The Use of Teleradiology in Turkey: Current Situation and Attitudes of Radiologists

Türkiye'de Teleradyoloji Kullanımı: Mevcut Durum ve Radyologların Tutumları

Bülent PETİK,[a]
Mehmet SIRIK,[a]
Deniz ÇOLAK,[a]
Tuncay DUMAN[a]

[a]Department of Radiology, Adıyaman University Faculty of Medicine, Adıyaman

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Yazışma Adresi/*Correspondence:*
Bülent PETİK
Adıyaman University Faculty of Medicine, Department of Radiology, Adıyaman, TÜRKİYE/TURKEY
petikbulent@yahoo.com

ABSTRACT Objective: In this study, we aimed to evaluate the teleradiology use in the daily practices of the radiologists and the attitudes regarding the use of teleradiology in Turkey. **Material and Methods:** The descriptive cross-sectional study was based on a 27-item questionnaire which was administered online and through in-person structured interviews. The questionnaires that were duly filled and returned within one year were included in the study. **Results:** A total of 226 radiologists participated in the study. Of these, 67 (29.6%) were working at university hospitals, 45 (19.9%) at training and research hospitals, 59 (26.1%) at state hospitals, 55 (24.3%) at private hospitals. Level of teleradiology knowledge was revealed as very little in 2.2%, little in 14.2%, moderate in 43.4%, considerable in 26.1%, and expert in 14.2%. The most common format for transmission of teleradiology data was Digital Imaging and Communications in Medicine (DICOM) 3.0 (63.3%). The most common disadvantage of teleradiology was revealed as insufficient integration of clinical history (62.8%). The majority expressed a positive opinion regarding the spread of teleradiology in Turkey (73%). **Conclusion:** A wide usage of teleradiology throughout Turkey was revealed although most of the radiologists have limited information regarding the use of teleradiology. The participants have a positive attitude towards the spread of teleradiology.

Key Words: Radiology information systems; teleradiology; telemedicine

ÖZET Amaç: Bu çalışmada, ülkemizde radyologların günlük pratiklerinde teleradyoloji kullanım sıklığını, teleradyoloji kullanımına ait ayrıntıları ve teleradyolojiye ait tutumlarını değerlendirmeyi amaçladık. **Gereç ve Yöntemler:** Tanımlayıcı kesitsel olarak planlanan bu çalışmada, 27 sorudan oluşan anketin bir kısmı elektronik posta ile bir kısmı ise elden dağıtılan anketlerin doldurulması ile elde edildi. Bir yıllık bir süre içerisinde tam ve hatasız doldurularak geri gönderilen anketler çalışmaya dâhil edildi. **Bulgular:** İki yüz yirmi altı anketin değerlendirmeye alındığı çalışmada, katılımcı radyologların %29,6 (67)'sının üniversite, %19,9 (45)'unun eğitim ve araştırma hastanesinde, %26,1 (59)'inin devlet hastanesinde, %24,3 (55)'ünün özel hastanelerde çalıştığı gözlendi. Öte yandan katılımcıların %2,2'sinin teleradyoloji hakkında hiç, %14,2'sinin az, %43,4'ünün orta, %26,1'inin fazla, %14,2'sinin çok fazla düzeyde bilgi sahibi olduğu saptandı. En sık %63,3 kullanılan teleradyolojik yöntemin radyologlara elektronik posta vb. yollarla DICOM 3.0 (Digital Imaging and Communications in Medicine) kullanılarak hasta görüntüleri göndermek (depola ve gönder) şeklinde yapıldığı öğrenildi. Teleradyolojinin en sık dezavantajının klinik bilgi yetersizliği olduğu ortaya konuldu (62,8%). Teleradyolojinin ülkemizde standartlara uygun bir şekilde yaygınlaştırılmasına radyologların %73'ünün olumlu baktığı öğrenildi. **Sonuç:** Bu çalışmada, ülkemizde, radyologların teleradyoloji ile ilgili az-orta seviyede bilgileri olmasına rağmen teleradyolojinin yaygın bir şekilde kullanıldığı ortaya konulmuştur. Katılımcıların çoğunluğu teleradyoloji için olumlu görüş bildirmektedir.

Anahtar Kelimeler: Radyoloji bilgi sistemleri; teleradyoloji; teletıp

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Telemedicine is defined by World Health Organization (WHO) as "the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities".[1,2] The use of telemedicine in Radiology is known as 'teleradiology', which is defined as the transmission of radiological images and the related data from one location to another for the purposes of interpretation and/or consultation.[3]

Teleradiology is the most common use for telemedicine and accounts for 57% of all telemedicine usage.[4,5] Teleradiology was first performed in the 1960s.[5] In Turkey, the first teleradiology system was introduced in 1997 by a professional teleradiologic software called Multiview (EMED, USA), which was distributed by a Turkish firm (Kutlutek/İstanbul) and enabled the online transmission of radiological images across the Turkish cities.[4-6]

Literature reviews have indicated that there have been no studies reporting the use of teleradiology in the daily practices of radiologists, the teleradiologic practices, and the attitudes towards the use of teleradiology in Turkey. For this reason, we conducted a survey to investigate the current situation of teleradiology and also to contribute to the development of teleradiologic applications in Turkey. Analysis of the results was aimed at assessing the teleradiology use in the daily practices of the radiologists and the attitudes regarding the use of teleradiology in Turkey.

MATERIAL AND METHODS

The descriptive cross-sectional study was based on a 27-item questionnaire that was made available to all members of the Turkish Society of Radiology (TSR) by using an online survey platform (www.surveymonkey.com). The members were informed by e-mail and asked to complete the questionnaire, and a total of 121 questionnaires were duly filled and returned by the participants. In addition, the same questionnaire was administered to the radiologists attending the annual radiology congress organized by the Turkish Society of Magnetic Resonance in May, 2014; the questionnaire was given only to the radiologist who did not receive the e-mail and/or not filled the online questionnaire by double-checking the name list provided by the online survey company. A total of 105 radiologists filled out the questionnaire completely and accurately. As a result, a total of 226 questionnaires were obtained during the one-year period between June 2013 and June 2014. An approval was received from the ethics committee. 'Surveymonkey®' is an online survey website which makes the survey process remarkably easier. Surveymonkey presents a total of 17 formats for the items in the questionnaire (open-ended, multiple choice, multiple-answer, true-false, etc.). Moreover, frequencies for each question answered by the respondents can be obtained and all data can be exported to statistical analysis programs like SAS or SPSS. In our study, a total of 226 questionnaires were administered and 121 of them were achieved via Surveymonkey.

STATISTICAL ANALYSIS

Data were analyzed using SPSS 15.0 for Windows (SPSS Inc., Michigan, IL, USA). The numerical data were expressed as Mean ± Standard Deviation (SD) and the categorical variables were expressed as n, (%).

The correlation between the percentage of the participants who expressed a positive opinion regarding the nationwide integration of teleradiology in Turkey and variables including professional experience, academic degree, the organization where she/he works, region, the level of knowledge about teleradiology, the reason for utilizing teleradiology, the insufficient integration of clinical history, and accessibility of the previous images was analyzed using chi square test and p values were calculated; $p<0.05$ was accepted statistically significant.

RESULTS

The 226 participants comprised 52 (23.1%) professors (23 professors, 16 associate professors, and 13 assistant professors), 148 (65.5%) specialists, and 26 (11.5%) assistant doctors. Their average professional experience in radiology was 10.9±8.0 years. The participants came from the 7 regions in Turkey, with most of coming from the Marmara Region (n=59; 26.1%), followed by the Central Anatolia Region (n=54; 23.9%), the Aegean Region (n=40; 17.7%), the Black Sea Region (n=24; 10.6%), the Mediterranean Region (n=19; 8.4%), the Southeastern Anatolia Region (n=16; 7.1%), the Eastern Anatolia Region (n=14; 6.2%) (Table 1). Principal workplaces included university hospitals (n=67; 29.6%) research and training hospitals (public tertiary referral hospitals) (n=45; 19.9%), state hospitals (public secondary care hospitals) (n=59; 26.1%), private hospitals (n=39; 17.3%), private medical centers (n=6; 2.7%), and the medical centers that we classified as 'others' (private polyclinics, clinics and consulting rooms) (n=10; 4.4%) (Table 2).

The participants were asked to declare their level of knowledge about teleradiology and the results obtained were as follows: very little, n=5, 2.2%; little, n=32, 14.2%; moderate, n=98, 43.4%; considerable, n=59, 26.1%; expert, n=32, 14.2% (Table 3).

Another question asked if they wanted the nationwide integration of teleradiology in line with the regulations on the standards published by TSR. Most of the participants expressed a positive opinion (n=165; 73%), whereas 42 (18.6%) of them expressed a negative opinion and the remaining 19 (8.4%) were neutral (Table 4).

TABLE 1: Geographical locations.

	%	n
Marmara Region	26.1	59
Central Anatolia Region	23.9	52
Aegean Region	17.7	40
Black Sea Region	10.6	24
Mediterranean Region	8.4	19
Eastern Anatolia Region	6.2	14
Southeastern Anatolia Region	7.1	16

TABLE 2: Location of main professional activities.

	%	n
University Hospital	29.6	67
Research and Training Hospital	19.9	45
State Hospital	26.1	59
Private Hospital	17.3	39
Private Medical Center	2.7	6
Others	4.4	10

TABLE 3: Level of teleradiology knowledge.

	%	n
Expert	14.2	32
Considerable	26.1	59
Moderate	43.4	98
Little	14.2	32
Very little	2.2	5

TABLE 4: Attitudes towards the nationwide spread of teleradiology.

	%	n
Positive	73	165
Negative	18.6	42
Neutral or did not respond	8.4	19

The participants declared that they used teleradiology mostly as a part of regular workflow (n=90; 39.8%) followed by primary and second-opinion readings (n=26; 11.5%), remote site readings during night shifts (n=21; 9.3%), secondary readings or expert consultation (n=11; 4.9%), primary readings (n=7; 3.1%), and primary or emergency readings (n=5; 2.2%). Moreover, 66 (29.2%) participants skipped this question (Table 5).

The most common disadvantage of teleradiology was revealed as insufficient integration of clinical history (n=142; 62.8%), followed by inaccurate clinical data leading to inadequate interpretation (n=133; 58.8%), absence of previous studies (n=102; 45.1%), and failure to communicate additional findings in a timely manner (n=88; 38.9%) (Table 6). DICOM was by far the most frequently transmitted format (n=143; 63.3%), followed by JPEG (n=40; 17.7%), AVI (n=4; 1.8%), and TIFF (n=3; 1.3%) (Table 7).

TABLE 5: Reasons for using teleradiology.

	%	n
Only primary readings	3.1	7
Only secondary of readings or consultation	4.9	11
Both primary and secondary readings	11.5	26
Emergency readings from home and/or another site (night)	9.3	21
As a part of regular workflow	39.8	90
Primary and secondary readings	2.2	5
Not using	29.2	66

TABLE 6: Disadvantages of teleradiology.

	%	n
Inaccurate clinical data leading to inadequate interpretation	58.8	133
Lack of access to previous radiographic images	62.8	142
Insufficient integration of clinical history	45.1	102
Failure to communicate additional findings in a timely manner	38.9	88

TABLE 7: Formats transmitted.

	%	n
DICOM	63.3	143
JPEG	17.7	40
AVI	1.8	4
TIFF	1.3	3

The sufficiency and the quality of teleradiology systems is an important issue. Therefore, the participants were asked to rate these systems in terms of sufficiency and image quality. It was revealed that they found the teleradiology systems sufficient in terms of image quality (43.4%) and transmitting accurate demographic data (38.5%), whereas they declared them to be insufficient due to the transmission of incorrect information by the sending/receiving sites (42%), incorrect labeling of patient information (46%), and erroneous linear measurements (37.2%) (Table 8).

Storing the radiology images sent via teleradiology is a legal obligation. The participants were asked whether they stored the images and most of them stated that the images were being stored (n=146; 64.6%). Nineteen participants (8.4%) did not store any images. Almost half of the participants (n=101; 44.7%) stated that the number of radiologists working in their hospitals/centers was not sufficient for efficient distribution of workload, whereas 71 (31.4%) declared it to be sufficient and the remaining 54 (23.9%) skipped the question.

In teleradiology systems, certain network and software security procedures should be available in order to safeguard the privacy of the patients' identification and images in accordance with legal requirements. The participants were asked whether they had such procedures and most of the participants (n = 92; 40.7%) answered "no", 49 (21.7%) answered "yes", 16 (7.1%) answered "don't know", and the remaining 69 (30.5%) did not respond.

There were not significant differences in the participants who expressed a positive opinion regarding the spread of teleradiology in Turkey for the professional experience (p=0.618), academic degree (p=0.196) the organization where s/he works (p=0.986), region (p=0.407), the level of knowledge about teleradiology (p=0.715), the reason to utilize teleradiology (p=0.509), the insufficient integration of clinical history (p=0.063), educated craft (p=0.091), and accessibility of the previous images (p=0.550).

There was a significant correlation between percentage of participants who expressed a positive opinion regarding the spread of teleradiology in Turkey and for storing radiology images (p=0.028).

TABLE 8: Evaluation on the sufficiency and quality of teleradiology.

	Yes		No	
	%	n	%	n
Are the demographic data sufficient?	38.5	87	32.2	73
Is the information regarding the sending/receiving sites sufficient?	27.9	63	42	95
Is labeling of patient information accurate?	22.6	51	46	104
Are linear measurements accurate?	31.9	72	37.2	84
Is image quality satisfactory?	43.4	98	27	61

DISCUSSION

Teleradiology became accessible and feasible to physicians in the 1960s and 1970s when medical images captured by X-rays were transmitted to radiologists, pathologists, and dermatologists via closed-circuit television (CCTV) systems. Through the 1970s and 1980s, computer-aided telemedicine approaches became more popular through a transition from real-time imaging to "store-and-send" system. This new system further simplified the teleradiology communications by eliminating the necessity for face-to-face consultation. Nevertheless, the teleradiology systems were still too costly at those times. In the present day, however, the factors affecting the use of teleradiology systems have dramatically changed over the last 15-20 years due to inexpensive computer and internet systems. Moreover, the prevalence of teleradiology has remarkably increased, mainly because the performance rate of these systems boosted and significant improvements were achieved in picture archiving and communication systems. Overall, the scarce availability of radiologists, the improvements in imaging techniques and access to healthcare in rural and underdeveloped areas, and the growing demands of patients and physicians have paved the way for the improvement of teleradiology systems.[5,7-9]

The most common usage of teleradiology in our study was the use of teleradiology as a part of regular workflow (n=90; 39.8%), which is called 'in-house image distribution' in Europe. When used effectively, this practice enables efficient distribution of workload both within the hospital/ center and across hospitals/centers.[7] The second most popular usage in Europe is on-call readings from home, whereas the second popular usage in our study was primary and secondary readings (n=26; 11.5%). In the USA, however, more than half of radiology communications are outsourcing their night-time and/or weekend readings to teleradiology companies. This is to mean that teleradiology remains to be standardized both in Turkey and Europe.[7]

Ranschaert et al. conducted a similar study across Europe and reported that the possibility for collaboration was revealed as the most important advantage of teleradiology (74%), followed by efficient distribution of workload (70%).[7] In the same study, 44.7% of the participants stated that there was a shortage of radiologists in their department and 31.4% stated that the number of radiologists was sufficient. In Turkey, teleradiology can be used to access subspecialty advice as well. In this way, the correct diagnosis can be established in a proper and timely manner through the consultation with a subspecialist radiologist. According to the standards defined by TSR, teleradiology should not be used to compensate for radiologist shortage or absence. In our study, the results revealed that 31% of teleradiology practices are used for primary and secondary readings, expert consultation, and emergency readings. This view is also endorsed by radiology authorities. When used effectively, teleradiology provides sophisticated workflow, particularly in secondary and emergency readings.

In the study by Ranschaert et al., it was also revealed that the teleradiology practices in Europe are mostly used for in-house image distribution (71%) and on-call readings from home (44%), and the outsourcing radiological examinations were mainly used as a part of regular workflow (49%), for a second or expert opinion (41%), when on-call (nights) (40%), and on a temporary basis (i.e. capacity problems) (19%).[7] In our study, we also found that using teleradiology as a part of regular workflow was the most common reason (39.8%). This means that the main use of teleradiology in Turkey is similar to the one in Europe.

Lack of financial support was revealed as a major cause of not using teleradiology in Europe (23%), followed by technical problems and absence of PACS (picture archiving and communication system) (21%).[7] Both in Europe and the USA, there is a wide range of teleradiology applications.[6,7] One of the main goals in Europe is to establish a high concentration of networked PACS. Commercial teleradiology services are rarely used in Europe and Turkey. Since a wide variety of languages are used across Europe, language remains an unsolved problem for further improvement of teleradiology systems. In our study, it was revealed that 41.6% of the participants did not use teleradi-

ology systems and we consider that the main reasons and lack of financial support and technical problems.[7,10-12]

It was also found that DICOM was the most commonly transmitted format (63.3%), as revealed in the European and Swiss survey.[7,10]

In our study, the most common reason for the use of teleradiology outsourcing was revealed as secondary readings and expert consultation, and the most common disadvantages were revealed as insufficient integration of clinical history and lack of contact with the radiologist. Of all the participants, 27% declared a lack of integration of clinical history, 27% stated a lack of contact, and 58.8% declared inaccurate clinical data leading to inadequate interpretation. Interestingly, a lack of integration of clinical history and a lack of contact were also revealed as the most important drawbacks the use of teleradiology outsourcing in Europe.[7,10] The participants also stated that a lack of contact with the radiologist is likely to impede the diagnostic progress of the patients, particularly in emergency cases.[13,14] These problems are serious threats for the effectivity and quality of teleradiology practices. Our results also suggested that the integration of accurate clinical history is of prime importance for the efficiency of teleradiology consultations. Therefore, it is wise to claim that both the sending and receiving sites should emphasize the importance of this issue in their technical and educational activities. In the European studies, a great majority of the participants (80%) presented a positive opinion for the spread of teleradiology to a larger population.[7] Similarly, we also found that most of our participants have a position opinion (73%), but all of the participants who provided a positive opinion stated that this spread should be controlled by the standards to be implemented by TSR and American College of Radiology (ACR), partly because they fear that the quality of teleradiology cannot be assured without implementing formal standards.

Security and privacy is another important issue in teleradiology. In our study, almost half of the participants (47.8%) stated that no consent is being received from the patients for the transmission of their clinical data, whereas 45.6% of them declared that they had no information and only 6.6% stated that consent is being obtained. Another result revealed that more than half of the participants (59.3%) stated that the patients are not being informed about the transmission of their clinical data and only 8.4% of them declared that the patients are being informed prior to transmission. Moreover, 40.7% of the participants stated that no software security was present, 37.6% of them skipped the question and only 21.7% of them declared the presence of security systems. These results are in line with the security problems in European teleradiology models. Therefore, there is need for reinforcement at a European level to provide uniform regulations for registration accreditation and revalidation. In addition, some legal issues, mainly regarding liability, and issues related to patient privacy and patient safety, as yet remain unsolved.[7,15-17] On the other hand, the major problems in Turkish models are similar to those in European models. Primary-reading teleradiology in Turkey have many serious problems such as unregistered, unlicensed, low-quality ghost reporting. The legal situation and responsibility of all teleradiology services must be clarified, as must those of the sending site and the receiving site. Ethical issues such as ghost reporting and also the need for informed consent from patients must also be clarified. Furthermore, privacy is another area needing attention, and authentications should be correctly defined. We recommend that all teleradiology vendors should be licensed, accredited, and audited to ensure they obey the regulations on standards published in 2010 by the TSR's Imaging Informatics Working Group in collaboration with the Medical Informatics Association. It will be up to lawmakers working with TSR and other medical associations to clarify legal responsibility for telepractitioners.

FUTURE

In European studies, most of the participants (80%) presented a positive opinion for the future of teleradiology. We also found a high rate of positive opinions among our participants and we consider that this is because the participants foresee a promising future for the nationwide spread of teleradiology. It appears

then that the future of teleradiology is viewed as a necessity both in Turkey and Europe, particularly due to the shortage of radiologists and the necessity of secondary consultation and the interpretation of emergency findings in a timely manner. On the other hand, the European study found a possible threat to the usage of teleradiology; if radiology is reduced to a commercial service, this might reduce the quality of radiological services and patient care.[7]

In light of the points discussed above, the responses obtained from our participants, and the technological improvements in the world, we consider that the expectations regarding the future of teleradiology can be divided into two sections:

(I) *Legal and Social Expectations*: A successful teleradiology model can be established by applying strict rules to assure quality and security, developing a proper medical image archiving system, increasing value of radiology reports, and constructing collaboration with referring physicians.

(II) *Technology-related Expectations*: PACS can be considered as the basis of teleradiology.[7,9,10] Therefore, we foresee a promising future for teleradiology since Information Technology (IT) applications are becoming less and less costly with increasing speed and accuracy.[6]

Furthermore, smart card technology can be a practical solution for the integration of the clinical data of the patients into a simple and portable card which could eliminate the necessity for transferring bulky documents across hospitals/centers and also enable a data storage system for recording the updates in the clinical progress of the patients. We believe that such a system is crucially needed and the main aim of such a system should be to promote the replacement of paper-based record systems with computer-based systems.[6,7]

Cloud computing (CC) is another notable system which could be a practical application for the use of teleradiology. CC provides the users an unlimited storage area as well as unlimited access to the users registered on the system. In CC, any piece of data can be uploaded by a user, called the Admin, and this data can be accessed from any platform by the users permitted by the Admin.[18] We consider that teleradiology can be integrated to CC by establishing a local and nationwide collaboration which could enable unlimited access to clinical data of the patients.

LIMITATIONS

Our study was limited in several ways and thus care should be taken when drawing conclusions from the findings of the survey. First of all, our study did not include a nationwide survey although the participants came from all the regions in Turkey. Nevertheless, since this is the first study in the literature reporting the state of teleradiology in Turkey, its results may provide important information for radiology professionals. Future studies are warranted to evaluate the state of teleradiology at a national or global level.

Secondly, the demographic distribution of our participants was not well-balanced because most of them came from three regions including the Marmara Region (26.1%), the Central Anatolia Region (23.9%), and the Aegean Region (17.7%), which together accounted for 67.7% of all the participants.

Finally, since the participants had little or no information about the PACS and outsourcing activities in their centers/hospitals, no evaluation was made regarding these two issues.

CONCLUSION

The results revealed that most of the participants are able to use teleradiology in their professional activities, though at a limited scale, and many of them have a positive opinion for the development of a collaborative model of teleradiology at a national level. We conclude that a successful teleradiology can be established by applying strict rules to assure quality and security, developing a proper medical image archiving system, increasing the value of radiology reports, and constructing collaboration with referring physicians.

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