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Knowledge and Skills of Radiographers concerning "Digital Chest Radiography"

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ABSTRACT

Aims Chest X ray is the first choice for the investigation of cardiovascular and respiratory disease. Radiographer technologists are responsible for managing the radiation exposure to patients and providing adequate image quality according to the ALARA (As Low as Radiation Achievable) concept. The knowledge and skills of radiographers in performing chest radiography helps to improve the diagnosis of diseases. The aim of this study was to assess the knowledge and skills of Radiographers on digital chest radiography in medical imaging departments.

Instruments & Methods A descriptive cross-sectional study was carried out on 65 of radiographers of Yasuj teaching hospitals, which were selected by the census sampling method. The knowledge was measured by the researcher- made questionnaire, and the checklist was used for measuring the skills of the radiographers. 390 digital chest radiographs were assessed during and after each procedure. Each radiography was analyzed by two expert radiologists and researchers according to the checklist, and the knowledge was analyzed with SPSS software version 21.

Findings The mean values of the radiographers' knowledge and skills were 85.48±6.48 and 78.79±8.99 (out of 100), respectively. 5.38% of digital chest radiography (21 of 390) led to repetition.

Conclusion Although the awareness and performance of the radiographers in the present study are appropriate, radiographers should be properly trained on digital chest radiography for reducing the patient radiation dose and improve image quality and radiological interpretation.

Keywords Chest X ray; Digital Radiography; Knowledge; Practice; Skills

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Introduction

As one of the medical imaging methods, radiography is mainly non-invasive and employs X ray to create anatomical and functional images through the body. Studies in several countries have reported that chest X ray is the most frequent radiographic examination [1]. It has been estimated that nearly 70 million chest radiographs are annually taken in the United State [2]. The chest radiography includes anatomical images of the heart, lungs, and thoracic viscera. Common radiographic findings in the chest radiography are pneumonia, emphysema, congestive heart failure, pneumothorax, pleural effusion, cardiomegaly, and pneumoperitoneum [3]. Moreover, posterior anterior (PA) chest projections are made periodically to evaluate particular populations with high occupational risk for lung disease (e.g. coal miners, silica workers, and asbestos workers). Furthermore, some studies have reported that chest radiography is important in managing and deciding the anesthesia method. Before surgery, chest radiography could help in evaluating the progress of diseases and identifying unexpected abnormalities which could affect the decision about the anesthesia method [4]. Therefore, standard chest radiography is critical for correct medical intervention and care management.

Several factors should take into account to obtain standard chest radiography. Some of these factors which are related to the technologists are: 1) Adequate positioning of patients regarding the patient's mental and physical condition which could be upright or recumbent [5, 6]. 2) Radiation exposure is an important factor in determining the quality of chest radiography and patient dose [7, 8]. 3) The source-to-image-receptor distance (SID) of 72 inches, especially for patients with cardiovascular problems [5]. 4) The angle of the X ray tube [5]. 5) The anti-scatter grid application for conventional radiography could improve the image quality but increase the patient absorbed dose [5, 9, 10]. 6) In the respiratory system images, deep inspiration is vital in image quality and physician interpretation [5, 6]. So, for perfect chest radiography, the radiographers should have enough knowledge of the standards of chest radiography.

Proper exposure conditions, SID, collimation, shielding, and other technical factors are mandatory to optimize the patient's dose [11]. Since the chest radiography is one of the most repeated x-ray examination; therefore it constitutes a significant portion of a cumulative effective dose of the population [1, 10]. Thus, radiographers' awareness and practice of standard chest radiography affect in optimization of patient dose and a cumulative effective dose of the population [11]. Even though the new imaging modalities like Magnetic Resonance Imaging (MRI) and High-Resolution Computed Tomography (HRCT) are overtaking the radiological methods, chest radiography is still one of the most frequent and challenging radiographic examinations. Several studies have evaluated radiographers' knowledge and performance effects on image quality and radiation dose. Some of these studies have investigated the effect of knowledge and awareness of radiographers on pediatric radiography and radiation dose [12, 13] and some others have been investigated technical and radiographic processes [14-16]. Few studies have addressed the radiographers' the knowledge and skills in hospitals or medical care units in terms of chest radiography. High-quality chest X-ray images cannot be obtained without adequate knowledge and practice of radiographers. Therefore, radiographers play an important role in the management of patient care. Most of the studies in this field have assessed the knowledge of technologists about other aspects of digital chest X ray such as image quality. The aim of this study was to assess the knowledge and skills of radiographers on digital chest X ray in medical imaging departments.

Instrument and Methods

The knowledge and skills of all of radiographers (65 person) working in the medical imaging departments of Yasuj University of Medical Sciences, Iran, in 2021 were evaluated in a descriptive cross-sectional study. Informed consent was taken from the technicians. The data was gathered by the researcher-made questionnaire and checklist.

The questionnaire includes demographic data (age, sex, education, work skills) in addition to 11 questions on the knowledge of radiographers. The questionnaires and checklist were established based on the physical and diagnostic features of chest radiography. The CAR (Canadian Association of Radiologists) standards [17], ACR (American College of Radiology) guidelines [18], and 13th edition of Merrill's Atlas [19] were used as the reference for the questionnaire and checklist. Their validity was confirmed by two qualified radiologists and its reliability was analyzed based on Cronbach's alpha coefficient as 0.83. The maximum score of the questionnaire is 100 and the answers were measured with a true and false scale.

390 digital chest radiographs, including PA and left lateral chest X ray projections were analyzed by two experienced radiologists and researchers to assess the skills of radiographers. To evaluate the different projections of chest radiography, a checklist was used for each digital chest radiography. For measuring the knowledge of radiographers, the questionnaire-based study was carried out on 65 radiographers and for assessing the skills of radiographers each radiography was analyzed by two experienced radiologists and researchers according to the checklist. Skills of radiographers (the checklist), were evaluated and analyzed during and after each procedure. 360 patients were taken digital chest radiographs with a transparent imaging plate,

selenium drum detector, and cesium iodide/ amorphous silicon (CsI/a Si) flat panel detector. 390 projections were addressed for this study.

The data were analyzed by SPSS 21 software. The mean and standard deviation scores of the results were expressed.

Findings

65 radiographers participated in the current study. Their age ranged between 23 to 52 years with a mean of 33.0±6.2 years. Their work skills were between 1 to 27 years with a mean of 9.8±5.8 years. No significant relationship was detected between demographic data and radiographers' knowledge and skills.

Table 1) Radiographers' knowledges regarding digital chest radiography

Questionnaire items	Knowledge
1-PA projection of chest X-ray (including positioning, central x-rays, beam collimator and shielding)	92.33±26.74
2-Lateral projection of chest X-ray (including positioning, central x-rays, beam collimator and shielding)	85.71±35.27
3-The correct location of specific tubes and lines	82.81±38.02
4-Radiation exposure factors	86.15±34.80
5-Inspiration (Deep or poor inspiration)	84.37±36.59
6-Patient dose from chest X-ray	74.60±43.87
7-Anatomical areas of chest X-ray	89.06±31.45
8-Artifacts of chest X-ray	85.93±35.03
9-Source-to-image-receptor distance (SID) of chest X-ray	98.46±12.40
10-Image quality (Spatial and Contrast resolutions) of chest X-ray	83.07±37.78
11-Post processing (Gray-scale processing, Edge enhancement, and multi-frequency processing)	77.77±41.90
Radiographers' knowledge	85.48±6.48

Table 2) Radiographers' skills regarding digital chest radiography

Checklist items	Practice
1- Correct demographic information	90.76±29.17
2-Asking about pregnancy	67.69±47.12
3-Screening of patients for artifacts	80.00±40.31
4-Adequate position of PA projection	78.12±41.66
5-Adequate position of Lateral projection	70.76±45.83
6-Source-to-image-receptor distance (SID)	72.30±45.09
7-Sufficient inspiration (Deep inspiration)	89.23±31.24
8-Selection of appropriate protocols	83.07±37.78
9-Adequate exposure factors	76.92±42.46
10-Correct marker placement	87.69±33.10
11-Image quality (Spatial and Contrast resolutions) of chest X-ray	64.61±48.18
12-Post processing (Gray-scale processing, Edge enhancement, and multi-frequency processing)	72.30±45.09
13-Pertinent anatomy demonstrated	90.76±29.17
Radiographers' skills	78.79±8.99

Radiographers' knowledge and skills about PA and Lateral projections (including positioning, central x-rays, beam collimator, and shielding) were assessed. The mean and standard deviation of the knowledge were 85.48 and 6.48, respectively (Table 1). The highest and lowest correct rates of knowledge about chest radiography were observed for Source-to-image-receptor distance and patient dose, respectively.

The patient's position and adequate technique factors for digital chest radiography projections were analyzed with a checklist as the skills of radiologic technicians (Table 2). The mean and standard deviation of the skills were 78.79 and 8.99, respectively.

Three of the images were repeated due to the carelessness of radiographers in screening patients for artifacts (Figure 1).

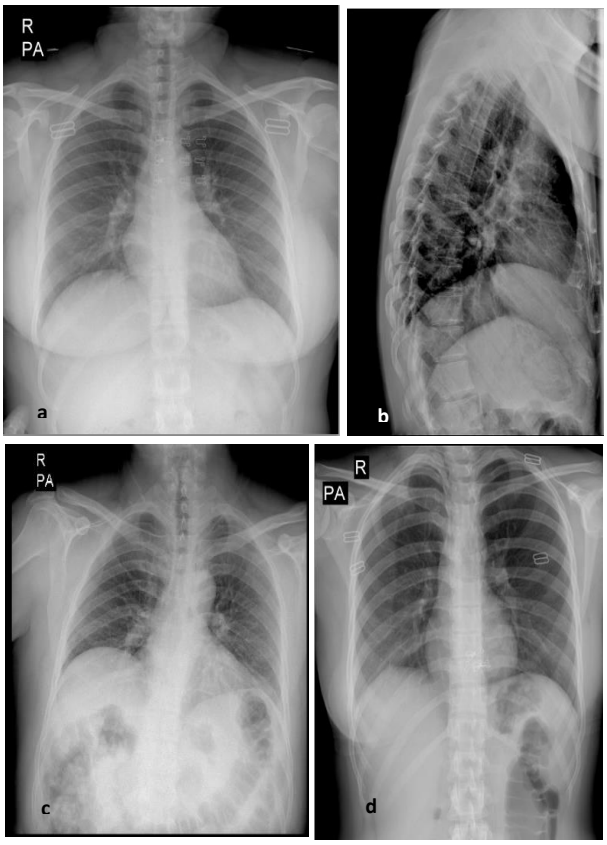

Figure 1) a: Inadequate screening of patients for artifacts; b: Rotation of the chest radiograph lateral view; c: Poor inspiration and rotation of chest radiography; d: Over penetration chest radiograph

Discussion

In the current study, the radiographers' good participation was noticeable, and the variables affecting the knowledge and skills of radiographers about chest radiography were assessed. This study, however, uniquely assessed the knowledge and skills of technologists about high-frequency digital chest radiography.

The knowledge of the radiographers on the patient's position and adequate technique was appropriate. In general, radiographers' skills was 78.79±8.99, and radiographers' knowledge was 85.48±6.48. Moreover, the radiographers' skills to take high-quality chest radiography were explored based on recommended standards in literature which is one of the advantages of this study over the previous ones [20-24].

In this study 5.38% of chest x-ray (21 of 390) led to image rejection and repetition. With the advent of digital imaging, image rejection rates have decreased [25]. Other studies show different values in digital radiographic image rejection [25-29]. In various researches, the image rejection has varied from 4 to 12 percent, which is due to the type of imaging center and the type of radiographs. For example, in emergency centers, the rejection rate of images is higher [27] and the chest rejection rate is higher than other radiographs [26]. The most common cause of image rejection is incorrect position [25, 27, 28]. Another reason for rejecting was cut-off the image and incorrect center of ray [16, 25, 27]. Repetition of radiographs increases the dose of the patient and thus increases the cumulative and unnecessary dose of the population [30]. Inappropriate position and technical problems like anatomy, expiratory status, artifacts, and rotation led to repetition. Three of the images were repeated due to the carelessness of radiographers in screening patients for artifacts. Some items of the current study are comparable with other studies conducted previously. Morrison et al demonstrated that 75% of images are cropped after image processing during pediatric radiography [31]. Our data showed post processing is 72.3%. Suboptimal positioning is 47% of rejected images in study conducted by Elin Kjelle [15]. Radiographers in current study obtained 78.12 and 70.76 percent of total score for PA and Lateral positions respectively. But we not evaluate the percentage of image rejection due to only positioning. As we now other studies evaluated knowledge and skills of radiographers about the factors affecting on the radiation protection. Hence, we considered factors affecting on image quality. Previous research conducted by Shafiee et al. the knowledge and practice medical professionals a bout radiation protection assessed. Their results demonstrated only 47.7% of participants comprehend the concept of ALARA while it is the basic principle of radiation protection [32]. However, in the present study, the knowledge of radiographer was 85.48±6.48, that is appropriate.

Radiographers should provide an adequate position for PA and Lateral projections. Chest radiography should not show signs of rotation, a slight amount of rotation will result in considerable distortion of the heart shadow in PA and Lateral projections. Physicians show superimposed posterior ribs; clavicles are equidistant from the spinous processes of the thoracic vertebral without rotation in Lateral and PA projections, respectively. Image 2 demonstrates rotation for Lateral chest X-ray projection. In this case, poor positioning of the patient was observed; therefore, some technicians require more training in patient positioning. Positioning the patient was the most important factor in the repetition of chest radiography.

It is well known that for chest radiography, the exposure must be made on the deep inspiration for optimal visualization of the lung base. In image 3, a patient provided poor inspiration and rotation before making the exposure. The inadequate skills of radiographers led to larger visualization of the heart. Image 3 was taken in poor inspiration which may lead to false-positive reading in physician interpretation.

It is strongly recommended that radiographers tune exposure factors based on patient age and body status. Appropriate protocols and adequate exposure factors are vital for optimal patient dose and image quality. To achieve lower patient dose and ensure adequate image quality, exposure factors and selection of appropriate protocols should be adjusted for various body habitus. Lack of radiographers' skills in this field may lead to an increase in patient dose and collective effective dose. Usually, radiographers must use high kVp, high mA and short exposure time [2]. Although automatic exposure control terminates radiation exposure when the image receptor has received a pre-determined amount of x-ray exposure, the use of appropriate protocols and adequate exposure factors is still of crucial importance.

From our observation, some radiographers prefer to use post-processing to obtain appropriate spatial and contrast resolutions instead of a selection of the correct configuration of protocols or applying an appropriate protocol. In image 4, the anatomy of chest radiography cannot be adequately visualized due to overexposure or over-penetration radiograph which may increase the repetition of the radiograph and enhance the radiation dose.

All images didn't provide appropriate collimation at the top and bottom or bilateral of the chest radiography. However, adequate collimation is one of the most important aspects in optimizing the X-ray dose and should be adjusted appropriately. Radiologic technologists are responsible for managing the radiation dose and provide proper image quality according to the ALARA (as low as reasonably achievable) concept. Radiographers used postexposure cutting instead of adequate collimation; likewise, masking portions of digital chest radiography are not a substitute for collimation. Inadequate collimation in chest radiography may increase the effective radiation dose of the thyroid gland (a radiosensitive organ). Freitas et al. [33] was observed a considerable variation of entrance surface dose values in digital chest radiography. Hence, many works can be done to reduce radiation exposure to patients by changing the technical parameters without loss of image quality.

These reports, combined with our results, highlight the need for training radiographers on digital chest radiography to reduce the repetition and radiation dose and improve the image quality and image interpretation.

The limitation of this study is the small number of participants due to the small statistical population in

the research area. Therefore, it is recommended to include greater participants in future surveys.

The amount of image rejection in this study is consistent with other studies, but efforts to reduce the repetition of radiographs should not be neglected. It is recommended that similar studies be conducted in different time periods for other radiographs in order to assess the need for retraining.

Conclusion

The knowledge and skills of radiography technicians are appropriate and only some items e.g., doing field collimation to reduce the patient's dose and asking about the patient's pregnancy and choosing the suitable technical conditions to increase the quality of the image, need training.

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Ethical Permissions: This manuscript is based on a research proposal that is already confirmed by ethics committee of Yasuj University of Medical Sciences (93.08.10.22). The participants in this research were informed about the objectives of the research and its implementation process and participated in this research by filling the informed consent form. In order to preserve privacy and comply with ethical principles in research, questionnaires were distributed and collected without mentioning personal information.

Conflicts of Interests: The authors declare that they have no Conflict of interests.

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