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Evaluation of Repeated X-Ray Examinations and their Underlying Causes in the Radiology Department

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ABSTRACT

Repeated X-ray examinations present significant challenges in diagnostic radiology by increasing radiation exposure, causing diagnostic delays, and reducing departmental efficiency. This study aimed to evaluate the frequency of repeated X-rays and investigate the underlying causes within the radiology department at AL-KHIDMAT Hospital, Peshawar. A cross-sectional observational design was used over four months, reviewing 114 X-ray cases and administering questionnaires to radiology staff. The findings revealed an alarmingly high repeat rate of 33.3%, far above the internationally recommended threshold of 5–7%. Chest radiographs were the most frequently repeated, constituting 44.7% of all repeat cases. The primary causes identified were poor image quality (23.6%), patient movement (26.3%), and incorrect positioning (15.8%). These results highlight the urgent need for interventions, including structured reject analysis programs, enhanced radiographer training, standardized imaging protocols, and

improved patient communication, to reduce unnecessary radiation exposure and optimize diagnostic workflow.

Keywords— X-ray repetition, diagnostic radiology, image quality, patient positioning, repeat rate, quality control.

Introduction

Medical X-ray imaging is one of the most widely used diagnostic tools in radiology worldwide. It plays a crucial role in detecting and managing a wide range of medical conditions by producing images of internal body structures. Despite its diagnostic value, X-ray imaging exposes patients to ionizing radiation, which carries potential biological risks. Diagnostic X-rays contribute to more than half of the artificial radiation exposure received by the general population. Even low doses of ionizing radiation may pose potential health risks, as there is no completely safe exposure threshold. Therefore, radiology departments must carefully balance image quality with patient safety by minimizing radiation dose while maintaining diagnostic image quality. This concept is known as the ALARA principle (As Low As Reasonably Achievable), which is a fundamental radiation protection guideline in diagnostic radiology (Stephenson et al., 2021; Jabbari et al., 2012). High-quality radiographic images are essential for accurate diagnosis and treatment planning. However, when an image is considered diagnostically unacceptable due to technical or procedural errors, the examination must be repeated. Such repeated imaging increases radiation exposure to patients and healthcare staff. To monitor and control this issue, radiology departments implement quality assurance (QA) programs that track the repeat rate, defined as the proportion of radiographs that must be retaken because the original image did not meet diagnostic standards. International guidelines generally recommend maintaining repeat rates below 5–6% to ensure optimal radiographic practice. When repeat rates exceed these limits, it often indicates underlying problems in radiographic technique, staff training, equipment performance, or patient preparation. Repeated radiographs also increase operational costs, prolong patient waiting times, and reduce overall departmental efficiency. Therefore, minimizing unnecessary repeat examinations is essential to enhance patient safety, reduce radiation exposure, and improve healthcare resource utilization (Dwivedi et al., 2024).

Radiology departments in developing and low-to-middle-income countries often face additional challenges that may contribute to higher repeat rates. These challenges include heavy patient workloads, outdated imaging equipment, limited maintenance resources, and variations in technologist training levels. In Pakistan, several studies have highlighted the issue of repeated radiographic examinations. For example, a quality audit conducted in a hospital in Peshawar reported a repeat rate of approximately 4.8% for chest radiographs. The most common causes of repeated examinations were exposure errors, such as overexposure or underexposure, and improper patient positioning (Khan et al., 2017). Another study conducted during the COVID-19 pandemic in Peshawar found a significantly higher reject rate of 17% in diagnostic radiographs, reflecting the challenges faced by busy radiology departments during periods of increased workload and operational pressure (Ali et al., 2021). These

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findings suggest that repeated X-ray examinations remain an important quality concern in the local healthcare system. A repeated X-ray examination, also referred to as a radiographic retake or repeat film, occurs when the initial radiographic image is considered unsuitable for diagnostic interpretation and must therefore be performed again. This may occur immediately during the same patient visit or during a subsequent appointment if the image quality is inadequate. Although repeat examinations may sometimes be unavoidable, many repeats result from preventable technical or procedural errors. Each repeated radiograph contributes additional radiation exposure to the patient and increases workload for radiology staff. Consequently, identifying the causes of repeat imaging is essential for improving radiographic practice and ensuring optimal patient safety (De Crop et al., 2022).

Several factors contribute to repeated radiographic examinations. One of the most common causes is improper patient positioning, where the anatomical region of interest is not correctly aligned with the X-ray detector. Poor centering and inadequate collimation may also lead to incomplete visualization of anatomical structures, making the image diagnostically unacceptable. Exposure errors represent another significant cause of repeat imaging. Incorrect selection of exposure parameters such as kilovoltage peak (kVp), milliamperes-seconds (mAs), or exposure time may result in overexposed or underexposed images that fail to provide adequate diagnostic detail. Patient-related factors may also influence image quality. For example, patient movement during the examination can produce motion blur, which reduces image clarity. Additionally, external artifacts such as clothing, jewelry, or medical devices may obscure anatomical structures and necessitate a repeat examination. Equipment malfunction, detector errors, or software-related issues may also lead to image rejection and repetition (De Crop et al., 2022). Repeated X-ray examinations are therefore often indicators of avoidable quality issues in radiology practice. The most common causes include positioning errors, incorrect exposure factors, patient movement, artifacts caused by external objects, and technical or equipment failures. Each repeated exposure increases the cumulative radiation dose delivered to the patient and contradicts the ALARA principle. High repeat rates may also indicate deficiencies in technologist training, patient communication, equipment maintenance, or quality control procedures. Moreover, repeat examinations increase departmental workload and may delay diagnostic reporting for other patients. For these reasons, analyzing the causes and frequency of repeated radiographic examinations is an essential component of radiology quality assurance.

Recent studies conducted worldwide have evaluated repeat radiography rates and their underlying causes. A study conducted in Australia in 2021 evaluated reject rates in emergency department radiography and reported an overall reject rate of 10.3%. The highest rejection rates were observed in anteroposterior (AP) chest, AP pelvis, and horizontal-beam hip and knee projections. Positioning errors and anatomical cut-off were identified as the most frequent causes of repeated examinations, accounting for more than two-thirds of repeat cases. The authors emphasized the importance of systematic reject analysis to identify patterns of errors and improve radiographic quality (Mohammed et al., 2021). Similarly, research conducted in Pakistan has reported significant repeat rates in routine radiography. In a study analyzing approximately

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15,000 radiographs in a public sector hospital, Ali et al. (2021) found that 17% of the images were rejected and required repetition. The primary reasons for rejection included positioning errors (30.5%), imaging artifacts (22.4%), and patient motion (12.1%). Extremity radiographs showed the highest rejection rates, followed by chest and spine examinations. The study concluded that implementing regular reject analysis and providing targeted training to radiologic technologists could substantially reduce repeat examinations and improve overall image quality.

Comparable findings have also been reported in other countries. In India, Dwivedi et al. (2024) evaluated more than 6,800 radiographic examinations in a teaching hospital and found that most repeat radiographs were caused by technical errors such as improper positioning, incorrect centering, and poor collimation. Patient-related factors, including higher body mass index and inadequate patient preparation, also contributed to repeat imaging. These findings reinforce the importance of continuous quality monitoring and adherence to radiation protection guidelines in diagnostic radiology (Al-Malki et al., 2003). Repeated imaging may also occur due to logistical or clinical reasons. For example, a study conducted in the United States involving orthopedic patients found that 65% of patients had their radiographs repeated during the initial consultation. The most common reasons were the unavailability of previous images and the absence of required radiographic views. In some cases, repeated imaging provided clinically important information that altered diagnosis or treatment plans. However, the study highlighted that many repeats occurred due to avoidable administrative or technical issues (Yayac et al., 2021).

Given the potential risks associated with repeated radiographic examinations, it is essential to evaluate their frequency and underlying causes within individual healthcare institutions. The rationale of the present study is therefore to assess the prevalence of repeated X-ray examinations in our radiology department and identify the main factors responsible for these repetitions. By analyzing repeat patterns, the study aims to provide baseline data that can support targeted interventions such as improved technologist training, enhanced patient preparation protocols, and better equipment maintenance. Ultimately, reducing repeat radiography will help minimize unnecessary radiation exposure, improve diagnostic efficiency, and enhance the overall quality of radiological services.

Methodology

Study Design

This study was a cross-sectional observational study conducted in the Department of Radiology at Al-Khidmat Hospital.

Study Duration

The study was conducted over a period of four months from May to August.

Sample Size

The required sample size was calculated using Cochran's formula for prevalence studies, considering a prevalence of 8.1%, a 95% confidence level, and a 5% margin of error. The calculated sample size was 114.

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Sampling Technique

A non-probability convenience sampling technique was used for the selection of study participants.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Patients of all age groups and genders undergoing plain X-ray examinations in the radiology department during the study period.
- X-ray examinations producing diagnostic images, including repeated scans, with complete imaging records available.
- Radiology personnel (radiographers and technicians) involved in performing X-ray examinations during the study period were included in the questionnaire survey.

Exclusion Criteria

- Imaging modalities other than plain radiography, such as CT, MRI, or ultrasound.
- Cases with incomplete, missing, or unreadable imaging records.
- X-ray examinations that were not fully documented or performed outside the study period.
- Examinations conducted by external or visiting consultants not regularly working in the radiology department.
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Data Collection Procedure

Data were collected using two methods:

Radiology Record Review:

Radiology logbooks and PACS records were reviewed to identify all X-ray examinations performed during the study period. Each examination was assessed for repeated exposures, defined as an additional exposure of the same view during the same session. Information including patient age, gender, type of examination, and occurrence of repeat imaging was recorded.

Staff Questionnaire:

A structured questionnaire was administered to radiology personnel working in the X-ray unit to collect information on possible factors contributing to repeat examinations, including operator experience, equipment-related issues, workload, and awareness of radiation safety practices. Participation was voluntary and responses were recorded anonymously.

Data Analysis

All collected data were entered and analyzed using IBM SPSS Statistics 27.

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Result:

This study was conducted to evaluate the frequency and underlying causes of repeated X-ray examinations in the radiology department. Data were collected from 114 patients who underwent different types of X-ray examinations during the study period through radiology record review and a structured questionnaire. The results are presented according to demographic characteristics of patients, distribution of X-ray examination types, frequency of repeated examinations, and the major causes responsible for repetition. The findings are illustrated using tables, bar charts, and pie charts to provide a clear representation of the observed trends. Each section includes a brief analysis highlighting the key findings in relation to the objectives of the study.

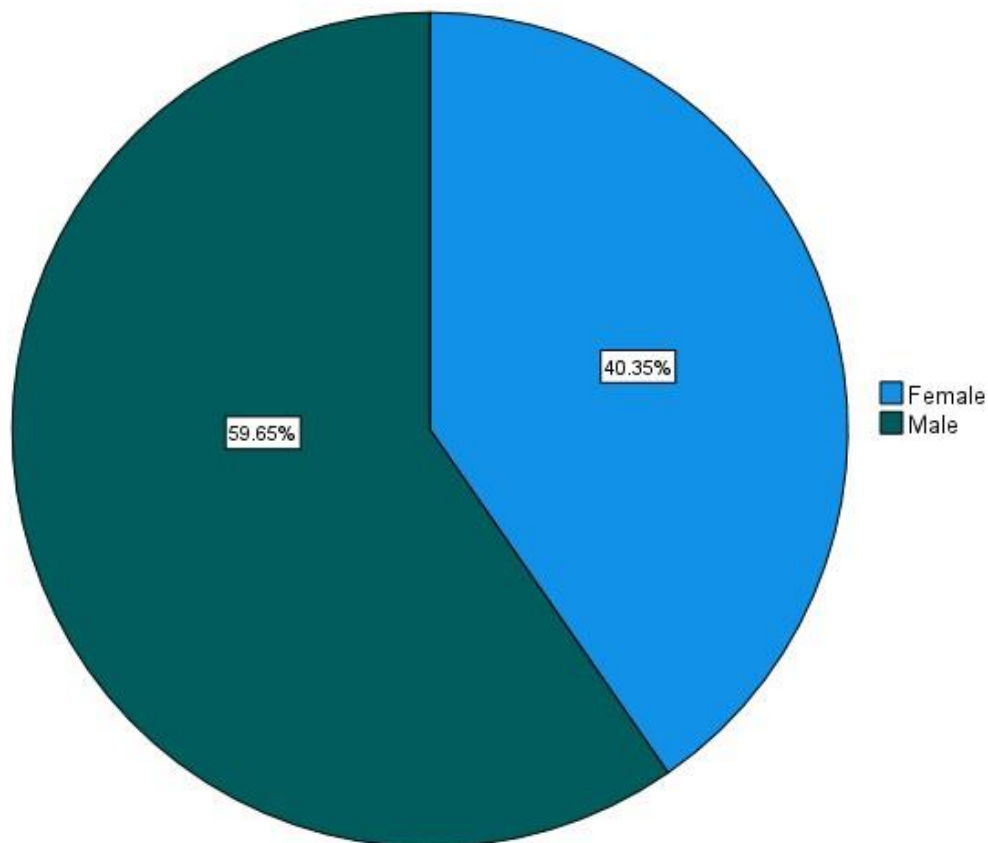


Figure 1: Gender-wise distribution

A total of 114 patients who came for X-ray examinations were recruited for the study. Out of these, 68 (59.6%) were males and 46 (40.4%) females. This shows a male predominance in the sample either a reflection of case distribution of the department or higher referral to X-rays for men during the study period.

Table 1: Age Group Frequency and Percentage

S No.	Age	Frequency (n)	Percentage (%)
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1	<18	5	4.4%
2	18–30	40	35.1%
3	31–45	38	33.3%
4	46–60	22	19.3%
5	>60	9	7.9%

Distribution by age of the 114 patients was characterized by young to middle-aged adults. The largest proportion was aged 18–30 years (35.1%), with 31–45 years also at 33.3%. Patients aged 46–60 years were 19.3%, and those above 60 years were 7.9%. The under-18 population had the lowest representation at 4.4%. This shows that the majority of X-ray studies were conducted on patients aged between 18 and 45 years.

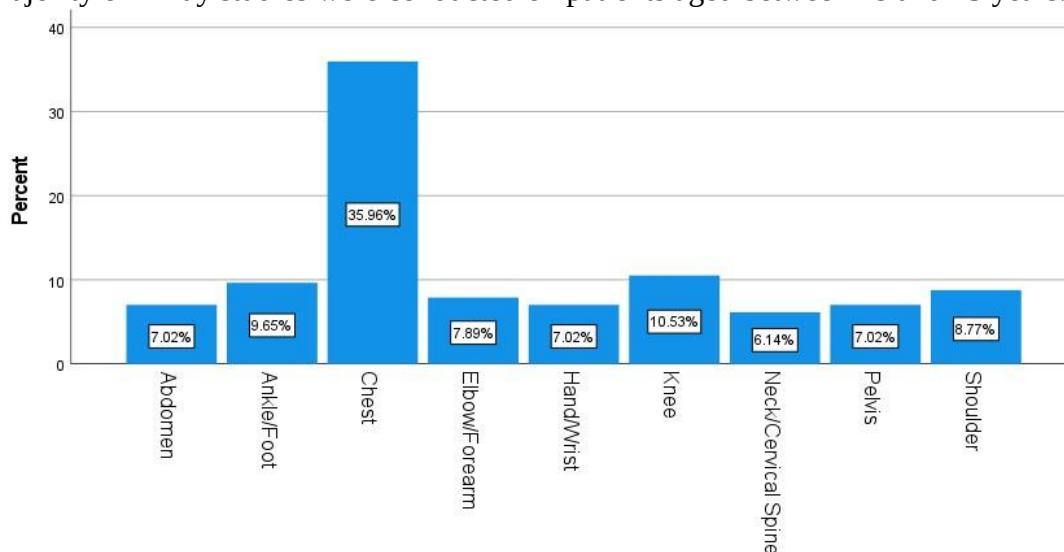


Figure 2: X-ray type distribution

The above bar chart illustrates the frequency of various types of X-ray examinations conducted among the 114 patients included in the study. Chest X-rays were the most commonly performed, accounting for 35.96% of all cases, significantly higher than other types. This was followed by knee X-rays at 10.53%, ankle/foot X-rays at 9.65%, and shoulder X-rays at 8.77%. Elbow/forearm examinations comprised 7.89%, while abdomen, hand/wrist, and pelvis X-rays each represented 7.02% of the total. Neck and cervical spine X-rays had the lowest frequency at 6.14%. These findings confirm that chest imaging remains the predominant type of diagnostic radiography, which aligns with its clinical importance in evaluating respiratory and cardiac conditions.

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Table 2: Repeated X-rays distribution

X-Ray Type	Repeated X-Rays (n)	Percentage (%) of Total Repeats (n=38)
Chest	17	44.7%
Knee	4	10.5%
Elbow	3	7.9%
Shoulder	3	7.9%
Ankle	3	7.9%
Hand	2	5.3%
Neck	2	5.3%
Pelvis	2	5.3%
Abdomen	2	5.3%
Total	38	100%

Of 114 X-ray studies reviewed, 38 were found to be repeats, or a repetition rate of 33.3%. This was much higher than the recommended threshold of 5–7% that has been considered to reflect potential issues with image quality, procedural perfoms, or technical proficiency. Of the 38 repeat studies, chest X-rays were the most repeated with 17 occurrences (44.7%). This was then followed by knee X-rays with 4 repeats (10.5%), and elbow, shoulder, and ankle X-rays with 3 repeats (7.9%). Hand, neck, pelvis, and abdomen X-rays each had 2 repeated cases (5.3%). The results indicate that chest radiography, although most frequently done, is also repeatedly done most likely because of challenges such as patient movement while breathing and problems in maintaining proper positioning.

Table 3: Distribution of Causes for Repeated X-Ray Examination

Cause of Repetition	Yes (n)	Percentage (%) among repeats
Patient movement	10	26.3%
Incorrect patient positioning	6	15.8%

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Equipment malfunction/technical failure	2	5.3%
Incorrect exposure settings	8	21.1%
Poor image quality	9	23.6%
Labeling error or incorrect data entry	3	7.9%

The most common reasons for repeated X-ray tests were poor image quality (23.6%), patient Movement (26.3%), and incorrect patient positioning (15.8%).

Discussion:

This study assessed the frequency and determinants of repeat X-ray examinations in a radiology department, analyzing 114 patients. The overall repeat rate was 33.3%, considerably higher than the international quality assurance benchmark of 5–7%. The leading contributors to repeat imaging were inadequate positioning (15.8%), poor image quality (23.6%), and patient movement (26.3%). Chest radiographs were the most frequently performed and repeated examination, comprising 35% of all studies and 44.7% of repeats. These findings highlight both operator- and patient-related factors as key determinants of repetition in diagnostic radiography. The disproportionately high repeat rate for chest X-rays in this study is consistent with prior research. Khan *et al.*, (2016) also reported chest radiographs as the most frequently repeated examination, with overexposure and underexposure as primary causes. Similarly, Liaqat *et al.*, (2021) identified positioning errors (44.5%) and collimation flaws (29.8%) as major contributors in digital chest radiography. In the current research, positioning errors were also the most frequent cause, suggesting that technical deficiencies rather than equipment malfunction remain the dominant driver of repeats. The elevated frequency of chest repeats may also be attributed to the clinical demand for chest imaging in patients with respiratory distress, trauma, or preoperative requirements, which increases both workload and error likelihood.

When compared with previous repeat audits, the observed 33.3% rate in this study is alarmingly high. Jha, Khan, and Rai (2022) documented a much lower rate of 1.87% in an Indian teaching hospital, while Dwivedi, Ojah, and Guha (2022) reported similarly low rates across 6,000 radiographs. The discrepancy could be explained by institutional differences such as departmental policy, staff workload, or the level of operator training. In contrast, Jabbari *et al.*, (2012) highlighted that over 50% of repeated radiographs were linked to exposure errors, resulting in unnecessary radiation burden findings that parallel the current study, where a substantial proportion of repeats could have been avoided through stricter adherence to standard operating procedures (SOPs) and quality assurance (QA) protocols.

Patient-related factors also contributed to the repeat rate in this study, with motion artifacts accounting for 18.4% of repetitions. Liaqat *et al.*, (2021) similarly identified motion-related artifacts in over 8% of rejected images, while Jha *et al.*, (2022) emphasized that patient preparation and effective communication can significantly reduce motion-induced repeats. In the present context, poor patient cooperation,

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anxiety, or inadequate instruction may explain the frequency of movement-related errors. Additionally, repeat variance across anatomical sites can be linked to exam complexity, with spine and extremity studies often requiring greater precision in positioning. A 2023 study (Hasaneen *et al.*, 2023) also reported spine (37.7%) and facial bones (19.7%) as the most frequently repeated body parts due to positioning errors and artifacts, underscoring the need for targeted training in technically challenging examinations. Environmental and workflow-related factors cannot be overlooked. Dahmarde *et al.*, (2023) observed that peak workload and high patient turnover were strongly associated with repeat imaging, largely due to human error. The high repeat rate in the present study may likewise be linked to staff fatigue, inadequate supervision, and absence of structured QA measures. This is further supported by the finding that only 26.3% of repeats were documented for post-review, highlighting significant gaps in departmental quality monitoring. As Jabbari *et al.*, (2012) and Hasaneen *et al.*, (2023) recommend, systematic reject analysis and regular audits are critical to identifying recurring errors, providing feedback, and improving radiographic performance.

The high repeat rate observed in this study reflects preventable technical errors such as poor positioning, suboptimal exposure, and patient motion. Compared to both regional and global reports, the findings suggest deficiencies in operator training, QA implementation, and workflow management. To reduce repeat imaging, it is essential to enforce structured reject analysis, strengthen radiographer training, ensure adherence to SOPs, and improve patient education and communication. Regular auditing, adequate supervision, and promoting a culture of accountability are further required to enhance diagnostic quality, reduce radiation exposure, and improve departmental efficiency.

Conclusion:

This study identified a high rate of repeated X-ray examinations in the radiology department, exceeding the internationally recommended benchmarks. The most common reasons for repetition were poor image quality, patient movement, and incorrect positioning. Chest radiography was found to be the most frequently performed and repeated examination. These findings indicate that technical errors, human factors, and workflow inefficiencies play a major role in repeat imaging. The lack of proper post-repeat documentation and structured quality assurance measures further reflects gaps in maintaining imaging standards and radiation safety. Although some repeated examinations were clinically necessary, many could have been avoided. Therefore, the study highlights the need for improved radiographer training, strict adherence to standard operating procedures, regular reject analysis, and effective quality assurance programs to reduce unnecessary radiation exposure and improve overall diagnostic quality.

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