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Analysis of Reject Radiographic Films as a Quality Assurance Element in Diagnostic Radiology

D. I. Jwanbot[1], U.A.I. Sirisena[2,] F.D. Akpolile.[2], T.S.Tungtur [2] & P.M. Nkop[3]

[1]Department of Physics, University of Jos, Jos
[2]Radiology Department, Jos University Teaching Hospital, Jos
[3]Department of Physics and Applied Physics, Plateau State University, Bokkos
Email of corresponding author: jwanbot2009@gahoo.com

ABSTRACT
Patients usually undergo repeated X-ray examinations after their initial radiographs are rejected due to poor image quality. This subjects the patients to excess radiation exposure and extra cost is also incurred on the hospital which leads to lost in revenue in the organization. This among many others necessitates the need to evaluate the radiographic reject rate. The aim of this paper is to evaluate the radiographic reject rate and also to access the image quality of radiographs produced in a radiation facility in a hospital in Jos. Analysis is an essential part of Quality Assurance which indicates the weak areas of radiographic/radiologic practices in a department. Also, it enables one to note any improvement after quality assurance Measure have been put into practice. The role of reject analysis in providing relevant information that would help achieve sound reduction in radiation exposure and cost as well as to develop acceptance image quality was exposed in this study. It is shown that, in spite of the good quality control measures maintained at the radiation facility of the hospital, reject radiographs were found. Reject analysis performed on 1,185 radiographs out of the total of 16,184 radiographic films indicates a 7.3% reject rate which is within the acceptance limit of <10% as stipulated by the Conference of Radiographic Control Programme Directorate (CRCPD). The accepted radiographs were found to be 14,999. From the distribution of reject radiographs according to body parts being examined, 34.8% were chest X-ray examinations, 13.7% were skull X-ray examinations, while 11.9% were Lumbosacral X-ray examinations. The major factors contributing to film reject were found to be under-exposure with 41.2%, over-exposure with 35.7%, and Projection with 13.0%. The results showed low reject rates by considering the factors for radiographic rejection analysis in relation to both equipment functionality and film development in the facility.
Keywords: Reject radiograph, X-ray, Quality Assurance, Hospital, Radiation facility

INTRODUCTION

The discovery of X-ray has proved to be beneficial. These benefits have been greatly utilized for medical diagnosis and therapeutic purposes. Unfortunately, X-ray has its adverse effects because it causes ionization of molecules in the body tissues and this among other hazards, is known to cause cancer and other malignancies. 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 bearest minimum (Watkinson, et al 1984). The radiation dose to a patient is linked to image quality and should be lowered to jeopardize the diagnostic outcome of the radiographic procedure. In order to produce a good quality image of anatomical structures for diagnostic purpose, both Quality Assurance Programme and Quality control measure are of great importance (Watkinson, et al 1984, Dunn and Rogers, 1988). The main goal of a diagnostic Quality Assurance Programme is to produce radiographs of consistent high quality (ICRP, 1990). Patients radiograph therefore serves as a Quality control check and should be factored into any departmental evaluation

programme (Beir, 1990; Almen et al, 1996). Quality Control Techniques are those techniques used in either monitoring or testing and maintenance of the components of an X-ray system (Geijer et al, 2001; Verdonck et al, 2001).

MATERIALS AND METHOD

The materials used for this work include 16184 radiographs and a viewing box (light box) and the films were collected from January to December, 2015. These were obtained from the archive of the radiation facility and the rejected radiographic films were analysed and counted according to size, reason for rejection and the anatomical part being examined. The reasons for the rejection were also categorized as overexposure, underexposure, rotation, positioning error, poor breathing, fogging Artifacts, processing and projection error. The movement fault, equipment fault, multiple exposure and size of the reject radiographs used ranged from: 43cm x 35cm, 35cm x 35cm, 40cm x 30cm, 30cm x 24cm, and 24cm x 18cm. The reject rate of interest was then tabulated for analysis using the Microsoft- Excel progamme. The rejected rate was calculated using the formula:

$$\text{Reject Rate \%} = \frac{\text{Total number of Radiographs Rejected} \times 100}{\text{Total number of films used}}\%$$

RESULTS

A total 16,184 films were used in the Radiation facility from January to December, 2015. 1185 were rejected after thorough examination by two experienced staff. The results are indicated in Table 1-3 and also on figures 1-3

Table 1: Sizes of the Rejected Radiographs

S/N	Sizes	No of rejected radiographs
1.	24cmx 30cm	415
2.	35cm x 43cm	375
3.	30cm x 40cm	181
4.	35cm x 3cm	108
5.	18cm x 24cm	107
TOTAL		**1,185**

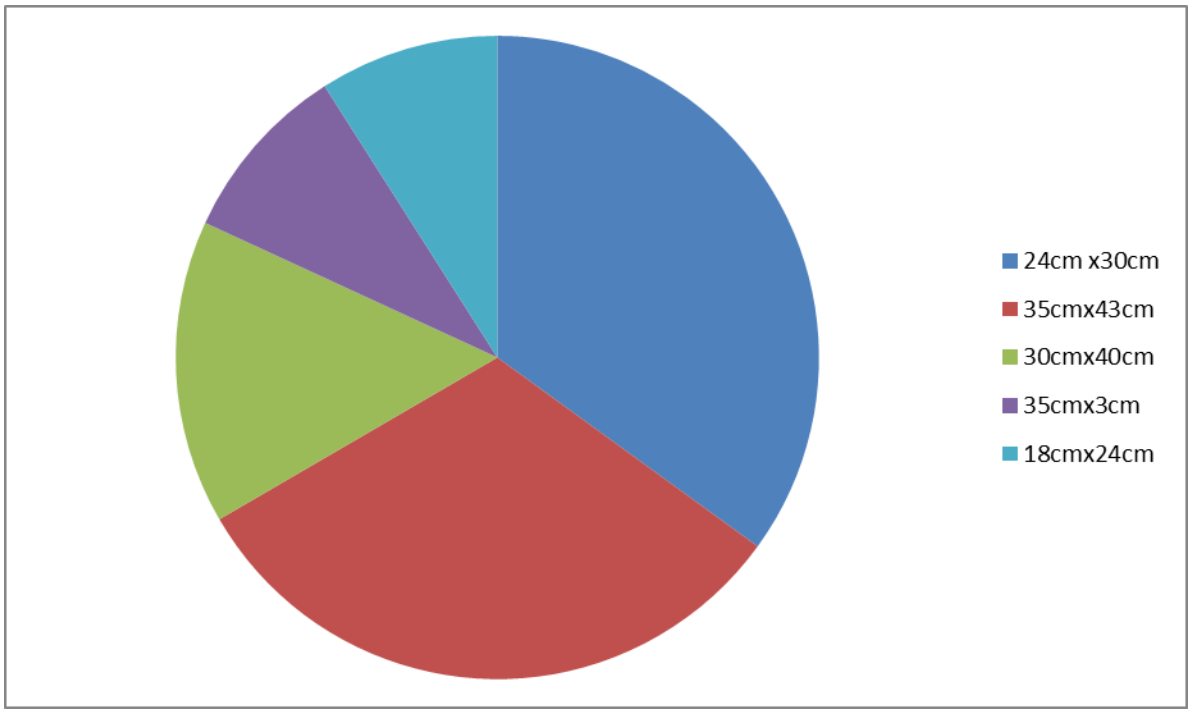

Table 2: Reasons for rejecting the radiographs

S/N	Reasons for Rejection	No of Reject Radiograph	Percentage (%)
1.	Underexposed	488	41.20
2.	Overexposed	423	35.70
3.	Projected	154	13.00
4.	Movement	5	0.42
5.	Equipment	-	0.00
6.	Artifact	5	0.42
7.	Multiple expose	2	0.16
8.	Processing	17	1.43
9.	Other (unprocessed,)	91	7.67
	TOTAL	**1,185**	**100**

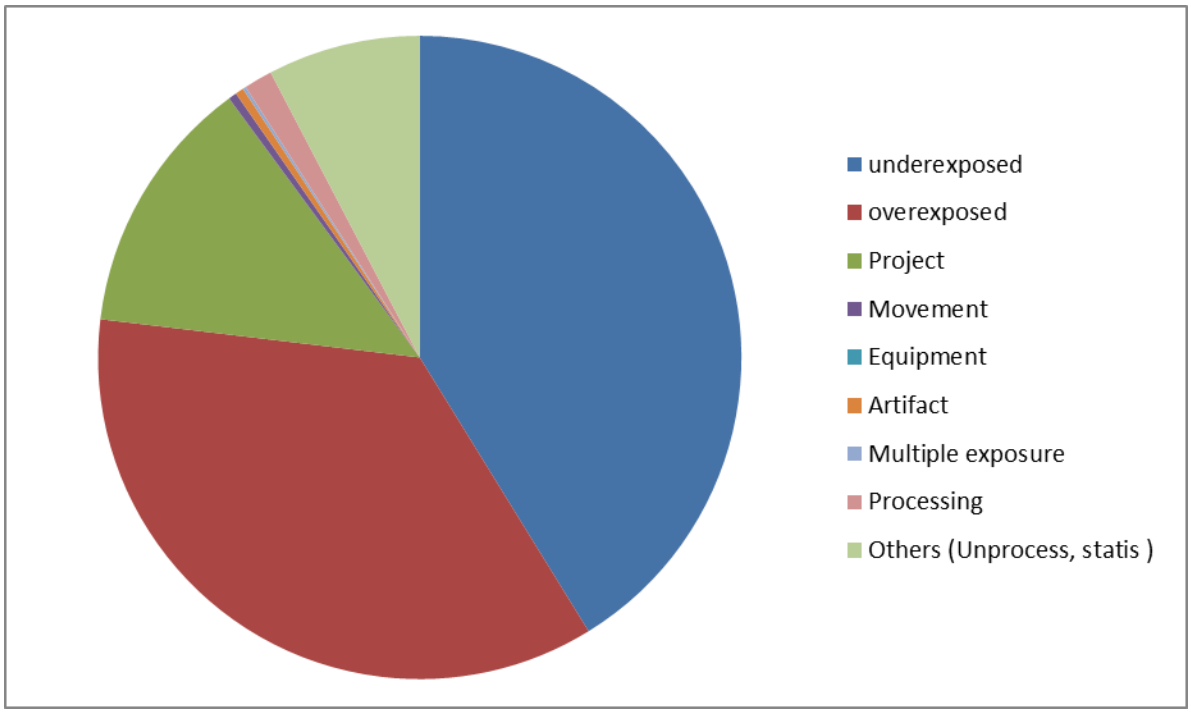

Figure 2: Pie chart on the causes of rejecting the radiographs

Table 3: Anatomical parts of the rejected radiographs

S/N	Reasons for Rejection	No of reject radiograph	Percentage (%)
1.	Chest	413	34.85
2.	Skull (Head)	162	13.67
3.	Lumbar sacral	142	12.00
4.	Sacral	65	5.48
5.	Neck	56	4.72
6.	Breast	62	5.23
7.	Thorax	85	7.17
8.	Extremities	112	9.45
9.	Shoulder	17	1.43
10.	Others	71	6.00
	TOTAL	**1,185**	**100**

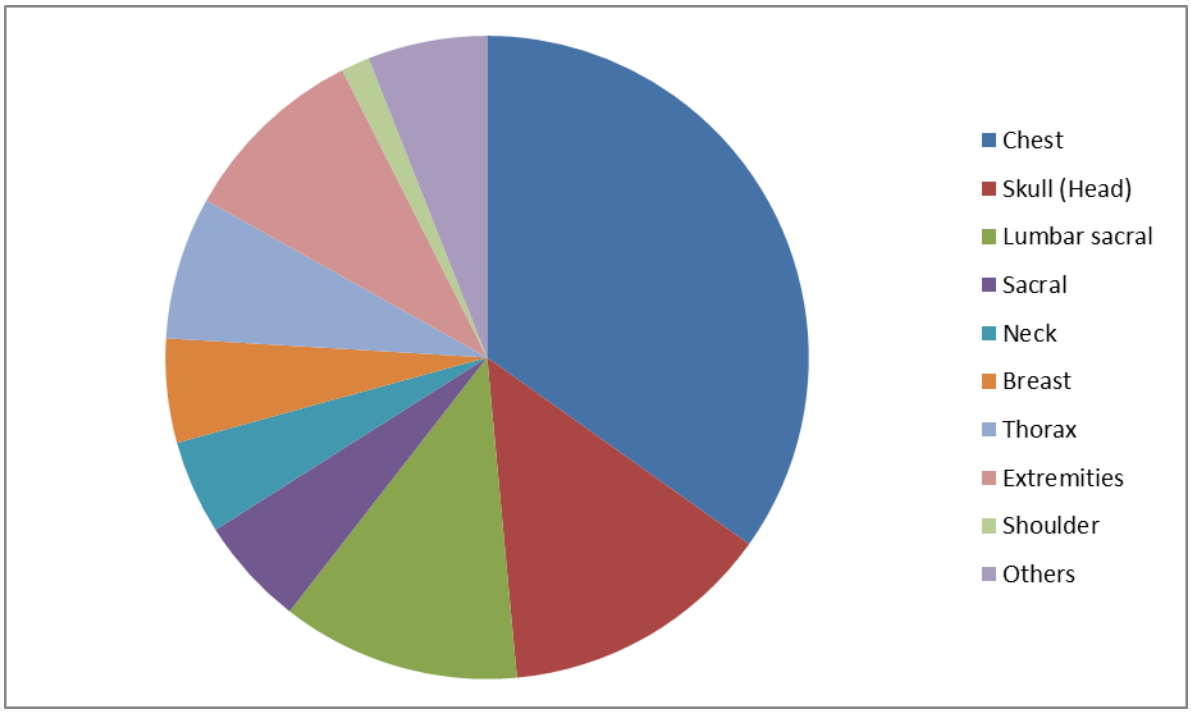

Figure 3: Pie chart of the anatomical part of the reject radiographs

DISCUSSION

Accurate exposure rate is one of the important (decisive) factors providing a good quality image with high resolution. High resolution image means an image that shows good structural detail.

Underexposure results in soft film and drop-out the detail and over-exposure gives a dark film with decreased resolution. Both the type of radiation to which the person is exposed and the pathway by which they are exposed influence health. Fetuses are also highly sensitive to radiation. The resulting effects depend on the systems which are developing at the time of exposure. Analysis of data has provided that the highest reject rate is that of chest X-ray (34.8%) with the main reason for rejection being under exposure (41.2%) which could either be due to machine fault, or operator's technical limitations. This finding agreed with all other similar studies in terms of type of reject, but causes for reject varied for example, patient positioning was considered the main cause of reject by Dunn and Rogers (1998). Pediatric chest X-ray had a reject rate of 34.8% with the main reason for rejection being patient motion giving a self-evident explanation. It is unavoidably encountered in pediatrics as it is difficult for children to comply with posing motionless -during X-ray examination. Skull X-rays showed the second highest reject at 11.9%, with underexposure being the main reason. Lumbosacral and Sacral X-ray showed 12.0% and 5.4% reject rates, respectively, although underexposure, was the main reason for reject in Lumbosacral, while other reasons were for Sacral. The sizes of the radiographs were independent of the causes of rejection. The size with the highest reject rate is "24cm x 30cm (415), followed by 35cm x 43cm and 30cm x 40cm with 374 and 181 respectively. Individual reject rates in this study were much higher than .similar studies conducted elsewhere.

Patient motion and positioning were the main reasons for, pediatric chest and lumbosacral as well as skull, and sacral respectively. The overall reject rate was 7.3%, which is just above the World Health Organization criteria of 5%, although, the Conference of Radiographic Control Programme Directorate (CRCPD's) committee on QA raises reject rates is up to 10%. Comparison with other figures from other causes showed that individual rejection by type varied from 2.2 % (Czech) to 11.02% (Ghana) and 13.6%

(Brazil) with many others falling between their ranges (Zewdeneh, 2008). QA programs and in adequate regular training programmes form a major explanation for avoidable film wastage and possibly elevated patient doses to achieve maximum benefit., all levels of management and technical staff must support and participate in the operation of a well-defined programme on a conclusion basis.

This study mainly found that underexposure and to a lesser extent overexposure as well as projection motion to be the main reasons of reject. These could be due to suboptimal X-ray machine performance, poor technical skill with an element of inattentiveness, which could be the major reasons when individual reject rates are seen. The over-all reject is within the accepted range. However, this will only be speculation as the above reasons have not been included in the study and need further independent investigation. The study has given some gross and basic input into the common problems of quality of radiography service, and recommends that a regular, and continuous Quality Assurance (QA) Programmes should be instituted at all levels of the department and that of hospital management for effective health service delivery, safe patient dose reduction, and sound resource management. Finally we recommend a large scale study at country level in order to reach plausible conclusion as to whether other factors such as equipment fault, or individual skill and performance may influence film reject rates and overall quality of service.

CONCLUSION

This study has shown the highest reject radiographs to be that if chest X-ray (34.4%), followed by skull (13.6%) and the Lumbosacral (12.0%), (which are the most common anatomical parts) with underexposure (41.2%), overexposure (35.7%) and projection (13.0%), respectively being the major causes. Although, the overall reject rate is well within the accepted range (7.2%), individual causes of reject have given light into some of the most common problems of quality of radiography service. Even though the reject rate is within the acceptable limit, (<10%), 7.2 % is a little high. This showed that the image quality of radiographs that was produce from January to December 2015 at the Radiation facility of the hospital selected will be seen to be low.

RECOMMENDATIONS

1. Radiographic film rejects analysis programmes should be done monthly and the hospitals with radiation facilities should have Quality Assurance (QA) and Control (QC) Programmes policy procedures that are well documented.
2. Radiation facilities should adopt be using a specific size of films for specific anatomical parts. For example due to the broadness of the chest, 35 x 43cm films should be used, the size of the various anatomical parts should be directly proportional to the size of film to be used for the examination. This will help greatly when analyzing the films.
3. Further recommendations include regular and cyclic QA Programmes to be instituted at all levels of the X-ray units and that of the hospital management for effective and sustained service delivery, X-ray dose reduction to patients and personnel, as well as economic management of scarce resource. Staff should be encouraged to participate in continuous professional development programmes such as seminars, courses and workshops, especially if a new equipment is introduced in the department. More staffs should be employed to enhance effective and quick service delivery.

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