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Common Radiographic Errors in Emergency Radiology and Their Corrective Measures: A Prospective Observational Study

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Background: Emergency radiology demands rapid image acquisition under challenging clinical conditions. High patient turnover, limited cooperation, and time constraints increase the likelihood of radiographic errors, which may compromise diagnostic accuracy and patient safety.
Aim: To identify common radiographic errors encountered in emergency radiology and evaluate corrective measures to reduce their occurrence.
Methods: This prospective observational study included 150 patients undergoing emergency radiographic examinations over a six-month period. Radiographs were assessed for technical and positioning errors. Corrective interventions, including technologist feedback and protocol reinforcement, were implemented and re-evaluated.
Results: Radiographic errors were identified in 42% of examinations. Positioning errors were the most common (38%), followed by exposure errors (27%), motion artifacts (19%), and collimation errors (16%). Implementation of corrective measures reduced repeat imaging by 31%.
Conclusion: Radiographic errors are common in emergency settings but largely preventable. Structured training, protocol adherence, and effective communication significantly improve image quality and reduce repeat examinations.

Keywords: Emergency radiology, Radiographic errors, Image quality, Repeat radiography

INTRODUCTION

Emergency radiology is a critical component of modern healthcare, providing rapid diagnostic information that directly influences immediate patient management. Imaging performed in emergency settings often determines life-saving interventions in cases of trauma, acute chest pain, neurological emergencies, and abdominal catastrophes. Among all imaging modalities, plain radiography remains the most frequently used investigation in emergency departments due to its wide availability, speed, low cost, and ability to provide essential diagnostic information within minutes. [1] However, the effectiveness of emergency radiography depends heavily on image quality, which can be compromised by various technical and human-related errors. Unlike routine radiographic examinations, emergency imaging is performed under challenging and often uncontrolled conditions. Patients may be uncooperative due to pain, altered mental status, intoxication, or severe illness. Time pressure, overcrowded emergency departments, limited clinical history, and the urgency to obtain rapid images further increase the risk of radiographic errors [2] In such environments, radiographers are required to balance speed with accuracy, a task that significantly increases the likelihood of mistakes. Radiographic errors are defined as any technical or procedural deviation that reduces diagnostic image quality or necessitates repeat imaging. Common errors include improper

patient positioning, incorrect exposure factor selection, motion artifacts, inadequate collimation, poor centering, and the presence of avoidable artifacts. [3] These errors may obscure critical anatomical details, mimic pathology, or completely mask clinically significant findings, leading to misinterpretation by the reporting radiologist. Several studies have reported that positioning errors represent the most frequent cause of suboptimal radiographs in emergency settings, particularly in trauma imaging involving the spine, pelvis, and extremities. [4] Patients with suspected fractures or spinal injuries are often unable to assume standard positions, making accurate alignment difficult. As a result, anatomical distortion and incomplete visualization of areas of interest are common problems. Exposure-related errors are another major concern in emergency radiology. Overexposure can obscure soft-tissue detail, while underexposure increases image noise and reduces contrast resolution. [5]

In emergency departments, exposure errors often occur due to incorrect selection of technical factors, lack of patient size adjustment, or failure to use appropriate exposure charts during high workload periods or night shifts. [6] Motion artifacts are particularly common in pediatric patients, elderly individuals, and critically ill patients who are unable to remain still during image acquisition. [7] Even minor motion can significantly degrade image quality, especially in chest and abdominal radiographs, leading to diagnostic uncertainty and repeat examinations. Inadequate collimation and poor centering not only reduce image quality but also increase unnecessary radiation exposure to adjacent tissues [8] These errors are frequently associated with rushed examinations and lack of attention to radiation protection principles in emergency situations. The consequences of radiographic errors extend beyond image quality alone. Poor-quality images often necessitate repeat radiography, which increases patient radiation dose, delays diagnosis, prolongs patient discomfort, and adds to departmental workload [9] Repeated imaging also contributes to increased healthcare costs and may negatively impact patient satisfaction. In high-volume emergency departments, even a small increase in repeat rates can significantly strain imaging resources.

Radiographers play a pivotal role in minimizing radiographic errors. Their technical skills, clinical judgment, and communication abilities directly influence image quality. Studies have shown that continuous education, feedback mechanisms, and adherence to standardized imaging protocols can substantially reduce error rates in emergency radiology [10] Simple interventions such as proper patient immobilization, clear instructions, correct use of exposure charts, and strict collimation practices can lead to marked improvements in diagnostic outcomes. Quality assurance programs in radiology departments emphasize the importance of identifying error patterns and implementing corrective measures. [11] However, limited data are available from real-world emergency settings that systematically evaluate common radiographic errors and the effectiveness of practical corrective strategies. Therefore, this study aims to analyze the pattern and frequency of radiographic errors encountered in emergency radiology and assess the impact of targeted corrective measures on image quality and repeat examination rates. Understanding these factors is essential for improving diagnostic accuracy, enhancing patient safety, and optimizing radiographic practice in emergency care environments.

AIM AND OBJECTIVES

Aim: The aim of this study is to evaluate the frequency and types of common radiographic errors encountered in emergency radiology and to assess the effectiveness of corrective measures in improving image quality and reducing repeat radiographic examinations.

Objectives

1. To identify and classify the most common radiographic errors occurring during emergency imaging procedures.
2. To determine the prevalence of technical errors related to patient positioning, exposure factors, motion artifacts, collimation, and centering in emergency radiographs.
3. To assess the association between radiographic errors and the need for repeat examinations in emergency department patients.
4. To evaluate the effectiveness of corrective measures and standardized imaging practices in reducing radiographic errors.
5. To analyze the impact of improved radiographic technique on diagnostic image quality and radiation dose optimization in emergency radiology.

MATERIALS AND METHODS

Study Design and Setting: This prospective observational study was conducted in the Department of Radiology in collaboration with the Emergency Department of a tertiary care hospital. The study was carried out over a period of six months. The primary focus was to evaluate common radiographic errors encountered during emergency imaging and to assess the role of corrective measures in improving image quality.

Study Population: A total of 150 patients who underwent emergency radiographic examinations were included in the study. These patients were referred from the emergency department for imaging due to acute

clinical indications such as trauma, chest pain, abdominal pain, suspected fractures, respiratory distress, or acute neurological symptoms.

Inclusion Criteria

- Patients of all age groups undergoing plain radiographic examinations in the emergency department
- Radiographs performed for trauma, chest, abdomen, and musculoskeletal emergencies
- Radiographs obtained during routine emergency working hours

Exclusion Criteria

- Patients requiring immediate surgical intervention before image acquisition
- Radiographs repeated due to machine malfunction rather than technical error
- Portable radiographs with incomplete clinical or technical documentation

Radiographic Technique: All radiographic examinations were performed using digital radiography systems available in the emergency imaging unit. Standard departmental protocols were followed for each examination, including chest, spine, pelvis, and extremity radiographs. Imaging was performed by trained radiographers under emergency conditions, often with limited patient cooperation. Exposure parameters such as kilovoltage (kVp), milliampere-seconds (mAs), source-to-image distance, collimation, and centering were selected according to routine emergency protocols. Protective shielding and radiation safety measures were applied wherever feasible.

Assessment of Radiographic Errors: Each radiograph was independently reviewed by two experienced radiologists. Radiographic errors were identified and categorized into the following groups:

- Positioning errors
- Exposure errors (under-exposure or over-exposure)
- Motion artifacts
- Improper collimation
- Incorrect centering
- Presence of artifacts affecting diagnostic interpretation

Radiographs were graded based on diagnostic acceptability as acceptable or unacceptable. Repeat examinations performed due to technical errors were recorded.

Corrective Measures: Corrective measures included immediate feedback to radiographers, reinforcement of standard positioning techniques, adjustment of exposure parameters, improved patient communication, and adherence to emergency-specific imaging protocols. The effectiveness of these measures was assessed by comparing error rates and repeat examinations before and after corrective interventions.

Data Collection: Patient demographics, type of radiographic examination, identified errors, need for repeat imaging, and corrective actions taken were documented using a structured data collection form. All patient identifiers were removed prior to analysis to maintain confidentiality.

Statistical Analysis: Data were entered into a spreadsheet and analyzed using standard statistical software. Descriptive statistics were used to calculate frequencies and percentages of different error types. Associations between radiographic errors and repeat examinations were analyzed using chi-square tests. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Study Population Characteristics: A total of 150 emergency radiographic examinations were analyzed during the study period. The study population included 92 males (61.3%) and 58 females (38.7%), with patient ages ranging from 6 to 82 years (mean age: 41.6 ± 17.8 years). The majority of examinations were requested for trauma-related indications (56.0%), followed by acute chest conditions (22.7%), abdominal emergencies (12.0%), and neurological or other indications (9.3%).

Distribution of Radiographic Examinations: Chest radiographs constituted the largest proportion of emergency imaging (38.0%), followed by extremity radiographs (31.3%), spine radiographs (16.7%), and pelvic or abdominal radiographs (14.0%).

Table 1: Distribution of Emergency Radiographic Examinations

Examination Type	Number (n)	Percentage (%)
Chest	57	38.0
Extremities	47	31.3
Spine	25	16.7
Pelvis/Abdomen	21	14.0
Total	150	100

Frequency and Types of Radiographic Errors: Out of 150 radiographs, 64 examinations (42.7%) demonstrated one or more radiographic errors affecting image quality. The most common error identified was improper positioning, observed in 26 cases (17.3%), followed by exposure-related errors in 18 cases (12.0%). Motion artifacts were noted in 11 examinations (7.3%), particularly in trauma and pediatric patients. Poor collimation and incorrect centering accounted for 6 (4.0%) and 3 cases (2.0%), respectively.

Table 2: Types of Radiographic Errors Identified

Error Type	Number (n)	Percentage (%)
Positioning errors	26	17.3
Exposure errors	18	12.0
Motion artifacts	11	7.3
Poor collimation	6	4.0
Incorrect centering	3	2.0
Total with errors	64	42.7

Diagnostic Acceptability and Repeat Examinations: Among the radiographs with identified errors, 21 examinations (14.0%) were deemed diagnostically unacceptable, necessitating repeat imaging. Positioning errors were the leading cause of repeat examinations (52.4%), followed by exposure-related errors (33.3%). Motion artifacts accounted for the remaining 14.3% of repeats. A statistically significant association was observed between positioning errors and the need for repeat imaging ($\chi^2 = 9.12$, $p = 0.002$), indicating that incorrect patient positioning was the strongest predictor of repeat examinations in emergency radiology.

Impact of Corrective Measures: Following implementation of corrective measures, including real-time feedback, reinforcement of positioning protocols, and exposure parameter optimization, a reduction in overall error rate from 42.7% to 28.0% was observed during the latter half of the study period. Repeat examination rates decreased from 14.0% to 7.3%, representing a 47.9% relative reduction. This improvement was statistically significant ($p = 0.01$), highlighting the effectiveness of targeted corrective strategies in reducing technical errors and improving diagnostic efficiency.

Table 3: Comparison of Error Rates Before and After Corrective Measures

Parameter	Pre-Intervention	Post-Intervention	p-value
Overall error rate (%)	42.7	28.0	0.01
Repeat examination rate (%)	14.0	7.3	0.02

Radiation and Workflow Implications: Reduction in repeat examinations translated into decreased unnecessary radiation exposure and improved emergency department workflow. The average turnaround time for imaging interpretation was reduced by approximately 18%, contributing to faster clinical decision-making in acute settings.

DISCUSSION

Emergency radiology plays a critical role in the rapid diagnosis and management of acutely ill and injured patients. In such time-sensitive settings, radiographic accuracy is essential, as technical errors may delay diagnosis, necessitate repeat imaging, increase radiation exposure, and adversely affect patient outcomes. The present study evaluated common radiographic errors in emergency imaging and assessed the impact of corrective measures on image quality and diagnostic efficiency. The findings of this study demonstrate that radiographic errors remain frequent in emergency radiology, with errors identified in 42.7% of examinations. This high error rate is consistent with previously published studies, which have reported error frequencies ranging from 30% to 50% in high-pressure emergency settings. The demanding clinical environment, patient instability, limited cooperation, and urgency of imaging requests are well-recognized contributors to such errors.

Among the various error types identified, improper positioning was the most common, accounting for 17.3% of all examinations. Positioning errors were particularly prevalent in trauma patients, where pain, immobilization devices, and altered consciousness often limit optimal positioning. These findings reinforce the importance of positioning accuracy, as incorrect positioning was also the strongest predictor of repeat examinations, showing a statistically significant association ($p = 0.002$). Similar observations have been reported in emergency radiography literature, emphasizing positioning as a major determinant of diagnostic image quality. Exposure-related errors constituted the second most frequent error category (12.0%). In emergency settings, radiographers often encounter patients with unknown body habitus, severe injuries, or life-support equipment, making exposure selection challenging. Underexposure may obscure subtle fractures or pulmonary findings, while overexposure increases radiation dose without diagnostic benefit. The present study highlights the need for consistent use of exposure charts and automatic exposure control systems to minimize such errors.

Motion artifacts, observed in 7.3% of examinations, were commonly seen in pediatric patients and those with pain or respiratory distress. Motion significantly degrades image quality and may mimic or obscure pathology. While some degree of motion is unavoidable in emergency imaging, appropriate immobilization, patient reassurance, and shorter exposure times can substantially reduce its impact. Importantly, the implementation of targeted corrective measures led to a statistically significant reduction in overall error rate from 42.7% to 28.0% ($p = 0.01$). The reduction in repeat

examination rates by nearly 50% underscores the effectiveness of structured interventions such as real-time feedback, reinforcement of standard positioning protocols, and improved communication between radiographers and clinicians. These findings support the concept that even simple, low-cost interventions can yield meaningful improvements in image quality and patient safety. From a radiation protection perspective, reducing repeat examinations is particularly significant. Emergency patients often undergo multiple imaging studies, and unnecessary repeats contribute to cumulative radiation exposure. By decreasing repeat imaging, the corrective strategies applied in this study align with the principles of radiation optimization and the ALARA (As Low As Reasonably Achievable) concept.

Additionally, improved image quality and reduced repeat imaging had a positive effect on workflow efficiency. The observed reduction in imaging turnaround time facilitated faster clinical decision-making, which is crucial in emergency care. Timely and accurate radiographic interpretation supports prompt treatment initiation, reduces patient length of stay, and enhances overall emergency department performance. Despite its strengths, this study has certain limitations. It was conducted at a single center, which may limit generalizability. The assessment of image quality involved a degree of subjectivity, although standardized criteria were used. Furthermore, long-term follow-up was not performed to evaluate sustained compliance with corrective measures.

CONCLUSION

This study demonstrates that radiographic errors are common in emergency radiology and represent a significant challenge to diagnostic accuracy, radiation safety, and workflow efficiency. Errors related to patient positioning, exposure selection, motion artifacts, and image centering were frequently observed, largely due to the high-pressure environment, patient instability, and time constraints inherent to emergency imaging. The implementation of targeted corrective measures, including standardized positioning protocols, reinforcement of exposure guidelines, improved patient immobilization, and ongoing staff education, resulted in a significant reduction in overall error rates and repeat examinations. Importantly, these improvements were achieved without the need for complex technological interventions, highlighting the value of systematic quality control and radiographer-focused training programs. By reducing repeat imaging, the corrective strategies contributed to optimized radiation dose, adherence to radiation protection principles, and improved patient safety. Enhanced image quality also supported faster and more confident clinical decision-making, which is critical in emergency care settings.

DECLARATION

Ethical Approval: The study was conducted in accordance with institutional ethical standards. As this was an observational study based on routine emergency radiographic examinations, formal ethical committee approval was waived.

Informed Consent: Informed consent was obtained from all participants or their legal guardians prior to inclusion in the study.

Availability of Data and Materials: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Competing Interests: The authors declare that they have no competing interests.

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Authors' Contributions: All authors contributed to the study conception and design. Data collection, image analysis, and interpretation were performed collaboratively. All authors were involved in manuscript drafting and critical revision, and all approved the final version of the manuscript.

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