AMERICAN JOURNAL OF DIAGNOSTIC IMAGING, 2019
VOL 5, NO. 1, PAGE 4–8
10.5455/ajdi.20180830110208

ORIGINAL ARTICLE

Open Access

Evaluation of reject analysis of chest radiographs in diagnostic radiology

Omar S. Alahmadi[1], Ahmed A. Alrehaili[1], Moawia B. Gameraddin[2]

[1]Almadina Specialist Hospital, Almadinah Almunawarah, Kingdom Saudi Arabia

[2]Department of Diagnostic Radiologic Technology, Faculty of Applied Medical Sciences, Taibah University, Almadinah Almunawarah, Kingdom Saudi Arabia

ABSTRACT

Introduction: Reject analysis is an important quality indicator and is required for reducing radiation exposure to the patient and increased cost-effectiveness.
Aim: The study aims to analyze reject rates and causes in direct chest radiographs (CXRs) to assess the radiographic quality.
Materials and Methods: A total of 150 CXRs had been retrospectively analyzed at King Fahad Hospital from January 17, 2016 to February 20, 2016.
Results: The rejection rate was 14.7%. Positioning errors and artifacts were the most significant factors for reject analysis in chest radiography. Positioning errors are the most common cause of rejection (16%) and artifacts are the second reason (11.33%). In consequence to positioning error, the scapular shadow was partially located at the lung field in 38% of the images.
Conclusion: CXRs are the most common X-ray examination requested. Positioning errors are still challenging, which affect the quality of the image. An overall rejection rate of 14.7% indicates a need for continuous practice in the Radiology Department to improve the performance.

ARTICLE HISTORY

Received August 30, 2018
Accepted January 03, 2019
Published January 17, 2019

KEYWORDS

Analysis; artifacts; chest; reject; positioning errors

Introduction

Digital radiography (DR) systems are in use throughout the medical imaging community and now represent the standard of care at many hospitals and imaging centers. In recent years, DR replaces computed tomography in the majority of radiologic departments. In the current literature, there is a little reported in the technical literature on quality performance, as measured regarding reject rates associated with the clinical use of these systems. The term reject refers to radiographs of patients that are unacceptable and need to be repeated as judged by the technologist who is acquiring the image [1]. Reject analysis is an essential program in many hospitals, especially in radiologic departments. It is considered as an indicator for quality of the department. Reject analysis is used to prevent causes that lead to reject images in the radiologic department and tries to reduce the radiation dose to the patient as much as possible. It is used to improve clinical practice for the staff and to avoid repetition of X-ray examinations, hence subjecting patients to incur extra cost and excess radiation exposure. Therefore, reject analysis is used to assess the efficiency of a diagnostic Radiology Department with optimizing the patient's dose [2]. Reject analysis provides information that would assist to reduce the radiation exposure of patients. The reject analysis has, therefore, become a significant parameter as a quality control tool in diagnostic radiography service delivery [3].

Rejects in radiography remains professional and ethical challenges within radiological imaging [4]; it occupies unnecessary processing and personnel resources [5,6], leads to suboptimal quality management [7,8], and exposes patients to unnecessary ionizing radiation [9].

Rejected images increase radiation exposure to patients, which may lead to severe biological effects as well as wasted time and resources. The poor

Contact Omar Salah Alahmadi ✉ omsalahmadi@moh.gov.sa Almadina Specialized Hospital, Almadinah Almunawarah, Kingdom Saudi Arabia.

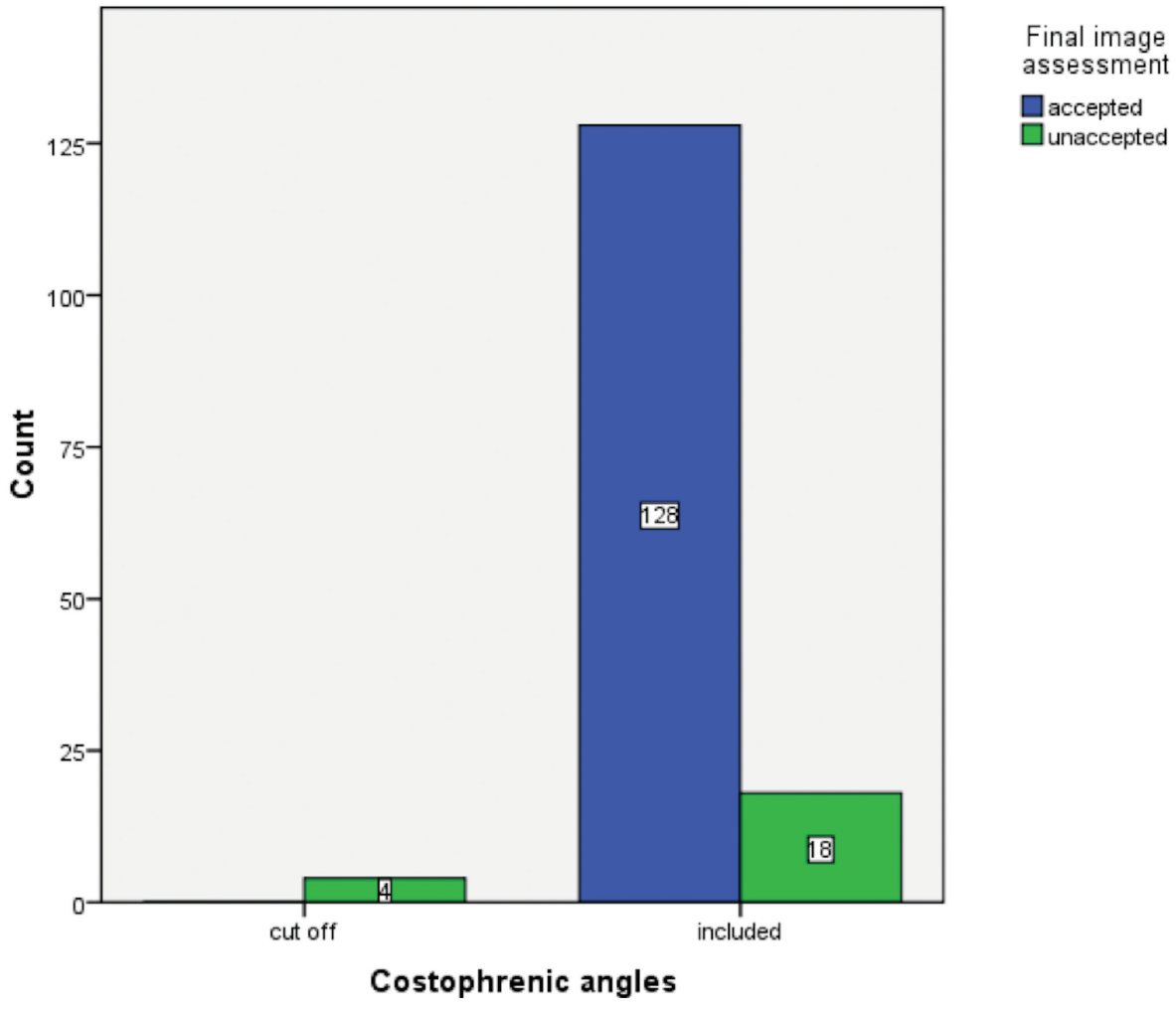

Figure 1. The overall rejection rate of the analyzed CXRs.

quality of image influences the diagnosis by obscuring the underlined pathologies. This study aims to study the chest radiographs (CXRs) to evaluate and determine the causes of image rejection. Chest radiography is the most common required investigation in the department.

Material and Methods

This is a retrospective study that involved the reject analysis of CXRs regarding image quality. The study was conducted in King Fahd Hospital from the period of January 17, 2016 to February 20, 2016. The study was approved by the ethical committee of the Faculty of Applied Medical Sciences at Taibah University. A total of 150 chests radiographs were analyzed, which were taken from picture archiving and communication system. More than one technologist analyzed the images. The pitfalls were registered carefully from the pictures. The radiographs were produced from a digital X-ray machine (model: Discovery XR656).

The data were analyzed using Statistical Package for Social Sciences version 16.

Results

In total, 150 chest radiographic images were analyzed. The rejection rate was 14.67% (128 accepted *versus* 22 unaccepted) as shown in Figure 1. Table 1 summarizes the possible causes of rejection for CXRs. It was found that positioning error was the most common cause of rejection (14 images, 9.33%). The artifact was the second cause (six images, 4%). Table 2 shows the details of the faults found in the analyzed chest images. It was observed that partial inclusion of the scapular shadow was

Table 1. The overall causes of rejection for CXRs.

	Frequency	Percentage
Positioning errors	14	9.33
Artifacts	6	4
Incorrect collimation	2	1.33

Table 2. Details of faults found in the analyzed chest images.

Faults	Frequency	Percentage
The partial inclusion of the scapula in the lung field (accepted models)	57	38
Artifacts	11	7.33
Rotational errors	10	6.67
Cut-off of CPA	4	2.67

Table 3. Significance of factors affecting the acceptance of final images.

Factors	*p*-values
Artifacts due to radiopaque objects	<0.001
Partial inclusion of scapula	0.24
Rotation errors	0.14
Cut-off CPAs	0.45

located in the lung field (57 cases, 38%). The artifacts and rotational errors were found in 11 and 10 images, 7.33% and 6.67%, respectively. The faults in Table 2 may not cause rejection considering the number of radiographs was accepted. Table 3 summarizes the factors that affect the acceptance of final images. It was observed that artifacts due to radiopaque objects were the most significant factors (p-value < 0.001).

Figure 2 revealed the assessment of costophrenic angles (CPAs) and the acceptance of the final images. It was observed that CPA was cut off in 4%.

Discussion

Reject analysis is an essential part of quality programs in all Radiology departments providing services in radiographic examinations to ensure radiation protection and adjust exposure factors for rejects and thus reducing the cost, workload, and radiation exposure to patients.

There were 150 CXRs had been analyzed to study the technical errors and to determine and investigate the causes of rejection. This is important to improve the quality of imaging in the radiology department by providing optimal quality radiographs. It is essential to evaluate the rejected radiographs which are performed to estimate the average reject rate and to establish the leading causes for reject images.

The results of the study showed that the rejection rate was 14.67. Owusu-Banahene et al. [3] reported a rejection rate of 12.5%. Andersen et al. [10] reported the rejection rate of 12%.

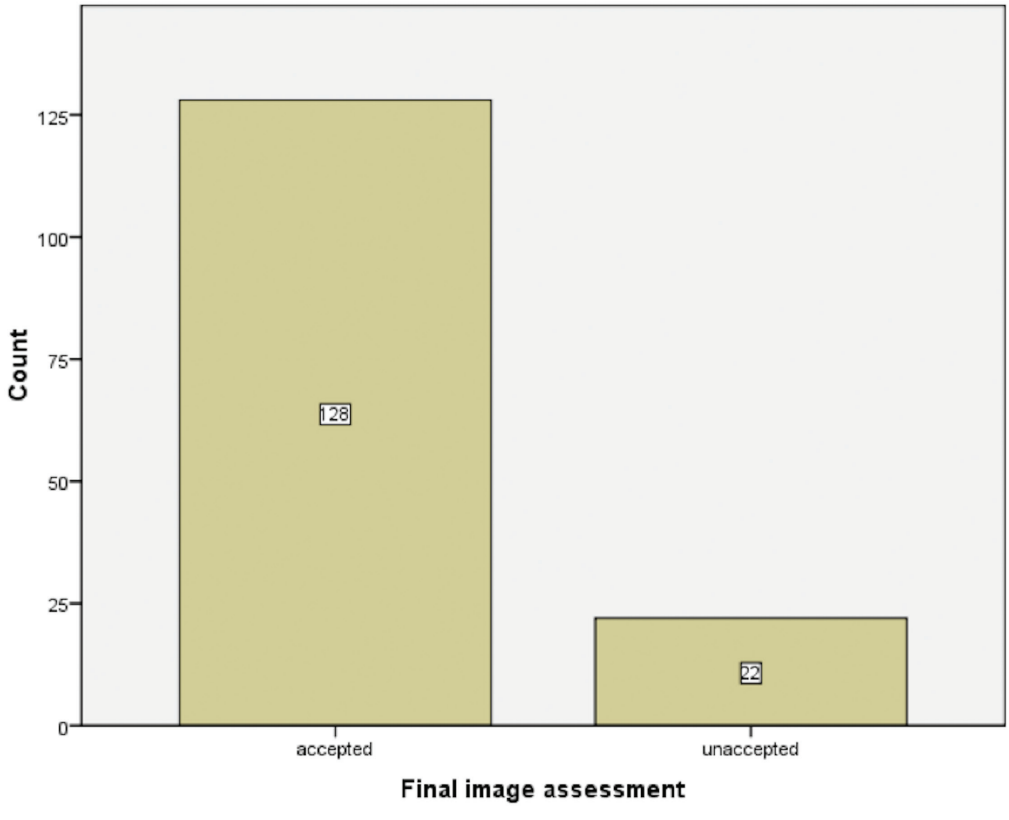

Figure 2. The assessment of CPAs and acceptance of chest images.

Similarly, Zewdu et al. [11] reported a reject rate of 16.85% in their study. Another study conducted by Sadiq et al. [12] reported a rejection rate of 29.34% in which CXR had the highest rejection (12.19). These results supported our finding of reject analysis which is not more than that reported in previous studies. In literature, rejection rates have been documented in the range of 10%–15% [8,11,14].

The production of high-quality diagnosable images requires proper positioning of the patient and selection of optimal exposure factors. These factors yield excellent image quality and precise diagnosis of the final image. The present study revealed that positioning errors were the most common cause of image rejects. Hofmann reported positioning error of 27.9% for chest radiography [15]. Khafaji and Haji [16] stated that positioning error was the primary cause for rejection, followed by artifact. A previous study reported that poor patient positioning and exposure error constituted between 52.0% and 23.0%, respectively, of the overall causes of image rejection [17]. Similar to this, our finding found that positioning error was the common reasons for image rejects. The positioning errors caused cut off CPAs and rotation of the radiographs. It was observed that the scapular shadow was partially located in the lung field in most of the cases, and this was attributed to the incomplete positioning of the hands on the hips and lack of forwarding pushing during chest radiography.

In the current study, it was observed that artifact was the second common reason for rejection rate. These artifacts were caused by patients' clothes. This was attributed to poor communication with the patients to undress the clothes. Previous studies showed that artifact was not common in chest radiography. Khafaji and Haji [16] reported that artifact was the second cause of rejection, while Hofmann et al. [15] said only 2.2% of the identified reasons was caused by artifacts. The disadvantages of the artifact are that it simulates pathology when projected on the lung fields.

As CXRs are the most common X-ray examination requested, training for radiographers is essential for quality improvement and reduction of radiation dose.

Limitation of the Study

The study faced a significant barrier that the duration of the study is not enough to assess the overall reject analysis of chest images. The number of images analyzed is not enough and needs to be high for further evaluation.

Conclusion

In conclusion, technical errors are still challenging in the DR of the chest, which affect the quality of the image. Image artifacts due to radiopaque objects were the second cause of reject for chest radiography. Training and education are of great importance for quality improvement.

References

[1] Foos DH, Sehnert WJ, Reiner B, Siegel EL, Segal A, Waldman DL. Digital radiography reject analysis: data collection methodology, results, and recommendations from an in-depth investigation at two hospitals. J Digit Imaging 2009; 22(1): 89–98.

[2] Sukumar S, Yadav S, Sahana S, David LR, Kumari M. X-ray image reject analysis in OPD X-ray department—a pilot study. Int J Med Pharm Sci 2012; 3:33–7.

[3] Owusu-Banahene J, Darko EO, Hasford F, Addison EK, Asirifi JO. Film reject analysis and image quality in Diagnostic Radiology Department of a Teaching hospital in Ghana. J Radiat Res Appl Sci 2014; 7(4):589–94.

[4] World Health Organization. Quality assurance workbook for radiographers and radiological technologists. WHO, Geneva, Switzerland, 2001. Available via http://whqlibdoc.who.int/publications/2001/9241546425.pdf?ua¼1 (Accessed 6 June 2018).

[5] Waaler D, Hammer S, Langdalen CC, Haug LT. How radiographers visually perceive X-ray images with the task of accepting or rejecting them—a pilot study. Radiography Open 2017; 3:2–3. Availalable via file:///C:/Users/abubu/Downloads/1997-Article%20Text-6491-4-10-20170404.pdf

[6] Waaler D, Hofmann B. Image rejects/retakes–radiographic challenges. Radiat Prot Dosimetry 2010; 139:375–9.

[7] Foos DH, Sehnert WJ, Reiner B, Siegel EL, Segal A, Waldman DL. Digital radiography reject analysis: Data collection methodology, results, and recommendations from an in-depth investigation at two hospitals. J Digit Imaging 2009; 22:89–98.

[8] Peer S, Peer R, Giacomuzzi SM, Jaschke W. Comparative reject analysis in conventional film-screen and digital storage phosphor radiography. Radiat Prot Dosimetry 2001; 94:69–71.

[9] Zhang M, Chu C. Optimization of the radiological protection of patients undergoing digital radiography. J Digit Imaging 2012; 25(1):196–200; doi:10.1007/s10278-011-9395-9

[10] Andersen ER, Jorde J, Taoussi N, Yaqoob SH, Konst B, Seierstad T. Reject analysis in direct digital radiography. Acta Radiol 2012; 53(2):174–8.
[11] Zewdu M, Kadir E, Berhane M. Analysis and economic implication of X-Ray film reject in diagnostic radiology department of Jimma University Specialized Hospital, Southwest Ethiopia. Ethiopian J Health Sci 2017; 27(4):421–6.
[12] Sadiq AA, Miftaudeen MN, Mohammed A, Akpaniwo GM, Girei A, Garba Nwobi IC. Reject-repeat analysis of plain radiographs as a quality indicator at University of Maiduguri teaching hospital (UMTH). EJPMR 2017; 4(2):188–91.
[13] Akhtar W, Aslam M, Ali A, et al. Film retakes in digital and conventional radiography. J Coll Physicians Surg Pak 2008; 18:151–153.
[14] Benza C, Damases-Kasi C, Daniels ER, Amkongo M, Nabasenja C. The causes of reject images in a radiology department at a state hospital in Windhoek, Namibia. South Afr Radiographer 2018; 56(1):37–8.
[15] Hofmann B, Rosanowsky TB, Jensen C, Wah KH. Image rejects in general direct digital radiography. Acta Radiologica Open 2015; 4(10):1–6.
[16] Khafaji MA, Hagi SK. Direct digital radiograph. Technicians role in obtaining good images. Saudi Med J 2014; 35(8):879–81.
[17] Ofori EK, Antwi WK, Arthur L, Yeboah CA, Dzefi-Tettey K. Analysis and economic implications of X-ray film repeat/reject in selected hospitals in Ghana. West Afr J Radiol 2013; 20:14–8.