Investigating the satisfaction level of physicians in regards to implementing medical picture archiving and communication system (PACS)

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Abstract

Background User's satisfaction with PACS is considered as one of the important criteria for assessing success in using PACS. The objective of this study is to determine the level of satisfaction in PACS' users and also comparing its functional features with traditional film-based systems.

Methods This analytical study was conducted in 2017. Residents at three large university hospitals in Kerman city were included. We used self-administered questionnaire that was consisted of three parts include: demographic information, individuals' satisfaction, comparing features of the two digital and traditional imaging systems. Validity of this questionnaire was approved by specialists and its reliability was obtained as 86%. Data analysis was done with using descriptive statistics and after checking the normality of data, data compared with the spearman, the Mann Whitney U and the Kruskal-Wallis statistical tests.

Results The mean of the participants' ages 31.4 (± 4.4) years old and approximately 59% of the participants were females. Mean of overall physicians' satisfaction with PACS' score has no significant relationship ($P>0.05$) with the variables of age, experience in using PACS, type of specialty, level of interpretation of images using PACS, however it did show a significant relationship with their computer skills ($P<0.05$).

Conclusions The mean for physicians' satisfaction with PACS was at a moderate to high level, yet there are still problems in successfully implementing these systems and establishing interoperability between them. PACS has not fully met all the demands of physicians and has not achieved its predetermined objectives such as all-access from different locations.

Background

Employing digital imaging systems in the field of radiology is rapidly increasing around the world. One of the digital imaging-related systems is the medical picture archiving and communication system (PACS) [1], which is considered as one of the most important medical imaging technologies that has greatly helped the digital radiography [2, 3] and has brought along a transformation in the archiving, communication and display of images and also the clinical work process [4].

In the traditional imaging systems, there are many problems, in addition to the dissatisfaction of physicians, radiologists, and patients due to undesirable quality and the need to repeat imaging; hospitals are faced with challenges in maintaining and costs of purchasing radiology films [5]. By using PACS, the retrieval process, communication and interpretation of medical images is conducted with much better dynamics and flexibility, and there are features for editing, displaying, discovering and reporting them for users. This system helps users by establishing communication with its computer station to change image display parameters including image quality, zoom and contrast and compare them with each other [6, 7]. Therefore, PACS users including radiologists will experience different opportunities and challenges when

using this system, which before when dealing with film-based imaging, they were not faced with such issues.

Since early 1980's, PACS system having advantages such as optimized image quality and image access [8–11], increasing radiologists' productivity [9, 12], reducing the number of lost images and images' search and retrieval time [9, 13], reducing radiology reports' delivery time [8, 12, 14], reducing the need for physical storage space [10], reducing the average length of stay in hospital [15], reducing staff costs [8], and better healthcare services delivery to patients [9], has been able to become an alternative system for traditional paper and film-based imaging [16].

Nevertheless, implementing PACS is a complex process, which requires extensive resources [17]. Despite the PACS system's abundant advantages, implementing and using this system may come with different challenges that should be taken into consideration. One of these challenges is users' resistance toward accepting this technology [16]. One of the main group of PACS users are physicians [18] and resistance against information technology is seen a lot amongst them [9, 19–21], which leads to many unsuccessful, lengthy or under-use of these new systems [19]. Generally, users' dissatisfaction toward implemented systems leads to abandon systems and forcing great amount of financial resources for purchasing and implementing another information system for the institute [22–24]. Thus, identifying and resolving issues related to the users' dissatisfaction with health information system seems necessary and user's satisfaction with PACS is considered as one of the important criteria for assessing success in using PACS [25]. There are very few studies that assess users' satisfaction of PACS [1, 26–28].

During recent years, a large number of hospitals in Iran have taken action in implementing and implementing this system for further developing their activities. To this day, no study has been done in the field of medical picture archiving and communication system's users' satisfaction in Iran and most studies in regards to this system have investigated the obstacles and issues in implementing PACS, the status of utilizing PACS [31] and also evaluating PACS's applicability [32, 33]. The objective of this study is to determine the level of satisfaction in PACS' users and also comparing its functional features with traditional film-based systems in Kerman Medical University's teaching hospitals.

Methods

Research Setting

This analytical study was conducted in 2017. All available residents with experience in using PACS at three large university hospitals in Kerman city [Shafa, Afzalipour and Bahonar) were included in this study. Kerman University of Medical Sciences is the largest medical university in southeast Iran.

Data Collection:

In order to collect data, we used self-administered questionnaire based on the review of relevant studies. This questionnaire was consisted of three parts;

1) The first part included questions related to demographic information including age, gender, type of specialty, experience in using PACS system, computer skills and also level of radiology images' interpretation by physicians.

2) The second part included 14 specialty questions regarding the individuals' satisfaction with the PACS system using a 7-choice Likert scale (from completely disagree to completely agree).

3) The third part includes 8 questions related to comparing features of the two digital and traditional film-based imaging systems using a 5-choice Likert scale (from score 1 to 5).

Also, in order to obtain other positive and negative aspects of PACS systems, two open questions were placed at the end of the questionnaire.

Validity of this questionnaire was approved by three specialists in the field of medical informatics and health information technology and two radiologists. Its reliability was obtained as 86% through the correlation coefficient. Researchers referred to three hospitals and after presenting some description in regards to the study's aim, questionnaires were distributed to physicians that had consented to participate in the study and then questionnaires were collected after being completed.

Data Analysis

Data analysis was done using SPSS.18 software with using descriptive statistics. Also, after checking the normality of data, the spearman statistical tests were used for assessing the relationship between the mean score of overall satisfaction with PACS and age and experience in using PACS system, the Mann Whitney U was used for assessing the relationship with individuals' gender and also, the Kruskal-Wallis test was used for assessing the relationship with the type of specialty, level of images' interpretation with PACS and skills in using the computer. Physicians' satisfaction level in using the PACS system was obtained based on the questionnaire's part two's questions; for this reason, after calculating the most and least scores (14 & 100) and after their differential, the scores' range was 14–42, 43–71 and 72–100, that were considered for the low, moderate and high satisfaction level, respectively.

Results

As shown in table 1, a total of 46 physicians participated in this study. The mean of the participants' ages 31.4 (± 4.4) years old and approximately 59% (n=27) of the participants were females. About, 30% (n=14), 26% (n=12) and 20% (n=9) of the participants in this study were consisted of emergency medicine residents, internal residents and radiology residents respectively. Almost 67% (n=31) of the physicians stated having a intermediate level of computer skills. The mean of experience in using the PACS system among physicians (±10.5) was 13.3 months. About 77% (n=35) of the physicians state that they

interpret more than half of the medical images using PACS. Results of this study showed that the mean of overall physicians' satisfaction with PACS' score has no significant relationship (P>0.05) with the variables of age, experience in using PACS, type of specialty, level of interpretation of images using PACS, however it did show a significant relationship with their computer skills (P<0.05).

Table 1: Mean of participants' satisfaction based on demographic information

P-value	Mean score of satisfaction	Frequency (percent)	Contextual data	
0.126	1.61± 4.02	(59%)27	Female	*Sex
	1.86 ± 4.65	(41%)19	Male	
0.093	1.9± 4.09	(30%)14	Emergency medicine	**Type of specialty
	1.73±3.35	(26%)12	Internal medicine	
	1.07±5.71	(20%)9	Radiology	
	1.62 ±4.28	(9%)4	Orthopedics	
	1.13±4.09	(7%)3	Cardiology	
	1.01 ±3.78	(4%)2	Pediatrics	
	4.85	(2%)1	Urology	
	6.14	(2%)1	Neurology	
0.022	1.92 ±3.38	(15%)7	Low	Computer skills**
	1.7 ±4.13	(67%)31	Intermediate	
	0.45 ± 5.62	(%18)8	High	
0.762	4.57	(2%)1	(1-25) %	**Percent of images interpretation with PACS
	1.42 ± 3.6	(20%)9	(26-50) %	
	1.09 ± 4.71	(%31)14	(51-75) %	
	2.11 ± 4.39	(%26)12	(76-100) %	
	2.4 ±4.15	(20%)9	100%	

* Mann-Whitney U

** Kruskal-Wallis

Approximately 58% of the physicians agreed that with using the PACS systems is a large achievement for their hospitals. Also, 50% of the participants believed that using PACS reduces images' interpretation time and 59% of them also stated that reviewing images with this system is easy. About 76% of physicians believed that the quality of PACS images is higher than radiography films. More than 60% of the physician agreed that PACS leads to less time in searching for images, accelerates diagnosis time and reduces any confusion in the images. Also, the same number of physicians believed that this system leads to optimization in the work process and training. About 56% of physicians believed that PACS has led to an optimization in the quality of treatment care. Close to 52% of the participants believed that PACS has not reduced the patients' admission time in the hospital. More than 50% of the physicians also believed that PACS leads to a reduction in costs and also, this system has been able to meet the users' expectations.

As displayed in table 2, the satisfaction level of 41% (n=19) of the physicians with PACS system was at a high level and overall, the satisfaction level of 72% of the physicians was moderate to high.

table 2- Overall satisfaction level with PACS

	Satisfaction Level	Overall Satisfaction with PACS
13(28%)	Low	
14(31%)	Moderate	
19(41%)	High	

Based on table 3, the mean satisfaction level of physicians with the easy to editing images, contrast and or presentation of details, pathological status clarity, ability to zoom images, trusting the system, trusting the images' results, possibility to compare previous and new images of a patient and easy to use the system in PACS was higher than traditional radiology systems, however, there was no significant difference between the two systems in the above components (table 3).

table 3: Mean score of satisfaction with PACS versus traditional radiology

Features	Mean score of satisfaction with digital imaging system (PACS)	Mean score of satisfaction with analogue imaging (film)	P-value
Easy to Editing Images	0.97 ± 4.37	1.35± 2.53	0.061
Contrast or Presentation of image's details	0.87 ± 4.49	1.09 ± 2.33	0.46
Pathological status clarity	1.29 ± 3.98	1.16 ± 2.74	0.464
Ability to zoom images	0.89 ± 4.45	1.1 ± 2.27	0.854
System's reliability	1.34 ± 3.71	1.33 ± 2.69	0.205
Reliability of images' findings	1.12± 3.98	1.18 ± 2.73	0.95
Possibility to compare patient's previous and new images	1.13± 4.36	1.4 ± 2.97	0.514
Easy to use the system	1.29 ± 4.05	1.42 ± 2.57	0.084

The major weakness points of PACS for physicians included time waste for looking at images on computer systems (n=6), inability to print images and inability to use these images at any medical centers outside the hospitals such as physician's office and followed by that, increase in patients' costs for being forced to go through the imaging process again and patients being exposed to x-ray again (n=5), inability to use this system at the bedside of patients and increase of images search time (n=4). Ability to change color and edit images especially images of the brain (n=1) is one the most important strengths of this system.

Discussion

The results of this study showed that most of those using the picture archiving and communication system were satisfied with this system. In this study, radiologists and also those who had higher computer literacy were more satisfied with PACS. Physicians believed that because of having different

capabilities such as editing, applying different changes to the images and also comparing patient's previous and new images, this system and its findings are more reliable. Despite all PACS's advantages a number of physicians believed that this system somewhat wastes their time. On the other hand, currently, considering the inability to use PACS images in the outside imaging centers, this system can increase patients' costs for re-imaging and also the risk of being exposes to x-ray again.

Optimization in work process, efficiency and quality of service

The results of this study showed that more than half of the physicians believed using PACS led to optimization of the work process, quality of treatment care and also training. In line with this finding, Tan's [1] study also revealed that more than two thirds of users believed that PACS system had led to optimization in their performance and compared to the traditional system of hard copies, this system has been able to improve physicians' performance. The findings of two other studies [7, 34] also showed that users consider PACS to be effective in improving the quality of their services and believed that this system has led to improvement in productivity, efficiency and quality of services offered by them.

System's ease of use

More than half of the physicians in this study believed that reviewing images with this system is easy and PACS system has been able to meet their expectations. In a study by Abuabbas and colleagues [34] findings showed that more than three-quarters of the radiologists and technologists, consider using PACS positive and it being user-friendly. Also, Joroukar and colleagues [35] in their study addressed the easiness in using PACS in users' viewpoint and reported that 85% of the users believed that PACS was very easy to use for them. The results of the mentioned studies are consistent with the present study.

Reducing hospital-stay time

In this study, more than half of the physicians believed that PACS had no influence in reducing the patients' length of stay (LOS) in hospital. Despite these results, Al-Alavi's study showed that about two thirds of PACS users agreed that this system leads to reducing patients' hospital stay [36]. Some studies have reviewed the impact of PACS on the patients' hospital stay time. The findings of these studies [15, 37, 38] showed that this system has been able to led to reducing patients' hospital stay time. However, Krave's study in Australia [39] indicated PACS having no effect on the patients' length of stay in hospital.

Reducing Costs

According to the findings of this study, more than half of the physicians believed that using PACS reduces costs. Costs related to PACS can be divided into two categories: direct and indirect costs. Direct costs are those expenses that come along with implementing the PACS system in hospitals such as PACS purchase cost and maintenance and purchase of equipment. While the indirect costs include lengthier patients' length of stay in hospital, repeating similar imaging, reducing productivity and physician's performance due to lack of access to images and reports and similar matters. Indirect costs are reduced

as PACS is implemented and can compensate for the direct expenses inflicted on the hospital and even overall it leads to reduction of general expenses.

The different standpoints of physicians about PACS can be related to the different standpoint regarding direct and indirect costs [40]. Presumably some physicians don't take into consideration the reduction in PACS's indirect expenses that are gained in long-term and this is why they believe that PACS leads to increase in costs. This is while indirect costs in PACS system are significantly lower compared to the traditional system.

Patients' Safety

According to 10% of physicians, because of the inability to print images or use these images at other treatment centers outside the hospital such as physicians' offices, the patients are forced to go through the imaging again, which this matter leads to patients' further exposure to rays and finally decreases safety for patients. Despite the findings of the present study, Moudrak and colleagues [41] conducted a study that showed after implementing PACS, considering the decrease in repeat imaging, patients' exposure to rays are reduced.

Currently in Iran, there is no exist interoperability of information among many health information systems such as hospital information systems with PACS. For this reason, physicians believed that patients will go through imaging and exposure to rays again at other treatment centers. Nevertheless, if the capability of establishing communication and transferring images between health information systems being used at governmental and private centers offering health care is developed, in addition to reducing repeat imaging, PACS system can lead to decreasing patients' exposure to rays and finally increase patient safety.

Comparison of PACS and Traditional Radiology

The results of this study showed that in the opinion of most physicians, since the PACS system has different capabilities such as editing images, applying some changes to images such change in contrast, change in clarity and zoom and also presenting details, it increases their satisfaction with this system compared to traditional radiology. However, easiness in use in both systems didn't have significant difference. In Abuabbas and colleagues' [34] study, most participants mentioned the system being user friendly. Also, Alyafi and colleagues [42] in their study reported 90% user friendliness for PACS system. The results of the mentioned studies are consistent with the present study's findings. However, the present study's findings regarding comparing the easiness in using PACS and traditional system are somewhat different with Joukar and colleagues' study [35] in which system users, described the PACS as being very user friendly. Possibly this level of difference in opinions refer to easiness in using PACS compared to traditional film-based systems is related to computer literacy of the users and or the lake of interoperability of PACS with other health information systems. Probably the more computer literacy of the users and proper designing system with interoperability to other systems will lead to increased easy to use and users satisfaction.

Relationships between satisfaction and demographic information

The results of this study showed that factors such as age, experience in using PACS, physicians' type of specialty have no significant relationship with level of satisfaction, however physicians' computer literacy was effective on the level of their satisfaction. In line with these findings, Abuabbas's study [34] showed that none of the demographic information and also users' computer literacy has no effect on their level of satisfaction.

Although the sample size in the study is not very large, nevertheless this study is the first study conducted in the regards to assessing users' satisfaction with PACS in Iran and those physicians participated in this study, those who had experience in working with PACS and had announced their interest and satisfaction in participating in this study and completing the questionnaire. The results of this study can help directors of treatment centers that intend to purchase or implement the PACS in their treatment center so that in addition to considering the strength and weakness points of these systems, they can attempt in resolving some issues. Also, policymakers in the field of communications technology along with the cooperation of the information system developers can attempt to develop inter-informational systems' data communication standards so that interaction between these systems can be made possible at any time and from anywhere.

Conclusions

The results of this study revealed that although generally the mean for physicians' satisfaction with PACS was at a moderate to high level, yet there are still problems in successfully implementing this system and establishing interoperability between them at different treatment centers. Results of this study showed that PACS has not fully met all the demands of physicians and has not achieved its predetermined objectives such as all-access from different locations. It is recommended that in order to overcome the mentioned obstacles, the number of work stations of these systems should be increased or to use a personal digital assistant (PDA) in order to reduce time waste and facilitate the care at patients' bedside and also, the feature for printing should be added.

List Of Abbreviations

LOS: length of stay

PACS: Picture Archiving and Communication System

PDA: Personal Digital Assistant

Declarations

Ethics approval and consent to participate

This study was approved by the Research Ethics Committee of Kashan University of Medical Sciences Research Council (Number: 1398.049) and conducted following the guidelines of the Declaration of Helsinki. In accordance with the opinion of the above mentioned Ethics Committee and given the fact that no information about participants is provided in this paper, participants who participated in this study gave verbal consent to participate in this research.

Consent for publication

Not applicable.

Availability of data and materials

The data generated and analyzed during this study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

RA, MSJ, and HT designed the study. HT supervised the project. RA and MSJ performed the experiments. HT and RA analyzed the data. All authors discussed the results and reviewed and approved the final manuscript. RA, HT wrote the final manuscript.

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