

Original Research Article

Improvement in radiographic quality workflow due to use of digital imaging and picture archiving and communication system

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Received: 02 April 2019

Accepted: 08 April 2019

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ABSTRACT

Background: PACS (Picture archiving and communication systems) and digital imaging (DI) has revolutionized radiology bringing about a paradigm shift in the way radiodiagnosis is perceived and practiced with a slew of benefits like elimination of the need for manual handling of films, helping in long term storage of digital images, easy transfer and retrieval of radiographic images. The objective of this study was to analyse the influence of PACS and digital imaging on the workflow in the radiology, performance of the radiographer and image storage and retrieval capabilities.

Methods: It was a questionnaire-based study in which questions were asked to the radiographers working in our hospital at five different working sites. Each questionnaire was aimed to evaluate the effect of digital imaging on radiology workflow, improvement in the performance of radiographers, reduction in the work-related frustration levels due to use of digital imaging and finally the utility of digital imaging in image storage, query and retrieval.

Results: Among the 50 questionnaires 41 were completed and retrieved. Among the respondents, 90.24% indicated that digital imaging has obviated the need for repeat examinations, 95.12% agreed with the fact that it resulted in the reduction of the number of reject images, 95.1% said it helped them in improving their performances, 92.6% of the respondents said they did not face any issue with its use and 95.1% of the participants agreed that the image query and retrieval could be accomplished in a hassle-free manner.

Conclusions: The digital imaging technique not only improves the performance of the radiographers but also increases the workflow of the health care hospitals or clinics. The digital imaging reduces the number of rejected images thus reducing radiation exposure to the patients. Further, it is highly cost-effective and time-saving.

Keywords: Digital imaging, Picture archiving and communication system, Questionnaire, Radiographer, Radiographic quality workflow, Retrieval

INTRODUCTION

Radiodiagnosis is one of the most important medical specialty providing vital back up to all other clinical specialties which cannot operate effectively without its support.¹ PACS (Picture archiving and communication

systems) and digital imaging (DI) has revolutionized radiology bringing about a paradigm shift in the way radiodiagnosis is perceived and practiced. PACS and digital imaging has a slew of benefits which include elimination of the need for manual handling of films and envelope, making heavy and usually dusty archive work

redundant. In addition, the pollution resulting from the use of chemicals in analogue technology is eliminated. The greatest benefit, however, is that the digital image is more easily distributed among the users than the analogue film. The analogue film only existed at one place at a time.² PACS allows continuous handling of radiological images in their original digital form.^{3,4} Utilization of digital data using PACS has positive influence on clinical and radiological workflow.⁵⁻⁷ Performing radiological work utilizing digital imaging and PACS positively impact radiologist's and radiographer's knowledge as well as perception of radiographic quality work. Digital imaging and PACS improves image quality, saves time, allows post-acquisition image processing, easy image transfer, digital storage and retrieval resulting in streamlining of radiographic workflow, quality enhancement and lessening the workload by effectively reducing the need for repeat examinations in many scenarios.^{8,9} Additionally, digital image utilization for educational purposes (teaching and learning) is easy, effective and has proved beneficial for the academics and continuous medical education in radiology.¹⁰⁻¹² PACS in concert with radiology information system (RIS) helps in effective patient management, scheduling, documentation, patient tracking, reporting, film tracking and billing. These systems are crucial to an efficient workflow in digital radiology practices. Radiographers work in collaboration with radiologists and play an essential role in the image production process and in the care of patients.^{6,9} The main responsibilities of the radiographer are to produce images and to ensure the patient's safety, security and well-being during the examination. In a longitudinal study of how PACS has influenced radiographer's work, Fridell states that they have developed from image producers to "jacks of all trades", because the skills required by the radiographer have become multifaceted and complex.⁷ Authors undertook this study with the main objective to analyze the influence of digital imaging on the workflow in the radiology, performance of the radiographer and image storage and retrieval capabilities.

METHODS

The empirical fieldwork for this prospective observational study began in May 2017 and was completed in February 2019. The investigations were conducted in five different sites of radiological department in our hospital, accident and emergency X-ray Department (site A), ward block (site B), accident and emergency CT scan (site C), multi slice CT section (site D) and MRI section (site E). These sites were chosen because they were actively engaged with aspects of quality improvement and learning. A quantitative method of analysis was used in this study and the study instrument consisted of a questionnaire. The questions were related to the effect of digital imaging on workflow, image quality, performance of radiographers and storage and retrieval capabilities of radiographic images. The questionnaire was distributed in the form of hard copy.

The questionnaire was divided into four parts. The first part of the questionnaire included questions about demographics of the participants. Part two of the questionnaire was composed of questions about the effect of digital imaging in workflow of radiology. Part three of the questionnaire included the questions about the effect of digital imaging in the radiology profession. The last part of the questionnaire was composed of the questions regarding the effect of digital imaging in image quality. In the selection of the participants age, gender or ethnicity limits were not considered.

The questionnaire consisted of total 30 questions. Total of 50 questionnaires were distributed, and 41 of them were retrieved back. The questionnaires were distributed among radiographers working in conventional as well as digital radiography. This research only involved hospital staff, and no ethical approval was needed, as it did not include any patient data. However, ethical guidelines have been taken into account, to assure the participants that they have a right to withhold their consent to take part in the study; that any information they provide will be treated confidentially, that the researcher will make use of the information only for the purposes of the research described. The questionnaires were distributed at five different sites as mentioned in Table 1.

Table 1: Distribution and retrieval of questionnaire as per the site.

Site	Questionnaire distributed	Questionnaire retrieved
Site A	15	11
Site B	10	8
Site C	9	7
Site D	11	10
Site E	5	5
Total	50	41

Statistical analysis

The data was analyzed using statistical software's SPSS v 20 and STATA v 11. Categorical variables were described in terms of percentage.

RESULTS

A total of 50 questionnaires were distributed and 41 were completed and returned. Among the respondents, 37 (90.24%) indicated that digital imaging reduces the number of steps in radiological procedures, minority of the respondents 1 (2.4%) disagreed with it and 3 (7.3%) were having a neutral opinion about it. Majority of the respondents 39 (95.12%) agreed with the fact that digital imaging has resulted in the reduction of the number of reject images, only 1 (2.4%) respondent disagreed and 1 (2.4%) had neutral opinion about it (Table 2 and Figure 1).

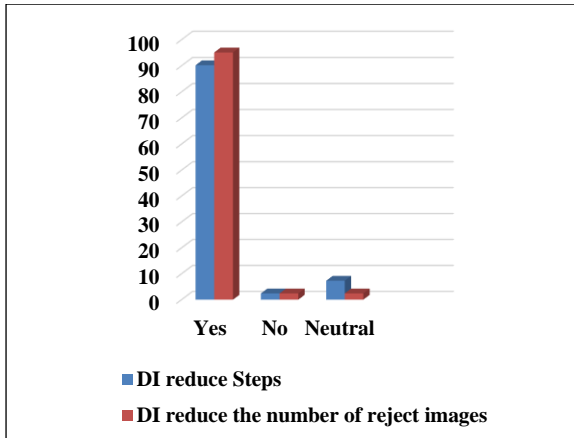


Figure 1: Bar diagram showing effect of DI on radiology workflow.

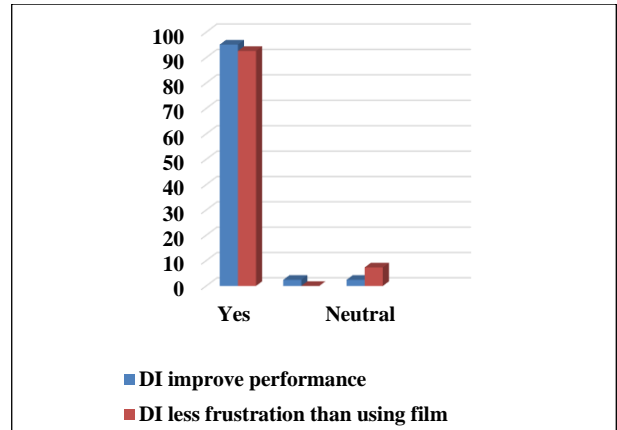


Figure 2: Improvement in performance and less frustration due to DI.

In the next question (Table 3) and (Figure 2), respondents were questioned about the improvement in performance when using digital imaging.

Majority of the respondents 39 (95.1%) said that digital imaging helped them in improving their performances, 1 (2.4%) disagreed and 1 (2.4%) had no opinion about it.

Table 3: Improvement in the performance and less frustration due to DI.

Statement	Yes (%)	No (%)	Neutral (%)	Total (%)
DI improves performance	39 (95.1)	1(2.4)	1(2.4)	41(100)
DI is less frustrating than using analogue films	38 (92.6)	0 (0.0)	3(7.3)	41(100)

Table 4: Effect of DI on image storage, query and retrieval.

Statement	Yes (%)	No (%)	Neutral (%)	Total (%)
Storage capabilities	40 (97.5)	0(0.0)	1(2.4)	41(100)
Image query and retrieval	39 (95.1)	0 (0.0)	2 (4.8)	41(100)

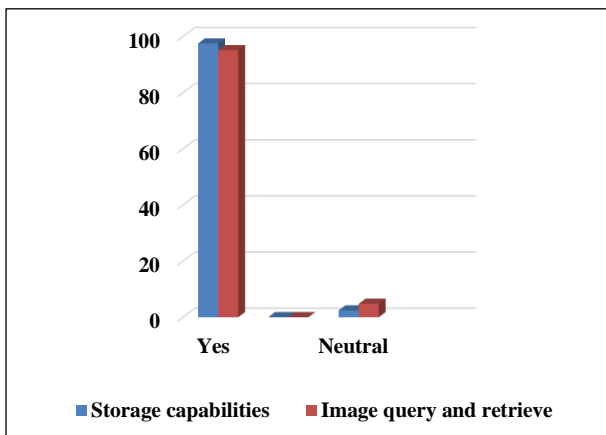


Figure 3: Effect of DI on image storage, query and retrieval.

When asked about DI being less frustrating than using analogue films 38 (92.6%) of the respondents said they did not face any issue with its use while 3 (7.3%) respondents had no opinion. (Table 4) and (Figure 3) shows the effect of using digital imaging on the storage capabilities, query and image retrieval.

According to the results, it was found that 40 (97.5%) of the participants agreed that the digital imaging would positively impact the storage capabilities while 1 (2.4%) respondent was clueless about its positive impact on storage capabilities. Also, 39 (95.1%) of the participants agreed that the image query and retrieval could be accomplished in a hassle-free manner while 2 (4.8%) respondents had no idea about its role in image query and retrieval.

DISCUSSION

The results of the present study revealed that the performance of the radiographers working in any health care system is now heavily dependent on the implementation of the digital imaging. The performance of the radiographers working with digital imaging and PACS has increased and radiographers feel more confident when imaging with these new technologies. The digital imaging has markedly reduced the number of procedure steps when compared to conventional radiography, thus saving lot of time for radiographers. This result is supported by another study that was

conducted to analyze the changes that are occurring in the radiological department due to the development and advancement of digital image techniques. This study indicated that the work environment and the workflow are influenced by the implementation of the techniques like digital imaging.¹³ The results also indicate that by using advanced technologies, number of repeat examinations has decreased owing to the capability of post-acquisition image processing, storage and subsequent retrieval of the images thereby also decreasing the radiation dose to the patients. This result is in concordance with another study that was conducted to evaluate image quality and patient radiation dose in digital radiography which showed that radiation dose to patient is less in digital radiography than analogue radiography.¹⁴ The use of digital imaging and PACS markedly improves the performance of radiographers and proves less cumbersome and frustrating to the operating radiographer. The use of digital imaging in the field of radiography has increased the competence and efficiency of radiographers. This observation is in tune with the results of another study which showed a direct relationship between the digital imaging and work practice of radiographers.¹⁵ Similar results were found in the previous studies that were conducted for the analysis of effect of digital imaging on the work practice of radiologists.¹⁶ The association of the digital imaging with the data storage and use of film combination approach has increased the demand of use of digital imaging for the diagnostic purpose.^{17,18} The linking of the software with digital imaging provides an effective command to use the diagnostic data in the clinical practices.¹⁸ Present study also indicates that the storage and image distribution capabilities due to digital radiography have increased. Digital images eliminate the need for manual handling of films and envelopes; the heavy and usually dusty archive work becomes redundant. In addition, the pollution resulting from the use of chemicals in analogue technology is eliminated. Similar results were achieved by another study that was conducted to see "how PACS and digital imaging influence the radiographers work".¹⁹

CONCLUSION

Authors conclude that the digital imaging improves the workflow and quality in the radiology department. Further the performance of the radiographers working in any health care organization is directly affected by the use of digital imaging. The digital imaging technique not only improves the performance of the radiographers but also increases the workflow of the health care hospitals or clinics. The use of digital imaging is valuable in improving the quality of diagnosis in the field of radiography. The digital imaging reduced the number of rejected images thus reducing radiation exposure to the patients. Further, it is highly cost-effective and time-saving. Digital imaging shows a positive and promising effect on the work practice of radiographers and radiologists and also provides improved diagnostic results. The limitation to this study is that the sample size

of the study was very small, and the study was conducted among the participants of a single hospital. There is an imperative need to conduct further advanced studies with larger sample size to validate the results of this study.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Baby A. A study of cost control strategies in the department of radio-diagnosis of a selected hospital (Doctoral dissertation, Rajiv Gandhi University of Health Sciences). 2007. Available at:
2. Lundberg N. IT in healthcare-artefacts, infrastructures and medical practices. rapport nr.: Gothenburg studies in informatics. 2000(17).
3. Lamminen H. "Picture archiving and fundus imaging in a glaucoma clinic." J Telemed Telecare. 2003;9(2):114-6.
4. Fridell K. A walk into the digital world-a long and winding road. Department Clinic Sci Intervent Technol.2011.
5. Siegel EL, Reiner B. Work flow redesign: the key to success when using PACS. J Dig Imag. 2003;16(1):164-8.
6. Larsson W, Aspelin P, Bergquist M, Hillergård K, Jacobsson B, Lindsköld L, et al. The effects of PACS on radiographer's work practice. Radiograph. 2007;13(3):235-40.
7. Fridell K. Individuals change when technology change. Department of Clinical Science, Intervention and Technology. Stockholm: Karolinska Inst. 2007. Available at: https://www.academia.edu/7087323/INDIVIDUAL_S_CHANGE_WHEN_TECHNOLOGY_CHANGE.
8. Larsson W, Aspelin P, Bergquist M, Hillergård K, Jacobsson B, Lindsköld L, et al. The effects of PACS on radiographer's work practice. Radiography. 2007;13(3):235-40.
9. Lau SL, Mak ASH, Lam WT, Chau CK, Lau KY. Reject analysis: a comparison of conventional film-screen radiography and computed radiography with PACS. Radiography. 2004;10(3):183-7.
10. Larsson W, Lundberg N, Hillergård K. Use your good judgement-radiographers' knowledge in image production work. Radiography. 2009;15(3): e11-21.
11. Fridell K, Aspelin P, Edgren L, Lindsköld L, Lundberg N. PACS influence the radiographer's work. Radiography. 2009;15(2):121-33.
12. Strickland NH. PACS (picture archiving and communication systems): filmless radiology. Archiv Dis Childhood. 2000;83(1):82-6.
13. Wenzel A, Møystad A. Work flow with digital intraoral radiography: a systematic review. Actaodontologica Scandinavica. 2010;68(2):106-14.
14. Bacher K. Evaluation of image quality and patient radiation dose in digital radiology (Doctoral

- dissertation, Ghent University). Accessed at: <https://biblio.ugent.be/publication/471172/file/1878301>.
15. Prabhu SP, Gandhi S, Goddard PR. Ergonomics of digital imaging. *British J Radiol.* 2005;78(931):582-6.
 16. Hellén-Halme K, Nilsson M, Petersson A. Digital radiography in general dental practice: a field study. *Dentomaxillo facial Radiol.* 2007;36(5):249-55.
 17. Barrett HH, Swindell W, Stanton R, eds. Radiological imaging: The theory of image formation detection and processing. *Physics Today*. Available at: https://books.google.co.uk/books?hl=en&lr=&id=jzy2HqpCzFQC&oi=fnd&pg=PP1&dq=significance+of+image+detection+in+radiography&ots=AYipKQgvuQ&sig=2Waj-FrnViRffSv98E-VGk_F3bY.
 18. Cohenca N, Simon JH, Roges R, Morag Y, Malfaz JM. Clinical indications for digital imaging in dento-alveolar trauma. Part 1: traumatic injuries. *Dental Traumatol.* 2007;23(2):95-104.
 19. Abuzaid MM, Saad R, Elshami W, Alyafei S. The effect of digital imaging on Radiography work practice. *Int J Sci Technol Res.* 2015;4(7):7-10.

Cite this article as: Wani AH, Parry AH, Khanday SA, Gojwari TA. Improvement in radiographic quality workflow due to use of digital imaging and picture archiving and communication system. *Int J Adv Med* 2019;6:701-5.