HOSTED BY
ELSEVIER
Available online at www.sciencedirect.com
ScienceDirect
Journal of Radiation Research and Applied Sciences
journal homepage: http://www.elsevier.com/locate/jrras

Film reject analysis and image quality in diagnostic Radiology Department of a Teaching hospital in Ghana

J. Owusu-Banahene [a,*], E.O. Darko [a], F. Hasford [b], E.K. Addison [c], J. Okyere Asirifi [d]

[a] Radiation Protection Institute, Ghana Atomic Energy Commission, P. O. Box LG 80, Legon, Accra, Ghana
[b] Radiological and Medical Sciences Research Institute, Ghana Atomic Energy Commission, P.O. Box LG 80, Legon, Accra, Ghana
[c] Department of Physics, Kwame Nkrumah University of Science and Technology, PMB, Kumasi, Ghana
[d] Biomedical Engineering Department, All Nations University College, PMB, Koforidua, Ghana

ARTICLE INFO

Article history:
Received 9 July 2014
Accepted 20 September 2014
Available online 7 October 2014

Keywords:
Radiation exposure
X-ray examination
Image quality
Film reject
Quality assurance

ABSTRACT

Patients usually undergo repeated X-ray examinations after their initial X-ray radiographs are rejected due to poor image quality. This subjects the patients to an excess radiation exposure and extra cost and necessitates the need to investigate the causes of reject. The use of reject analysis as part of the overall quality assurance programs in clinical radiography and radiology services is vital in the evaluation of image quality of a well-established practice. It is shown that, in spite of good quality control maintained by the Radiology Department of a Teaching hospital in Ghana, reject analysis performed on a number of radiographic films developed indicated 14.1% reject rate against 85.9% accepted films. The highest reject rate was 57.1 ± 0.7% which occurs in cervical spine and the lowest was7.7 ± 0.5% for lumbar spine. The major factors contributing to film rejection were found to be over exposure and patient positioning in cervical spine examinations. The most frequent examination was chest X-ray which accounts for about 42.2% of the total examinations. The results show low reject rates by considering the factors for radiographic rejection analysis in relation to both equipment functionality and film development in the facility.

1. Introduction

A diagnostic radiology facility is any facility in which an X-ray system is used to irradiate any part of the human body for the purpose of diagnosis or visualization. In radiological procedures involving X-rays both patients and staffs are exposed to varying degrees of radiation doses. The quality of information obtained from radiographs is dependent on a number of factors.

* *Corresponding author.*
E-mail address: owusubanas@yahoo.com (J. Owusu-Banahene).
Peer review under responsibility of The Egyptian Society of Radiation Sciences and Applications.
http://dx.doi.org/10.1016/j.jrras.2014.09.012

The aim of radiology is to obtain images which are adequate for the clinical purpose with minimum radiation dose to the patient. If optimum performance is to be achieved, assessment of image quality must be made to balance against patient dose. X-rays are known to cause malignancies, skin damage and other side effects and therefore are potentially dangerous. It is therefore essential and mandatory to reduce the radiation dose to patients in diagnostic radiology to the barest minimum (Watkinson, Moores, & Hill, 1984).

The radiation dose to a patient is linked to image quality and should not be lowered to jeopardize the diagnostic outcome of a radiographic procedure. In order to produce a good quality image of anatomical structures for diagnostic purposes, both quality assurance program and quality control measures are of great importance (Dunn & Rogers, 1998; Watkinson et al., 1984).

. The nature and extent of this program will vary with the size and type of the facility and the type of examinations conducted. The main goal of a diagnostic quality assurance program is to produce radiographs of consistent high quality (ICRP, 1990). Patient radiographs therefore serve as a quality control check and should be factored into any departmental evaluation program (Almén, Lööf, & Mattsson, 1996; Beir, 1990). Quality control techniques are those techniques used in either monitoring or testing and maintenance of the components of an X-ray system (Geijer, Beckman, Andersson, Persliden, 2001; Verdonck, Nijlunsing, Melman, & Geijer, 2001).

It is very common to encounter patients undergoing several repeat X-ray examinations after the initial X-ray examinations are rejected due to poor image quality, hence subjecting patients to extra cost and excess radiation exposure. This has necessitated the need to explore the causes of film reject and repeat of X-ray examinations. Reject analysis provides information that would assist to achieve a sound reduction in extra cost and over radiation exposure of patients. Film reject analysis has therefore become a major parameter as a quality control tool in diagnostic radiography service delivery.

The objective of this study is to assess the reject or repeat rate of X-ray films in order to obtain information for further recommendations on image quality, cost and radiation exposure at the radiology department of a selected teaching hospital in Ghana. The Film Reject Analysis (FRA) method will be used to assess the causes of poor image quality. The results obtained from the study will also be useful for the diagnostic radiology department to identify problem areas, scrutinize the reasons for these problems and finding ways of rectifying them.

2. Methods of analysis

The study covers a diagnostic radiology department of a teaching hospital in Ghana. The hospital is located in the Ashanti region of Ghana. On the average, about 199 patients are referred to the X-ray department of the hospital for different forms of examinations every month. Reports on a number of quality control measurements performed on the X-ray unit and darkroom indicates that, the hospital maintains good quality control program in the X-ray department (RPB, 2008). In spite of the strict quality control measures observed in the hospital, image quality continues to be a problem. To identify the causes and contributory factors to poor image quality, film reject analysis was used to assess the causes of film reject and repeat.

2.1. *Quality control measurements:*

A rejected film is considered as useless and cannot be used in the clinical practice. A rejected film is retaken to provide further diagnostic information. The causes for poor image quality has been identified and categorized. Data on radiological parameters and patient data were collected from the radiology department of the hospital. The data include age, film size, type of examination, technique factors and film reject or accept. The data were compiled for analysis at the end of the study period. Statistical methods were used to test the level of significance.

2.2. *Calculation of reject and repeat rates*

The reject or repeat rate was determined as follows:

$$\text{Reject Rate }(\%) = \frac{\text{Number of rejected films}}{\text{Number of examinations}} \times 100 \quad (1)$$

and

$$\text{Repeat Rate }(\%) = \frac{\text{Number of repeated films}}{\text{Number of examinations}} \times 100\% \quad (2)$$

The rejected and repeated films were categorized into seven according to the reasons for rejection. These are (i) under-exposure, (ii) over-exposure, (iii) patient positioning, (iv) patient motion, (v) artifact, (vi) selection of technique factors and (vii) others.

The data was analyzed satisfactorily using the "Chi square test" to determine the level of significance of the number of rejected and repeated films at the 95% confidence interval as follows.

$$\chi^2 = \frac{\Sigma(X_i - X_{ave})^2}{X_{ave}} \quad (3)$$

where X_{ave} is the average number of reject or repeat films and X_i is the number of reject or repeat films for a particular examination type. At 95% confidence interval, the highest value obtained was 0.7% and this was observed in both cervical spine and knee examinations.

3. Results and discussions

Results for this study are given in Tables 1–2 and Figs. 1–5. Tables 1 and 2 give the average values of the technique factors used for the various types of examination and the distribution of reject and repeat rate respectively. Figs. 1 and 2 show respectively, the variation of rejected or accepted films with age group of patients and the percentage distribution for each type of examination. Fig. 3 shows the distribution of various age groups with average kV values. Fig. 4 shows the distribution of various age groups with average mAs values whilst