

Online Radiotherapy Information Application

Online Radyoterapi Bilgilendirme Aplikasyonu

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**Abstract:** The aim of this study is to inform patients about the malfunction of the device on which radiotherapy is applied, the duration of treatment, the time of treatment, and to obtain disease-specific information. We provide real time information about the status of two external (linear accelerator), one internal (brachytherapy) RT devices and the computerized tomography (CT) simulator used for RT planning (operating/under maintenance/faulty), which we treat in our clinic. A 32-question survey regarding application satisfaction was conducted on 151 cases using the application, and the contribution of the application to the transportation time and cost and the patient's treatment compliance in patients receiving RT was investigated. 117 (77.5%) of 151 patients received curative RT and 34 (22.5%) received palliative RT. Median age is 55 (min:28, max:80). 102 (67.5%) patients stated that the application saved them time on the road and/or travel expenses. Among the questions asked, the highest scores were received by the questions "I am sufficiently informed about the use of the application", "I find the application sustainable" and "I recommend the application" with a mean of 4.58. Applications in radiation oncology are lacking in providing patient information in RT patients and sharing device information in order to prevent unnecessary transport, especially in cases where RT is applied. Instant information about RT devices and information specific to the patient's diagnosis are very important for patient treatment compliance, and applications need to be developed to improve it.

**Keywords:** Mobile Application, Radiotherapy, Device Malfunction, Instant Patient Information

**Özet:** Bu çalışmanın amacı, hastalara radyoterapi (RT) uygulanan cihazın arızası, tedavi süresi, tedavi zamanı hakkında ve hastalığa özgü bilgi vermektir. Kliniğimizde tedavi ettiğimiz iki eksternal (lineer hızlandırıcı), bir internal (brakiterapi) RT cihazı ve RT planlamasında kullanılan bilgisayarlı tomografi (BT) simülatörünün (çalışıyor/bakım altında/arızalı) durumu hakkında gerçek zamanlı bilgi sağlanmıştır. Uygulamayı kullanan 151 vakaya uygulama memnuniyetine ilişkin 32 soruluk bir anket uygulanmış ve RT alan hastalarda uygulamanın ulaşım süresine, maliyetine ve hastanın tedaviye uyumuna katkısı araştırılmıştır. 151 hastanın 117'si (%77,5) küratif RT ve 34'ü (%22,5) palyatif RT almıştır. Ortanca yaş 55'tir (min:28, maks:80). 102 (%67,5) hasta, uygulamanın kendilerine yolda ve/veya seyahat masraflarında zaman kazandırdığını belirtmiştir. Sorulan sorular arasında en yüksek puanları "Uygulamanın kullanımı hakkında yeterince bilgi sahibiyim", "Uygulamayı sürdürülebilir buluyorum" ve "Uygulamayı tavsiye ediyorum" soruları almış olup ortalama puan 4,58 (min:0 , maks: 5)'tür. Radyasyon onkolojisindeki uygulamalar, RT hastalarında özellikle gereksiz hasta transportunu önlemek için hasta bilgisi sağlama ve cihaz bilgisi paylaşma konusunda eksiktir. RT cihazları hakkında anında bilgi ve hastanın tanısına özgü bilgi, hastanın tedavi uyumu için çok önemlidir ve bunu iyileştirmek için uygulamalar geliştirilmelidir.

**Anahtar Kelimeler:** Mobil Uygulama, Radyoterapi, Cihaz Arızası, Anlık Hasta Bilgilendirmesi

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## 1. Introduction

Technological developments in the 21st century have enabled us to have a better communication network, regardless of socioeconomic status, age group and population. Today, radiotherapy (RT) is an important component in the treatment of cancer patients. As it is known, one in every two cancer patients needs RT during their treatment. Mobile technologies can be used as a guiding tool for patients receiving RT, both to provide personalized information about the disease and to provide guidance on technical issues such as device availability, device malfunction, and appointment time reminders while receiving treatment. Although there are applications in oncology such as side effect monitoring and follow-up of cases receiving chemotherapy (CT), there is still no application to inform patients about the technical status of the RT device (1-3). RT services continue in certain centers due to both strict radiation safety and the cost of the devices. This situation causes patients to reach these centers from a certain distance (from neighboring provinces and districts). In the United States, the average distance of RT centers to the patient's home is 36 km (4). It is thought that notifying patients of a possible device malfunction in advance will reduce unnecessary transportation of cancer patients, labor costs, time and costs. In general, possible disruptions occur in these high-tech devices, not only due to malfunction but also not providing treatment if they do not reach the desired level at quality control points. The downtime rate in this radiation treatment varies between 5-15%. In cases where RT is ongoing, outpatient clinic check-ups are required at certain intervals (such as blood values monitoring, side effect evaluation, Chemotherapy plan and continuation). However, from time to time, some cases disrupt their control, and these disruptions can change the course of treatment, including oncological outcomes (treatment response, progression-free survival, overall survival).

Today, RT is an important component in the treatment of cancer patients. Toxicity monitoring during RT is very important to limit possible side effects. In addition, it is known that chemotherapy administered

simultaneously with RT as a radiosensitizer increases survival by 10% in some tumor types (5). Although patients are reminded of their outpatient clinic check-ups and their importance at the beginning and throughout the treatment, some patients forget their check-ups and even their chemotherapy days. These processes also affect oncological outcomes. Due to the cost of RT devices, RT centers are available in certain regions and patient transportation is required from neighboring provinces and districts. Considering that RT generally takes an average of 2 weeks in palliative patients and an average of 5-6 weeks (8 weeks in some cases) in curative patients, transportation for cases coming from out of town, days of device malfunction can lead to loss of time, financial loss and emotional trauma. In case of device malfunction, cases are called by the secretariat in the order of treatment hours, and some cases are on their way by the time they are called. Therefore, a more effective communication system is essential in this group. Applications are software that can run on web browsers, computers, mobile phones and other electronic devices that work as tablets. They are simple, independent programs that enable users to perform certain tasks in a simple and user-friendly manner (6). In recent years, thousands of applications have been developed from all fields of science, and such applications are increasing in oncology (7-10). There are many cancer-focused applications in the digital market, and while there were 166 applications before 2014, this number has increased rapidly after 2014 (11). When we look at the application contents, most of them lack patient information, treatment and side effects monitoring. Applications in oncology are lacking in providing patient information in RT patients and sharing device information in order to prevent unnecessary transport, especially in cases where RT is applied.

The aim of the study is to inform patients who applied to Osmangazi University Faculty of Medicine Department of Radiation Oncology about the disease, report device suitability / malfunction status, improve oncological

results, increase treatment comfort, treatment compliance and awareness level.

## 2. Materials and Methods

151 patients who started RT in the Radiation Oncology Department of Osmangazi University Faculty of Medicine downloaded the free "Radiotherapy Information" application from their smartphones via Play Store (Android, Google) and App Store (iOS, Apple) from the beginning of their treatment.

Then, data was obtained through a survey administered to the patients. Survey questions are available in Table-1a and Table-1b. The extent to which patients benefited from the application and in what cases it helped the treatment process was determined by a survey administered to the patients. The technical part of the application and its applicability to the treatment process were also examined in the survey. The survey form was filled out by the patients at the end of RT. There are 32 questions in total in the survey. 14 of these 32 questions consist of questions suitable for the Likert scale (strongly agree---strongly disagree). The remaining 6 consist of open-ended questions and the remaining 12 consist of questions with options. The survey consists of questions asking how patients are transported from home to the RT center, the distance between home and RT center, the amount of time and travel costs saved in case of device malfunction/maintenance thanks to the application, whether the training videos contribute to the patients, and the applicability of the application.

SPSS 22.0 (released 2013, IBM SPSS Statistics for Windows, version 22.0; IBM Corp., Armonk, NY, USA) was used in the analyses. T-test was used in the analysis of the effectiveness of the application on patients. Data are summarized as mean  $\pm$ SD. Analysis of variance (ANOVA) was used to determine differences between group means, and Tukey's test was used in post hoc tests to determine differences. Chi-square test was used in the analysis of the created cross-tables.  $P < 0.05$  was considered statistically significant. Regarding the reliability of the survey, Cronbach's alpha statistical method was used.

Cronbach's alpha value is a value ranging from 0 to 1 and is a coefficient that measures the correlation between answers in a survey by analyzing the answers given by participants. As it approaches 1, the security of the indicators increases. The generally accepted lower limit is 0.7, but some studies have stated that 0.6 is also an acceptable value. The Cronbach Alpha Reliability classification is as follows: Very low ( $\alpha \leq 0.30$ ); Low ( $0.30 < \alpha \leq 0.60$ ); Moderate ( $0.60 < \alpha \leq 0.75$ ); High ( $0.75 < \alpha \leq 0.90$ ) and Very high ( $\alpha > 0.90$ ) (12).

Before the study, permission was obtained from Eskişehir Osmangazi University Ethics Committee.

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## 3. Results

We asked a total of 151 cancer patients to whom we applied RT to download the application and answer the application evaluation survey at the end of the treatment. While 117 of the patients received curative RT, palliative RT was planned in 34 cases. The median age of the participants is 55 (min: 28, max: 80). 115 (76.2%) of the patients participating in the survey come from within the city and 36 (23.8%) come from outside the city. 92(60.9%) patients stated that the application did not save them financially, 28(18.5%) patients made a profit of 0-200 TL during RT, 18(11.9%) patients made a profit of 201-400 TL, 3(2%) patients stated that they made a profit of 401-600 TL and 10 (6.6%) patients stated that they made a profit of more than 600 TL.

However, there are 102 (67.5%) who stated that they saved time and/or travel expenses. 66.2% of the patients who came to RT stated that they came to treatment with their own cars. While 87 (57.6%) patients watched the educational videos in the application, 51 (33.8%) did not watch them, and 13 (8.6%) stated that they had no information about the video. 141 (93.4%) patients thought that the application guided them correctly. There are

14 questions in the survey that include the answers "strongly agree/agree/neutral/disagree/strongly disagree". The results regarding these questions are available in Table-2.

The average score given to the application by survey participants is 8.28 out of 10 (min: 3-max: 10). Cronbach's alpha statistical method was used regarding survey reliability. This coefficient > 0.80 indicates high reliability. In the survey in the current study, Cronbach's alpha coefficient was found to be 0.887. Pearson correlation test was used to test the

consistency between the score given to the application and the score given to the questions created in accordance with the Likert scale. A significant relationship was found between these two data ( $p < 0.001$ ). Among the questions asked, the lowest score was the question "I saved money and expenses thanks to the application" with a mean of 3.84, and the highest score was the question "I was sufficiently informed about the use of the application", "I find the application sustainable" and "I recommend the application" with a mean of 4.58. has received.

**Table-1a.** Survey Questions

<p>1- How far is your home from radiotherapy center ?</p> <p><input type="checkbox"/> 0-20 km</p> <p><input type="checkbox"/> 21-40 km</p> <p><input type="checkbox"/> 41-60 km</p> <p><input type="checkbox"/> 61-80 km</p> <p><input type="checkbox"/> &gt; 80 km</p>
<p>2- Is your house in Eskişehir City Center ?</p> <p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p>
<p>3- How do you get to the Radiotherapy center?</p> <p><input type="checkbox"/> With my own car</p> <p><input type="checkbox"/> By urban public transportation</p> <p><input type="checkbox"/> By intercity public transportation</p> <p><input type="checkbox"/> Health care services- By ambulance</p> <p><input type="checkbox"/> By walk</p>
<p>4-How many TL do you estimate that you saved ?</p> <p><input type="checkbox"/> I've not saved any Money.</p> <p><input type="checkbox"/> 0-200 TL</p> <p><input type="checkbox"/> 201-400 TL</p> <p><input type="checkbox"/> 401-600 TL</p> <p><input type="checkbox"/> More than 600 TL</p>
<p>5- Have you watched the training videos ?</p> <p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p> <p><input type="checkbox"/> I did not know there was a training video.</p>
<p>6-If you watched the training videos, did you find them useful ?</p> <p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p> <p><input type="checkbox"/> I'm not sure.</p>

<p>7-Were there any points that you did not understand from the training videos you watched?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> I did not know there was a training video.</p>
<p>8-Were you able to ask your doctor about the issues that you did not understand in the training videos?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>
<p>9-How often do you use the application?</p>
<p>10-How many times do you login to the application in a day ?</p>
<p>11- Have you ever not wanted to use the application?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> I'm not sure.</p>
<p>12-If your answer is 'Yes' to the question above, why did you not want to use it?</p>
<p>13-Has the application ever misled you?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> I'm not sure.</p>
<p>14- If your answer is 'Yes' to the question above, how often did it happen ?</p>
<p>15-Which feature of the application did you benefit from the most? (You can tick more than one option)</p> <p><input type="checkbox"/> Notification of the device failure <input type="checkbox"/> Training videos <input type="checkbox"/> Tracking my treatment days <input type="checkbox"/> Other (.....) .....)</p>
<p>16-Is there a feature you would like to add to the application?</p>
<p>17- Is there a feature you would like to change in the application?</p>
<p>18- If you want to rate the application between 1-10, how many points would you give?</p> <p><input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10</p>

**Table-1b.** Survey Questions

QUESTION	Absolutely I agree	I agree	I'm undecided	I do not agree	I strongly disagree
I had no problems downloading the application to my phone and/or registering.					
I was sufficiently informed about the use of online radiotherapy application.					
I had no difficulty in using the online radiotherapy application.					
After I started using the online radiotherapy application, I saved on travel time and/or travel expenses.					
I found the training given by the doctor / medical physicist / secretary regarding the use of the application useful.					
Thanks to the application, I was notified of device malfunctions in a timely manner.					
I find the practice sustainable.					
I would also like to receive other notifications about my treatment from the application (outpatient clinic control days, chemotherapy day reminders, things I should pay attention to during treatment, etc.).					
I recommend the application.					
Since using the application, I have been able to go to my outpatient clinic check-ups more regularly while receiving radiotherapy.					
I did not experience any technical problems while using the application during my treatment.					
I think that the information given by the secretaries and the application usage brochure are sufficient for the necessary assistance in using the application.					
Thanks to this application, my compliance with the treatment and my motivation increased.					
I find this application more useful when compared to other phone applications I use in daily life.					

**Table-2.** Likert Scale Questions

QUESTION	Absolutely I agree n(%)	I agree n(%)	I'm undecided n(%)	I do not agree n(%)	I strongly disagree n(%)
I had no problems downloading the application to my phone and/or registering.	99 (%65.6)	43 (%28.5)	0 (%0)	6 (%4)	3 (%2)

I was sufficiently informed about the use of online radiotherapy application.	94 (%62.4)	53 (%35.1)	2 (%1.3)	2 (%1.3)	0 (%0)
I had no difficulty in using the online radiotherapy application.	92 (%60.9)	48 (%31.8)	2 (%1.3)	7 (%4.6)	2 (%1.3)
After I started using the online radiotherapy application, I saved on travel time and/or travel expenses.	54 (%35.8)	48 (%31.8)	25 (%16.6)	19 (%12.6)	5 (%3.3)
I found the training given by the doctor / medical physicist / secretary regarding the use of the application useful.	84 (%55.6)	63 (%41.7)	4 (%2.6)	0 (%0)	0 (%0)
Thanks to the application, I was notified of device malfunctions in a timely manner.	89 (%58.9)	57 (%37.7)	4 (%2.6)	1 (%0.7)	0 (%0)
I find the practice sustainable.	93 (%61.6)	53 (%35.1)	5 (%3.3)	0 (%0)	0 (%0)
I would also like to receive other notifications about my treatment from the application (outpatient clinic control days, chemotherapy day reminders, things I should pay attention to during treatment, etc.).	87 (%57.6)	47 (%31.1)	10 (%6.6)	6 (%4)	1 (%0.7)
I recommend the application.	91 (%60.3)	57 (%37.7)	3 (%2)	0 (%0)	0 (%0)
Since using the application, I have been able to go to my outpatient clinic check-ups more regularly while receiving radiotherapy.	63 (%41.7)	47 (%31.1)	18 (%11.9)	21 (%13.9)	2 (%1.3)
I did not experience any technical problems while using the application during my treatment.	84 (%55.6)	59 (%39.1)	4 (%2.6)	4 (%2.6)	0 (%0)
I think that the information given by the secretaries and the application usage brochure are sufficient for the necessary assistance in using the application.	85 (%56.1)	60 (%39.7)	4 (%2.6)	1 (%0.7)	1 (%0.7)
Thanks to this application, my compliance with the treatment and my motivation increased.	65 (%43)	59 (%39.1)	24 (%15.9)	3 (%2)	0 (%0)
I find this application more useful when compared to other phone applications I use in daily life.	62 (%41.1)	55 (%36.4)	28 (%18.5)	5 (%3.3)	1 (%0.7)

#### 4. Discussion

Smartphones have revolutionized people's lives in medical information in recent years. In 2022, 78% of the world's population owned a smartphone, with usage rates increasing over the years. A wide variety of health apps are available for smartphones. While the first of the two categories of applications is healthy living/fitness and health management applications, other categories include medication reminders and electronic patient portal. The World Health Organization (WHO) classifies such tools under the label MHealth or eHealth and defines them as 'care and public health programs with mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants and other wireless devices' (13).

Cancer is the leading cause of death worldwide. Accordingly, there are various

cancer-focused applications and the number of research articles examining the use of applications in the field of general/clinical oncology is increasing. According to Kessel et al., the majority of healthcare professionals are in favor of the use of oncological applications by patients (14). In addition, mobile applications for the surveillance and follow-up of cancer patients receiving RT are thought to be useful (15-16). Mobile applications have several advantages, including monitoring patient-reported outcomes and improving patient compliance, optimizing patient interaction with healthcare professionals, and educating patients. Additionally, these practices can have positive psychological effects by empowering patients to follow treatment, monitor side effects, or schedule follow-up appointments. Despite applications in the field of oncology in



general and echoes in the scientific literature, little is known about their specific effects and uses in the field of radiation oncology.

Cancer is one of the leading causes of death worldwide, with more than 19.3 million newly diagnosed cases (17). RT has an important role in the treatment of cancer cases, and many patients require RT at some stage of their treatment. The rapid development of digital technologies has led to the use of a wide variety of mobile and Web applications for screening, diagnosis, treatment and education in cancer care (18). In a study conducted by Denis et al., it was reported that early initiation of palliative care with the application improved survival (19). When we look at the literature, there are several applications for RT cases. In these applications, symptom and side effect monitoring was performed for patients during and after RT, and radiation dose calculation was performed for healthcare professionals (20-24).

It is very important that the patient reaches the RT center and receives treatment without any problems. In breast surgery, surgeons may choose mastectomy or lumpectomy depending on the distance of the patient's home to the RT center. Hypofractionation RT applications can be chosen to shorten the patient's treatment time. As in Covid-19 outbreaks, people's unnecessary use of transportation vehicles can increase contamination and health risks. The transportation cost of patients living in cities outside the RT center can exceed \$1500 (4, 25)

Although mobile apps have many benefits, for some applications there is not enough evidence to support their use. Lack of current information and insufficient scientific evidence prevent mobile applications from being a useful tool. Due to the diversity of existing applications and the lack of scientific studies, it is difficult to determine the most appropriate application and the most effective method of use for each patient. In our current pilot study, it was aimed to inform patients undergoing RT about device malfunctions online, to announce device maintenance in advance, and to provide information about RT

and cancer with videos. The main purpose of the first version of the planned application is to provide online real-time notifications to patients about malfunctions, reduce unnecessary travel expenses and time spent on the road, and increase patient compliance with treatment. In later versions, it is planned to add additional features such as reminding the patient of outpatient clinic checks and chemotherapy days, side effect monitoring and informing about side effects, and providing doctor-patient communication. The application is currently only available in Turkish. English and Arabic languages can also be added.

In the current study, 102 (67.5%) patients reported that time spent on the road and travel costs were reduced thanks to the mobile application. Due to the expense of RT devices and strict radiation safety measures, RT centers are generally located in big cities and centres. Patients living in the periphery lose both time and money in reaching RT services. Since RT devices are highly technological devices, malfunctions are generally unpredictable and repairs may take hours and sometimes even days if parts are needed from abroad. Additionally, these devices require frequent calibration. In case of device failure, patients have to return home before RT can be administered. RT is a long treatment process and may last up to 8-9 weeks in some patients. When we look at Türkiye in general, inpatient Radiation Oncology departments are quite few. In case of every malfunction/calibration, patients incur unnecessary time loss and travel expenses. In the current study, unnecessary time and travel expenses were saved. In addition, patients' compliance with the application is quite high, and 146 (96.6%) of the 151 patients surveyed found the application sustainable. Additionally, 148 (98%) patients reported that they recommended the application.

## 5. Conclusion

Mobile applications have become an important tool that facilitates access to information that can be used, developed and tested by expert healthcare personnel and patients, and facilitates patient safety and



communication. Such applications will have significant benefits in patient practice. It is thought that these applications will make life easier for patients receiving RT via mobile phones and may even improve oncological

outcomes by increasing patient compliance with the treatment. In light of all these requirements, it is recommended that such an application be used in all centers for patients undergoing RT.

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#### Ethics

**Ethics Committee Approval:** The study was approved by Eskisehir Osmangazi University Noninterventional Clinical Research Ethical Committee (Decision no: 19, Date: 26.04.2022).

**Informed Consent:** The authors declared that it was not considered necessary to get consent from the patients because the study was a retrospective data analysis.

**Authorship Contributions:** Medical Practices: MY, DE. Concept: MY,DE,DK,KD. Design: MY,DE,DK,KD. Data, Collection or Processing: MY,DE,DK,KD,ÖB. Analysis or Interpretation: MY,DE,DK,KD. Literature Search: MY,DE,DK,KD Writing: MY,DE,DK,KD

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