Analysis of the potential reasons for repeated radiography: a study in a major hospital in south eastern Iran

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Abstract

Rejecting, removing and repeating the process of taking diagnostic X-ray images could lead to professional and moral challenges in the case of radiologic imaging. The aim of this study was to investigate the common causes of repetitive imaging and the types of images mostly repeated. Radiographs taken in our medical center form January 1st 2021 to July 1st 2021 were evaluated. After gathering information and importing form-related data into the statistical software SPSS Ver. 26. In this study, a total of 4916 were evaluated. Among 398 repeated radiographs, 94 repetitions (23.62%) were due to inappropriate positioning, 92 repetitions (23.12%) were due to patient's movements, 56 repetitions (14.07%) were due to inadequate radiation, 51 repetitions (12.81%) were due to inadequate processing, 46 repetitions (11.56%) were due to inadequate preparation of the patient, and 59 repetitions (14.82 %) were due to other reasons. In this study, the rate of repeated radiographs taken in a tertiary hospital was estimated at 8.10%, with the most common cause for repetitions being inappropriate positioning. Considering the fact that repeated radiography mostly depends on operator-related factors, it is recommended to repeat the study after educating staff in order to compare the rate and reason of repetition.

Introduction

Rejecting, removing and repeating the process of taking diagnostic radiographic images could lead to professional and moral challenges in the case of radiologic imaging. Rejection analysis is one of the important parts of qualification assurance programs in medical imaging departments.[1] The analysis is a basis for determining the reason behind the rejection of images and maybe beneficial in radiography-related education, improving quality of work in the radiology department, and finally reducing patients' exposure to radiation.[2] The radiographic examination is mostly done in at least two planes in order to gain diagnostic images to help diagnose disorders or damages.[3] A rejected image is one considered to have inadequate quality by a radiologist. The radiologist decides that the image does not hold technical standards for a certain diagnosis process and consequently rejects the image demanding another one.[4]

This recurrent imaging process increases the patient's exposure to radiation and thus violates the concept of keeping ionizing radiation exposure at a fair minimum. Moreover, rejected images reduce the efficiency of the department and patients' consent which accordingly increases institutional costs.[5]

Evaluating the rate of repeated images is a part of the rejection analysis process, which is an acceptable standard to assure the quality in general radiology. Observing repeated radiographs can help evaluating the quality of diagnostic images, improving examination protocols, educating staff, and assessing patients' radiation exposure.[6,7]

For a diagnostic radiology department to be able to provide images of high quality with the minimum exposure of patients and staff to the radiation, a program of quality assurance needs to be set and accomplished.[8,9] The reasons for the rejection of images correspond with technical alternated advances. The most common reason to reject images in conventional film-screen radiology was reported to be exposure errors (that is, too much or too little exposure).[10,11] Currently, this issue is a position error in computed radiography (CR) and digital radiology. The accuracy of results achieved by rejection analysis depends on radiologists' obligation to categorize their rejected images appropriately. Also, the ability of the imaging department to reduce the rate of rejected images depends on the application of findings acquired by rejection analysis using a feedback and education system.[12-15] This study reports the repetition rate in an imaging department in Iran. The aim of this study was to investigate the causes for repetitive imaging and to evaluate the types of images mostly repeated.

Materials and Methods

This study was approved by the ethical committee of Zahedan University of Medical Sciences. The radiographic images taken in radiology department of Ali Ibn-e-Abi Talib hospital, Zahedan, Iran form January 1st 2021 to July 1st 2021 were included. First, a radiology technician was asked not to delete any repetitive images for different reasons and to save them just the same. At the end of each week, repetitive images were referred to the researcher to analyze the frequency of repetitive radiographs and the causes. There was a form that the specialist should fill if they want to ask for a repeated imaging where they were provided with 6 options: i) inadequate radiation (too much or too little amount of radiation), ii) inappropriate positioning, iii) patient's movements, iv) inadequate processing, v) inadequate preparation of the

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Ethics approval and consent to participate: the Ethics Committee of Zahedan University of Medical Sciences approved this study (IR.ZAUMS.REC.1399.314). The study is conformed with the Helsinki Declaration of 1964, as revised in 2013, concerning human and animal rights.

Informed consent: All patients participating in this study signed a written informed consent form for participating in this study.

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patient, vi) other reasons. These filled forms were reviewed by a radiologist and in cases where the radiologist was not consistent with the specialist, the issue was discussed with a second radiologist who was experience in that specific field and the final decision was made by him/her. Inadequate processing includes items such as lack of marking or false marking, false crop, the false record of names and other features of radiographic. Other reasons consist of items such as dysfunction of radiology device, cassette size-related problems in portable Images, errors regarding the type of radiography which was asked for, presence of artifacts, and other items leading to repetition.

Repeated images were also differentiated based on anatomic areas, including skull, spine, chest, abdomen, hips, and limbs, and the frequency of repetition was analyzed in each as well as their causes (Table 1). It is necessary to mention that radiographs taken of knee, femur, ankle, and foot were all subgroups of lower limbs, while radiographs taken of the elbow, shoulder, wrist, hand, radius, ulna, and humerus were subgroups of upper limbs.

Statistical analysis

After gathering information and importing form-related data into the statistical software SPSS Ver. 26. statistical indexes regarding descriptive statistics such as frequency and percentage were first calculated. The results were then represented as charts and tables.

Results

In this study, a total of 4916 radiographs were included. Radiographs were categorized and assessed in 7 anatomic groups including chest, hips, abdomen, upper limbs, lower limbs, skull and spine.

Most of the radiographs among the data obtained were chest images (CXR), of which there were a number of 3060 (62.25%), secondly abdomen (718 images accounting for 14.61%), and thirdly lower limb (472 images accounting for 9.60%). The numbers and percentages of radiographs taken of each body area are represented in Table 1.

Most frequent repetitions were seen in radiographs of the skull and upper limbs (respectively 8 images accounting for 13.33% and 30 images accounting for 10.34%) while the fewest repetitions occurred in abdominal radiographs (8 images accounting for 1.11%). The numbers and percentages of radiographs taken of different body areas are represented in Table 1.

Reasons of repetition included inadequate radiation (too much or too little amount of radiation), inappropriate positioning, patient's movements, inadequate processing, inadequate preparation of the patient, and other reasons. It is necessary to say inadequate processing includes items such as lack of marking or false marking, false crop, the false record of names and other features of radiographic, etc. Other reasons consist of items such as dysfunction of radiology device, cassette size-related problems in portable Images, errors regarding the type of radiography which was asked for, presence of artifacts, and other items leading to repetition. Among 398 repetitive radiographs, 94 repetitions (23.62%) were due to inappropriate positioning, 92 repetitions (23.12%) were due to patient's movements, 56 repetitions (14.07%) were due to inadequate radiation, 51 repetitions (12.81%) were due to inadequate processing, 46 repetitions (11.56%) were due to inadequate preparation of the patient, and 59 repetitions (14.82 %) were due to other reasons. The number and percentage of each radiographic repetition factor are represented in Table 2.

Discussion

Repeated radiographic imaging made up 398 images (8.10%) of 4916 radiographic images totally taken in our study. This amount has been 16.85% in Zewdu *et al.*'s study[13] and 14.1% in Owsue *et al.*'s study.[15] Meanwhile, Yurt *et al.*'s reported a repeated frequency of 1.2%,[14] which is lower compared to the current study. When evaluating the repeated images based on the anatomical area in our study along with other studies (Table 3) showed that the repeat rate is higher than the other parts. Pelvis (ranging from 4% to 31.1%) and spinal cord (ranging from 4.6% to 20%) radiographic images seem more likely to be repeated based on previous studies.[12-22] Meanwhile our study found the highest rate of repetition in skull radiographic images (13.3%), which was consistent with the previous studies in terms of frequency.[13,19,21] This might indicate the need for more training specifically regarding these areas.[21]

In Fintelmann's[12] study, in which only chest radiographs were assessed, repetitions accounted for 13.3% of the images, while in

Table 1. The number and frequency of evaluated radiographs and the repeats.

Radiograph	Number (%)	Number of repeat (%)
Skull	60 (1.2)	8 (13.33)
Upper limb	290 (5.9)	30 (10.34)
Chest	3060 (62.5)	304 (9.93)
Lower limb	472 (9.6)	32 (6.78)
Spinal cord	328 (4.64)	14 (6.14)
Pelvis	88 (1.79)	2 (2.27)
Abdomen	718 (14.61)	8 (1.11)
Overall	4916 (100)	398 (8.1)

Table 2. Different reasons of repeated radiography.

Characteristic		The reason for repeated radiography						Overall
		Positioning error	Patient movement	Exposure error	Inappropriate image processing	Inappropriate patient preparation	Other	
Radiographs (4916)	Skull (60)	2(25)	2(25)	4(50)	0(0)	0(0)	0(0)	8
	Upper limb (290)	8(26.67)	6(20)	2(6.67)	0(0)	0(0)	6(20)	30
	Chest (3060)	74(24.34)	72(23.68)	34(11.18)	35(11.51)	40(13.16)	49(16.12)	304
	Lower limb (472)	4(12.5)	8(25)	10(31.25)	4(12.5)	2(6.25)	4(12.5)	32
	Spinal cord (228)	4(28.57)	2(14.29)	4(28.57)	2(14.29)	2(14.29)	0(0)	14
	Pelvis (88)	0(0)	0(0)	2(100)	0(0)	0(0)	0(0)	2
	Abdomen (718)	2(25)	2(25)	0(0)	2(25)	2(25)	0(0)	8

Table 3. The frequency of repeated radiographs in different studies.

Radiograph	Fintelmann (%)	Zewdu (%)	Yurt (%)	Owusu-Banahene (%)	Haghparast (%)	Mahmoodi (%)	Jadidi (%)	Asgharzadeh (%)	Atkinson (%)	Alashban (%)
Skull	N/A	13.9	3	N/A	11	N/A	13.7	7	14	4.5
Upper limb	N/A	N/A	8	N/A	3.8	N/A	9.9	4	8	6.7
Chest	13.3	13.7	24	12.5	6.7	N/A	14.6	5.7	7	8.9
Lower limb	N/A	15.57	15	12.5	3.7	N/A	11.1	4.3	11	3.8
Spinal cord	N/A	20	1	25%	9.3	N/A	17.1	4.6	17.6	10
Pelvis	N/A	31.11		9	9	N/A	4	7	23	20
Abdomen	N/A	13.2	8	N/A	7	N/A	19.4	2.6	12	13.9
Overall	N/A	16.85	1.2	14.1	6	8.7	7.98	4.9	9	9.5

Table 4. The causes of repeated radiographs in different studies.

Reasons	Fintelmann (%)	Zewdu (%)	Yurt (%)	Owusu-Banahene (%)	Haghparast (%)	Mahmoodi (%)	Jadidi (%)	Asgharzadeh (%)	Atkinson (%)	Alashban (%)
Positioning error	84.8	N/A	36.11	N/A	24.1	9.3	29.3	N/A	49	41.3
Patient movement	4.6	N/A	16.67	N/A	1.5	14.1	N/A	5.6	5	14.5
Exposure error	N/A	N/A	1.01	N/A	55.2	6	12.6	49	5	4.4
Inappropriate image processing	1.5	N/A	5.56	N/A	0.4	3.1	2	9.4	1	N/A
Inappropriate patient preparation	N/A	N/A	15.66	N/A	N/A	5.3	N/A	N/A	N/A	N/A

our study repetitions accounted for 9.93%. This rate was different from 5.7% to 24% in the previous studies (Table 4).[12-22]

It is essential to consider that in different hospitals, the number of repetitions in each anatomic area might be affected by existing specialties, the professionalism of the radiology department assistants.[21]

Evaluating the causes of image repetition is a very crucial part of studying the imaging repetition. The most common cause of repetition in our study was inappropriate positioning which was in line with most of the previous studies.[12,13,20,21] Earlier studies which evaluated film-based radiography reported exposure errors as the most common error for leading to repetition.[16,20]

By reviewing similar papers (Table 2), it can be seen that in most studies, the most prevalent reasons behind repetitive radiographs have been related to positioning or inappropriate radiation, which depend on the radiology staff, the hospital being educational, lack of experience for students or new staff, not using tables and radiation factor controllers, the large number of patients, lack of accuracy, inadequate knowledge and experience, application.[20,22] These factors are mostly manageable and can be partially corrected by educating staff.

In addition, some studies reflect a variation in the reasons for repeated radiographs in different regions of a city or different hospitals.[16,20] In each region, reasons for repetitions in hospitals differed according to substructures, equipment, staff, the load of work, different departments, and specialties, and thus different percentages have occurred regarding various factors.[16,20]

Conclusions

In this study, the rate of repeated radiographs taken in a tertiary hospital was 8.10%, with the most common reason for repetitions being inappropriate positioning. Considering the fact that repetitive radiography mostly depends on operator-related factors, it is recommended to repeat the study after educating staff in order to compare the rate and reason of repetition.

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