during treatment. Because tumours can change in size, shape, and location over time, IGRT adapts the treatment plan to take these changes into account and provides accurate and effective treatment. By comparing the actual treatment location with the planned location, clinicians can ensure the intended treatment is delivered correctly. This verification process increases quality assurance and helps maintain the highest standards of care in radiation therapy (Kilburn et al., 2016; Sun et al., 2017; Pinitpatcharalert et al., 2019).

The specific monitoring systems used for IGRT may vary depending on the treatment facility, the equipment available, and the type of cancer being treated. Radiation oncologists and medical physicists evaluate and select the most appropriate monitoring system based on each patient's needs and treatment requirements. IGRT has become increasingly common and widely adopted over the past decade due to its numerous benefits in improving treatment fidelity and outcomes. It has been incorporated into standard radiation therapy practice in many developed countries and is considered a standard of care for certain types of cancer. Due to its accuracy in target tracking, advances in IGRT demonstrate clinically superior benefits of stereotactic RT (SBRT or SRS) over conventional treatments in specific disease regions such as lung, brain, liver, and prostate (Zelefsky et al., 2012; Sun et al., 2017; Chen et al., 2020).

However, the use of IGRT depends on the capabilities of the clinics and the experience of the staff. In high-resource settings such as North America, Western Europe, and parts of Asia, IGRT is relatively common and routinely used in radiation therapy departments. In these regions, the frequency of IGRT use is generally higher. In environments where resources are limited or in areas where access to advanced technology is limited, the frequency of IGRT use is lower. Challenges such as cost, infrastructure, training, and availability of imaging equipment limit the widespread use of IGRT in some regions (Simpson et al., 2010; Nabavizadeh et al., 2016; Luh et al, 2020).

Although it is known that IGRT applications increase the accuracy and precision of radiotherapy treatments, the frequency of its clinical application has not been investigated before. This study aimed to evaluate the use of image-guided radiotherapy in Radiotherapy centers in Türkiye.

2. MATERIAL AND METHOD

The research was evaluated with a survey applied to associate degree students and graduates studying in the Radiotherapy program, with the permission of the Altınbaş University Ethics Committee numbered 30.03.2023-48240. The survey was conducted by the Principles of the Declaration of Helsinki. Since there is no previous study on this subject, the content validity of the questions prepared was determined by applying the Kendall agreement coefficient W correlation test in line with expert opinions ($p>0.05$). In the analysis, the factor loadings of the questions vary between 0.455 and 0.765. The total variance explained is 35,673. High factor loadings indicate that the questions are related to each other and explain 45% to 76% of the total variance. This means that the questions share a common variance with other questions. As a result of the pilot study, the Cronbach Alpha value was determined to be 0.842 in the reliability test, and then a full-scale application was carried out ($0.60 \leq \alpha \leq 0.80$ is quite reliable). The survey was conducted both face-to-face and online. Participants in the research study were informed about the research and volunteers were included. Consent was obtained from volunteer participants.

In the first part of the survey, demographic questions such as age and gender were asked. The second part of the study comprised 9-31 questions designed to assess the technical infrastructure and competency levels of participants in radiotherapy clinics. The 32-53 questions assess the frequency of utilization of the existing infrastructure by technicians engaged in radiotherapy clinics. A 5-point Likert scale was used when creating some questions.

The data obtained after the survey was collected and evaluated in a single center and SPSS 28.0 was used to analyze the data. While evaluating the study data, descriptive statistical methods (frequency, percentage) were used.

3. RESULTS AND DISCUSSION

IGRT has become increasingly common over the past decade due to its numerous benefits in improving the accuracy and outcomes of radiotherapy treatment. It has been incorporated into standard radiation therapy practice in many developed countries. In our study to determine the usage status and frequency in our country, a total of 314 people participated in the survey. 45.9% of the participants were female (n = 144) and 54.1% were male (n = 170). The average age was 42.7% and was between 25-31 (n=134). The number and brands of LINACs and the number of technicians and physicists in the participants' clinics are given in Tables 1 and 2. While only 17.2% of the centres participating in the survey have a single LINAC, a significant portion have two LINACs. While the number of clinics working with a single technician is 1.6%, 79.3% of the clinics have more than four technicians. While 23.2% of the centres employ a single medical physicist, two physicians work in 34.1% of the clinics. The majority of respondents (41.4%) were aged between 18 and 24 years, while 11.5% were aged between 32 and 38 years, 3.2% were aged between 39 and 45 years, and the remainder were aged 46 years or older. The majority of participants (65%) were employed in private clinics (n = 204), while the remaining 35% were employed in public hospitals (n = 110). The majority of participants (39.2%, n=123) have between one and three years of experience, while 30.9% (n=97) have between four and six years of experience. The remaining 19.4% (n=61) have more than six years of experience. The average working hours of employees are 7-8 hours. It was observed that the clinics participating in the study had appropriate equipment and technical personnel to perform IGRT. It seems that the number of personnel per device in clinics is sufficient.

Table 1. *Number of Linear Accelerators, Technicians, and Physicists in the clinics where the participants are located*

	Number of Linear Accelerators in the Clinics				
	1	**2**	**3**	**4 and above**	**Total**
n	54	156	72	32	314
%	17,2	49,7	22,9	10,2	100
	Number of Technicians in the Clinics				
	1	**2**	**3**	**4 and above**	**Total**
n	5	15	45	249	314
%	1,6	4,8	14,3	79,3	100
	Number of Physicists in the Clinics				
	1	**2**	**3**	**4 and above**	**Total**
n	73	107	35	99	314
%	23,2	34,1	11,1	31,5	100

It is important to note that the figures shown in Figure 1 do not indicate the number of devices. According to the 2022 report of the Nuclear Regulatory Board (NDK), there are a total of 381 treatment devices in our country, including 264 LINAC, 3 Co-60, 4 MR-LINAC, 12 CyberKnife, 14 GammaKnife, 24 Tomotherapy and 60 Brachytherapy devices (NDK, 2022). According to Figure 1, 29% of the participants work with Elekta, 23% with Varian, 29% with Siemens, 13% with Tomotherapy, 14% with CyberKnife and 5% with MRLinac.

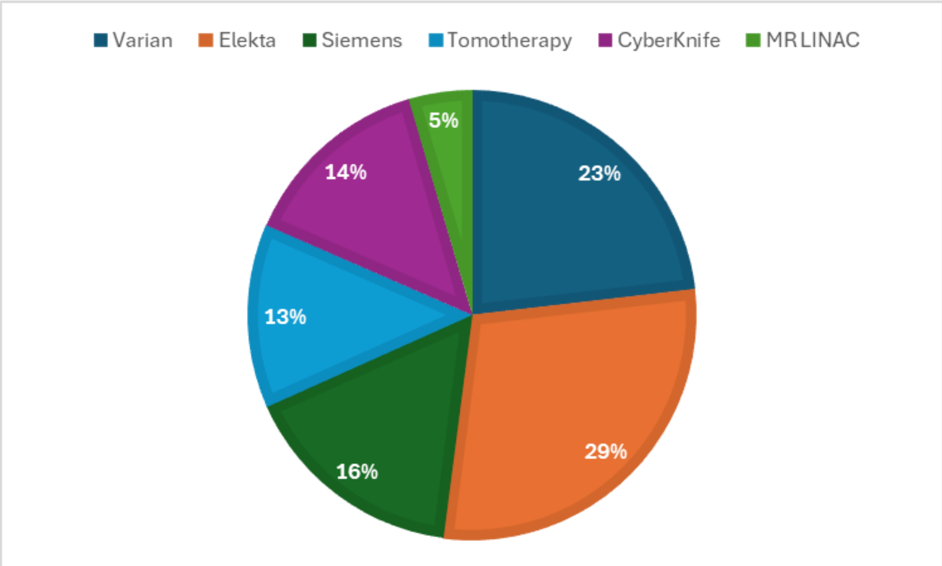

Figure 1. *Distribution of linear accelerators used by participants according to brands*

Simpson et al. (2010) demonstrated that IGRT users primarily treated genitourinary (91.1%), head and neck (74.2%), central nervous system (71.9%), and lung (66.9%) disease areas (Simpson et al., 2010). Pan et al. (2011) reported in their study with American oncologists that SBRT of the lung (51.8%), spine (39.0%) and liver (31.0%) was performed more commonly (Pan et al., 2011). In our study, daily patients treated mostly had stomach cancer (20.6%), rectal cancer (18.9%), prostate cancer (17.6%), head and neck cancer (14.5%), lung cancer (14.3%), and breast cancer (13.9%) patients. It is seen that the number of patients received daily in a center varies between 40-59. The number of patients treated by the participants daily is given in Table 2.

Tumour tracking systems used in the clinics where the participants worked are shown in Figure 2.

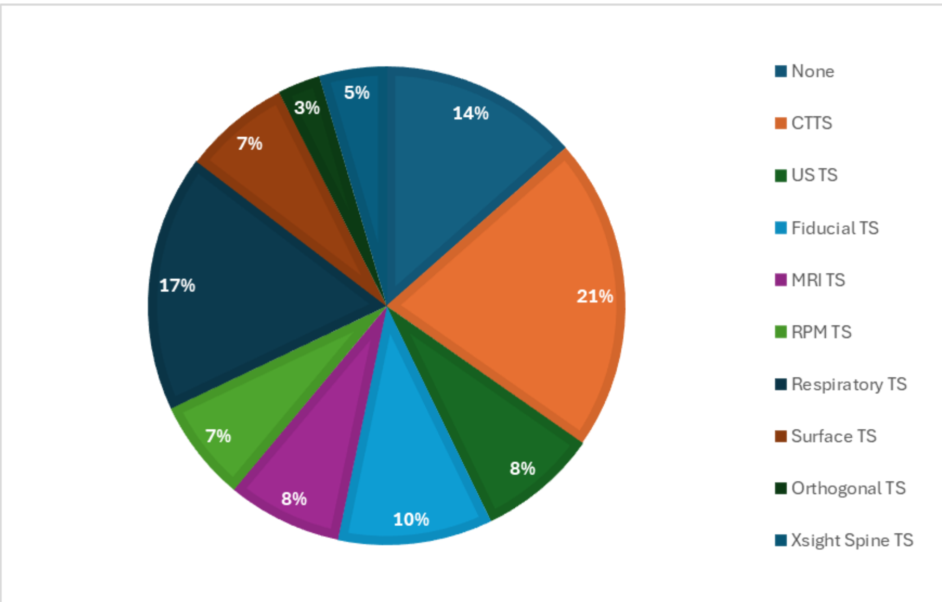

Figure 2. *Percentage distribution of tumour tracking systems used by participants in the clinics where they work*

Table 2. *Daily number of patients treated in the clinics where the participants are located*

	Daily number of breast cancer patients						
	None	**1-10**	**11-15**	**16-20**	**21-40**	**41-60**	**Total**
n	13	**102**	93	60	25	21	314
%	4,1	**32,5**	29,6	19,1	8	6,7	100
	Daily number of prostate cancer patients						
	None	**1.Eki**	**Kas.15**	**16-20**	**21-40**	**41-60**	**Total**
n	27	**129**	79	31	23	25	314
%	8,6	**41,1**	25,2	9,9	7,3	8	100
	Daily number of lung cancer patients						
	None	**1.Eki**	**Kas.15**	**16-20**	**21-40**	**41-60**	**Total**
n	12	**105**	103	50	21	23	314
%	3,8	**33,4**	32,8	15,9	6,7	7,3	100
	Daily number of stomach cancer patients						
	None	**1.Eki**	**Kas.15**	**16-20**	**21-40**	**41-60**	**Total**
n	19	**151**	63	35	10	36	314
%	6,1	**48,1**	20,1	11,1	3,2	11,5	100
	Daily number of rectum cancer patients						
	None	**1.Eki**	**Kas.15**	**16-20**	**21-40**	**41-60**	**Total**
n	30	**139**	68	28	9	40	314
%	9,6	**44,3**	21,7	8,9	2,9	12,7	100
	Number of patients per day head and neck						
	None	**1.Eki**	**Kas.15**	**16-20**	**21-40**	**41-60**	**Total**
n	28	**106**	83	36	36	25	314
%	8,9	**33,8**	26,4	11,5	11,5	8	100

According to the HERO survey by the European Society for Health Economics in Radiation Oncology, less than half of all linear accelerators in Europe (49%) are capable of IGRT. The percentages of linear accelerators capable of IGRT in different countries are as follows: 53%; Netherlands: 95%) (Vaandering et al., 2023). It is seen that 81.1% SRS/SBRT, 62.1% TBI, 54.5% Brachytherapy and 82.2% Adaptive radiotherapy applications are performed in the clinics participating in the survey in our country. The clinics where the participants work, the treatment modalities and the frequencies they use are shown in Table 3.

Table 3. *Clinics where the participants worked, treatment modalities and frequencies used*

	Is SRS/SBRT applied?		
	Yes	**No**	**Total**
n	**257**	57	314
%	**81,8**	18,2	100
	Is TBI performed?		
	Yes	**No**	**Total**
n	**195**	119	314
%	**62,1**	37,9	100

***Table 3.** continued*

	Is Brachytherapy applied?				
	Yes		**No**		**Total**
n	**171**		143		314
%	**54,5**		45,5		100
	Is Adaptive RT applied?				
	Yes		**No**		**Total**
n	**258**		56		314
%	**82,2**		17,8		100
	Monthly frequency of SRS/SBRT application				
	0-5	**6-10**	**11-15**	**16 and above**	**Total**
n	147	79	47	41	314
%	46,8	25,2	15	13,1	100
	Monthly frequency of TBI application				
	0-5	**6-10**	**11-15**	**16 and above**	**Total**
n	251	42	18	3	314
%	79,9	13,4	5,7	1	100
	Monthly frequency of brachytherapy application				
	0-5	**6-10**	**11-15**	**16 and above**	**Total**
n	209	49	39	17	314
%	66,6	15,6	12,4	5,4	100
	Monthly frequency of Adaptive RT application				
	0-5	**6-10**	**11-15**	**16 and above**	**Total**
n	164	89	47	14	314
%	52,2	28,3	15	4,5	100

Nabavizadeh et al. (2016) administered a survey containing 5979 questions regarding IGRT to members of the American Society of Radiation Oncology (ASTRO) and found that the most preferred method was portal imaging (67.4%). This was reported to be followed by kV planar imaging (32%) and CBCT (10.4%). In their study, it was reported that ultrasound-based (most commonly in the intact prostate, 4.8%), fluoroscopy-based (most commonly in the lung, 1.7%), or CT-guided tracking systems were used (most commonly in the prostate fossa, 2.4%) (Nabavizadeh et al., 2016).

Beasley et al. (2019) administered a survey containing a maximum of 32 questions regarding lung stereotactic ablative radiotherapy (SABR) to 62 radiotherapy centers in the UK. Centers reported 6% use of kV-based monitoring and 88% use of CBCT. They reported in their study that two-thirds (66.7%) of the centers participating in the survey did not use any active tumour tracking system, and 11% used breath holding and surface tracking systems. It was also stated that 14% used kV tumour tracking, while 8% used an internal tracking system (Beasley et al., 2019).

Batumalai et al. (2017) investigated the frequency of IGRT use in Australia. CBCT (97%), kV electronic portal image (EPI) (89%) and MV EPI (75%) methods were most frequently used in their studies. They reported in their study that RPM was most commonly applied in patients with central nervous system (CNS) (12%), breast (12%) and lung (6%). While the spirometer (ABC) system is used in breast (6%) and gastrointestinal (GI) cancers (3%), optical (VisionRT & C-rad) systems are used in the CNS (3%) and breast (3%) patients. They reported that the radiofrequency (Calypso) system was used in the CNS (3%), lung (3%) and GI (3%), while the ultrasound tracking system was used in the GI (6%) and breast (3%) (Batumalai et al., 2017).

Simpson et al. (2010) reported that the most commonly used IGRT methods are MV planar (62.7%), volumetric (58.8%) and kV planar imaging (57.7%). They reported that the percentage of use of ultrasound, video, megavoltage (MV) planar, kilovoltage (kV) planar and volumetric technologies is 22.3%, 3.2%, 62.7%, 57.7%, and 58.8% respectively (Simpson et al., 2010).

According to the results obtained from our study, it was observed that MV ports (35.7%) were used more frequently in daily checks. It has been stated that 1-25 MV ports are drawn daily. This is followed by CBCT and kV port controls. It was observed that the most common monitoring system was RPM. These are followed by fiducial, surface, X-spine, orthogonal kV and US tracking systems, respectively. It is thought that these numbers are shaped by both the availability of follow-up systems and the incoming patient profile. The daily and monthly numbers of patients treated with these follow-up systems are given in Table 4.

Table 4. *Number of daily and monthly follow-ups received by follow-up systems in the clinics where the participants are located*

	Number of kV Ports per Day					
	0	**1-25**	**26-50**	**51-75**	**76-100**	**Total**
n	75	**81**	60	25	73	314
%	23,9	**25,8**	19,1	8	23,2	100
	Daily Number of MV Ports					
	0	**1-25**	**26-50**	**51-75**	**76-100**	**Total**
n	90	**112**	61	31	20	314
%	28,7	**35,7**	19,4	9,9	6,4	100
	Number of CBCTs per day					
	0	**1-25**	**26-50**	**51-75**	**76-100**	**Total**
n	76	**92**	73	36	37	314
%	24,2	**29,3**	23,2	11,5	11,8	100
	Daily Number of CT Follow-Ups					
	0	**1-25**	**26-50**	**51-75**	**76-100**	**Total**
n	**133**	99	51	21	10	314
%	**42,4**	31,5	16,2	6,7	3,2	100
	Daily Number of MRI Follow-ups					
	0	**1-25**	**26-50**	**51-75**	**76-100**	**Total**
n	**178**	74	42	18	2	314
%	**56,7**	23,6	13,4	5,7	0,6	100
	Daily RPM Tracking Count					
	0	**1-25**	**26-50**	**51-75**	**76-100**	**Total**
n	**163**	87	43	16	5	314
%	**51,9**	27,7	13,7	5,1	1,6	100

Table 4. *continued*

	Monthly Number of Surface Tracking					
	0	**1-25**	**26-50**	**51-75**	**76-100**	**Total**
n	**141**	92	59	15	7	314
%	**44,9**	29,3	18,8	4,8	2,2	100
	Monthly Respiratory Monitoring Number					
	0	**1-25**	**26-50**	**51-75**	**76-100**	**Total**
n	113	**126**	45	19	11	314
%	36	**40,1**	14,3	6,1	3,5	100
	Monthly Number of Fiducial Follow-Ups					
	0	**1-25**	**26-50**	**51-75**	**76-100**	**Total**
n	**165**	98	35	15	1	314
%	**52,5**	31,2	11,1	4,8	0,3	100
	Monthly Orthogonal kV Monitoring Number					
	0	**1-25**	**26-50**	**51-75**	**76-100**	**Total**
n	**215**	60	28	8	3	314
%	**68,5**	19,1	8,9	2,5	1	100
	Monthly Number of Xspine Followers					
	0	**1-25**	**26-50**	**51-75**	**76-100**	**Total**
n	**208**	73	20	13	0	314
%	**66,2**	23,2	6,4	4,1	0	100
	Monthly US Tracking Number					
	0	**1-25**	**26-50**	**51-75**	**76-100**	**Total**
n	**197**	57	40	14	6	314
%	**62,7**	18,2	12,7	4,5	1,9	100

The answers given by the participants regarding the use of tumour tracking systems are shown in Table 5.

Table 5. *Participants' answers regarding the use of tumour tracking systems*

Is it necessary to use IGRT systems in the clinic?						
	Definitely not	**Not at all**	**No idea**	**To some extent**	**Quite a bit**	**Total**
n	0	14	19	**221**	60	314
%	0	4,5	6,1	**70,4**	19,1	100
Do you think IGRT systems are used adequately in your clinic?						
	Definitely not	**Not at all**	**No idea**	**To some extent**	**Quite a bit**	**Total**
n	8	21	**202**	51	32	314
%	2,5	6,7	**64,3**	16,2	10,2	100

Table 5. *continued*

Do you think the reason why IGRT systems are less used is the lack of equipment?						
	Definitely not	**Not at all**	**No idea**	**To some extent**	**Quite a bit**	**Total**
n	12	29	**219**	47	7	314
%	3,8	9,2	**69,7**	15	2,2	100
Do you think the reason for the low use of IGRT systems is the large number of patients?						
	Definitely not	**Not at all**	**No idea**	**To some extent**	**Quite a bit**	**Total**
n	9	36	**210**	42	17	314
%	2,9	11,5	**66,9**	13,4	5,4	100
Do you think the reason why IGRT systems are less used is the lack of technicians?						
	Definitely not	**Not at all**	**No idea**	**To some extent**	**Quite a bit**	**Total**
n	15	37	**207**	43	12	314
%	4,8	11,8	**65,9**	13,7	3,8	100
Do you think the reason why IGRT systems are less used is the lack of physicists?						
	Definitely not	**Not at all**	**No idea**	**To some extent**	**Quite a bit**	**Total**
n	15	**216**	40	33	10	314
%	4,8	**68,8**	12,7	10,5	3,2	100
Do you think the reason for the low use of IGRT systems is the lack of oncologists?						
	Definitely not	**Not at all**	**No idea**	**To some extent**	**Quite a bit**	**Total**
n	17	**205**	59	29	4	314
%	5,4	**65,3**	18,8	9,2	1,3	100
Do you think the reason for the underuse of IGRT systems is lack of education?						
	Definitely not	**Not at all**	**No idea**	**To some extent**	**Quite a bit**	**Total**
n	24	**203**	32	46	9	314
%	7,6	**64,6**	10,2	14,6	2,9	100
Do you think the reason why IGRT systems are less used is to reduce overdose intake?						
	Definitely not	**Not at all**	**No idea**	**To some extent**	**Quite a bit**	**Total**
n	16	18	**217**	54	9	314
%	5,1	5,7	**69,1**	17,2	2,9	100
Do you think the reason why IGRT systems are less used is because they are not paid for?						
	Definitely not	**Not at all**	**No idea**	**To some extent**	**Quite a bit**	**Total**
n	23	20	**216**	43	12	314
%	7,3	6,4	**68,8**	13,7	3,8	100

When asked whether the use of IGRT is necessary, 70.4% of the participants answered Quite a bit. To the question of whether the use of IGRT is sufficient, 64.3% of the survey participants answered "I have no idea" and 16.2% answered "Quite a bit". When asked whether the use of IGRT was related to lack of equipment, large number of patients, and lack of technicians, the majority answered "I have no idea." The majority of participants think that the number of oncologists and physicists and the lack of training are not an obstacle to the use of IGRT. The majority of those who said they had no idea about the questions investigating the relationship between the low use of IGRT and the cost or low doses of patients were the ones who said they had no idea.

A certain number of centers and personnel could be reached with the survey applied. There is a need for larger studies that will include all centers in the country. Considering that the use of IGRT will increase in the future, dissemination of the necessary protocols and applications, control of the application and detection of deficiencies can be solved with such surveys.

4. CONCLUSION

There has been a significant increase in the number of radiotherapy machines over the past 10 years. However, the use and prevalence of tumor imaging techniques in treatment is questionable. The International Atomic Energy Agency (IAEA) provides a nuanced interpretation of the staffing recommendations for radiation oncology clinics outlined by the World Health Organization (WHO). While the WHO specifies the need for 1 radiotherapy technician for every 60 patients, 1 health physicist for every 400 patients, and 1 megavoltage device for every 300 new patients, the IAEA expands on these guidelines by emphasizing the complexity and context-specific nature of staffing needs. The IAEA acknowledges these baseline recommendations but argues that staffing levels should also account for the complexity of the treatments provided, the specific equipment used, and the percentage of time staff spend on non-clinical duties such as teaching, research, and management. This approach aims to ensure safe, efficient, and high-quality radiotherapy services tailored to each clinic's unique situation (Podgorsak, 2005; WHO, 2020). According to the survey results we conducted with a limited number of participants, it is thought that the number of patients, technicians and personnel per machine is sufficient in the surveyed clinics. However, a more comprehensive investigation is needed. However, considering that the general population and the incidence of the disease are increasing, it is thought that there is a need for technicians, physicists and physicians.

IGRT has become a mainstay of modern RT. By using imaging techniques such as portal imaging, CT, MRI or ultrasound, it is possible to cover the tumor with a sufficient radiation dose and protect normal tissues. However, the routine use of tumor tracking systems appears to vary from clinic to clinic. It is thought that national protocols regarding the use of IGRT have not yet been established and efforts to develop them should be initiated. The number of image-guided treatments is expected to increase as reimbursement policies change.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

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