Original article

X-ray reject analysis in Tikur Anbessa and Bethzatha Hospitals

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Abstract

Background: It is not uncommon to encounter patients undergo repeat x-ray examinations after their initial x-rays are rejected for poor image quality thereby subjecting them to excess radiation exposure and avoidable extra cost. This creates a situation which necessitates the need to explore causes of reject and repeat of x-ray examinations. The employment of reject analysis as part of overall Quality Assurance (QA) programmes in clinical radiography and radiology services in the evaluation of image quality is a well established practice. The role of reject analysis in providing relevant information that would help achieve sound reduction in radiation exposure and cost as well as develop acceptable image quality was explored in this study.

Objective: To assess the reject rate of x-ray films and obtain information for further recommendation on quality, cost, and radiation exposure in the two hospitals.

Methods: Prospective and cross-sectional study approaches were employed. Reject rate was measured for two x-ray departments (one from public and the other from private) across all plain x-ray films examinations using a structured format on which relevant data for reject were recorded by investigators (radiologists and a medical physicist). Results were then collected and entered into a database for analysis.

Results: Reject rate along with exposure rate was measured across all plain film exams for the hospitals. Analysis has shown that the overall reject rate was 4.94% in 4470 and 0.83% in 1870 exposed films for the public and private hospitals, respectively.

Conclusion: The study has shown the highest reject to be that of chest x-ray in both adults and children with overexposure and patient motion, respectively being the major causes. Although the overall reject rate is well within the accepted range, individual causes of reject have given light into some of the most common problems of quality of radiography service and we recommend that regular and cyclic QA programmes should be instituted at all levels of the x-ray department and that of hospital management for effective and sustained service delivery, x-ray dose reduction to patients and personnel as well as economic management of scarce resource. [*Ethiop.J.Health Dev.* 2008;22(1):63-67]

Introduction

The employment of reject analysis in the evaluation of image quality has quite a long history. It is an important component of quality assurance programs (1). The role of reject analysis in providing relevant information that would help achieve sound reduction in cost and radiation exposure both for patients and personnel cannot be overemphasized. The concern carries a significant weight in light of unavoidable stochastic effects in which even very minimal radiation doses carry potential risk (2). Hence, clinically un-indicated, avoidable repeat or un - optimized x-ray examinations may lead to adverse health effects and need serious optimization (3). Film reject analysis, as one of the numerous parameters for appraising the extent of quality compromise remains to be an important tool in radiography service delivery (4) in the identification of factors associated with sub-optimal radiographic images and subsequent rectification (5).

Diagnostic radiology service delivery departments would be able to identify potential problem areas, scrutinize the reasons for these problems and come up with ways to rectify them. These explanations, therefore, explicitly show that reject analysis is an integral part of standard radiology service evaluation, which is the basis for optimization of radiology and reasonable budgeting and planning of service delivery. The objective of the study was to assess the reject rate for further recommendation on quality, cost and radiation exposure in two hospitals.

Methods

Study population: Plain x-ray films of patients from Tikur Anbessa Hospital (TAH), and Bethzata Private Hospital were included in the time period of October 15/2005-November 30/2005.

Study Design: **The study employed prospective and cross-sectional hospital based study approaches.**

Sampling Procedure: One hospital from public service and another from the private sector were selected based on the size of the hospitals by convenience. All x-ray films of patients from the two hospitals during the study period were included. A total of 4470 films from Tikur Anbessa, and 1870 from Bethzatha hospitals were included. Quota sampling technique was used in the study to include films.

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Data Collection: After a thorough discussion with the staff of the radiology department working on quality control and experts from the National Radiation Protection Authority of Ethiopia, an agreed-upon list of common causes of film reject was prepared. Copies of the list were prepared for daily use in a table form and kept in each radiography room as well as in x-ray reporting rooms. The tables were prepared by film size, type of examination and cause of reject or repeat. Daily recordings were compiled by frontline radiographers and senior residents initially in the processing room and reporting room after which agreement on findings by principal investigators was reached to avoid inter-observer variation. The collected data were compiled at the end of each week and entered into a computer for analysis at the end of the study period.

Operational Definitions: Reject: an x-ray film considered useless and discarded based on the recommendations of the International Atomic Energy agency (IAEA).

Repeat: a radiograph which is taken to provide further diagnostic information and is sent with the original for reporting

Exposed films = Total number of reject films + total number of repeat films

a) Reject rate (%) = $\dfrac{\text{Number of rejected films X 100}}{\text{Total number of films used}}$

b) Exposure rate % = $\dfrac{\text{No of exposed films by exam type X100}}{\text{Total no of exposed films}}$

c) Causal reject rate (%) = $\dfrac{\text{Number of rejected films for a specific cause X100}}{\begin{array}{c}\text{Total number of film rejects}\\\text{for a specific type of}\\\text{examination}\end{array}}$

Data Analysis: Data were collected in standardized formats as recommended by the National Radiation Protection Authority (NRPA), and the International Atomic Energy Agency (IAEA). Rates and proportions were calculated and presented in table form. Moreover, costs of examinations and rejects were estimated.

Results
The reject rate by examination type and cause broken down into the three top reasons for Tikur Anbessa

Hospital (TAH) and Bethzatha Private Hospital (BZPH) is shown in Table 1.

The highest reject rate was that of adult chest (27.5%) corresponding to a parallel exposure rate 41.17% with the main reason for causal reject being over exposure (22.8%).

Pediatric chest shows the second highest exposure rate at 23.56 % but with a reject rate of 16.4 %. The main reason for causal reject was patient motion at 23.5%. Abdominal x-ray showed relatively low exposure rate at 2.48 % with a reject rate of 8.7%. A significant number of rejects failed under the category of others for adult chest, skull, extremities and spine. A break-down of details for this category shows that poor centering and flat exposures were the main reasons while double exposure, artifact and cut films were the culprits for a negligible number of film rejections.

Parallel review in the private hospital, showed that adult chest x-rays to have an exposure rate of 13.2% with a reject rate of 2.43% which was the highest in the series, but lower exposure rate .The main reasons for reject was patient motion.

Abdominal and skull x-ray showed exposure rates of 19.46% and 18.18% with reject rates, of 0.82% and 0.56%, respectively.

Extremity x-rays had an exposure rate of 16.68% with no reject. Surprisingly, pediatric chest x-rays had an exposure of 14.65% with a reject rate of 0.36%. Patient motion was the main reason for reject for adult, pediatric and abdominal x-ray at 33%, 100% and 67 % in that order.

Table 2 depicts the cost of total examination and reject by type and film size in Tikur Anebessa Hospital and Bethzatha Private Hospital (BZPH). It can be seen that individually the highest wasted money was seen for abdomen (18.01%), skull (14.8%), and spine (12.8%), but this is only a reflection of the small number of examinations and relatively high cost of films in these categories.

In the entire study period, in TAH the total cost of film for all categories was 27,717.83 birr, while that of total reject cost was 1371.49 birr, which gives an overall percentage of 4.95%. This would grant us approximately a total reject cost of 10,972 Birr per year.

Table 1: Reject rate by exam type and reason in Tikur Anbessa Hospital and Bethzata Private Hospital (BZHP), from October 15 - November 30, 2005

Exam Type	Exposure Rate			Reject Rate N (%)			Main reason for reject		2nd reason		3rd reason	
	TAH	BPZH	TOTAL	TAH	BPZH	TOTAL	TAH	BPZH	TAH	BPZH	TAH	BPZH
Adult Chest	1795(41.2)	247(13.2)	**(2042(32.2)	67(25.5)	6(2.4)	73(30.9)	Over exp (22.8%)	P.Motion (33%)	Others *(20.8%)	Others *(31%)	Under Exposed (19.3%)	Under Exposed (17%)
Pediatric Chest	1053(23.6)	274(14.6)	**(1327(20.9)	34(16.4)	1(0.3)	35(14.8)	P.Motion (23.5%)	P.Motion (100%)	Under Exposed (17.7%)	—	Positioning (17.6%)	—
Abdomen	111(2.48)	364(19.5)	**475(7.5)	20(8.7)	3(0.8)	23(9.7)	Other *(38.8%)	P.Motion (67%)	Under Exposed (5.5%)	P.Motion (33%)	Positioning (11%)	—
Skull	350(7.8)	340(18.2)	**690(10.8)	52(25.6)	1(0.6)	53(22.5)	Over Exposed (24.5%)	P.Motion (50%)	Others *(18.7%)	P.Motion (50%)	Positioning (17%)	—
Extremities	974(21.2)	312(16.7)	1286(20.3)	24(11.1)	0(0)	24(10.2)	Under Exposed (34.7%)	—	Others *(34.7%)	—	Over Exposed (26.1%)	—
Spine	187(4.2)	333(17.8)	**520(8.2)	24(11.1)	4(0.1)	28(11.9)	Under Exposed (43.5%)	P.Motion (33%)	Others *(34.7%)	Under Exposed (25.5%)	Over Exposed (21.7%)	Under developing (25%)

* Others - (Centering, flat, double exposure, artifact, cut films etc...)
** There was a significant difference in exposure rate between the two hospitals in all examination types except extremities. Because of the small sample size no comparison was made for reject rate

Table 2: Cost of total and reject films by type and size - Tikur Anbessa Hospital and Bethzatha Private Hospital (BZPH) from October 15-November 30, 2005

Examination type	Total examination		Number of rejects		Type of Film used by size(cm)	unit price/birr	Total cost of Examination/Birr		Total Cost Reject film/Birr		% of wasted Money	
	TAH	BZPH	TAH	BZHP	TAH & BZPH	TAH & BZPH	TAH	BZPH	TAH	BZPH	TAH	BZPH
Adult CXR	1795	247	67	6	35x35	7.7	1373.8	1889.6	512.6	45.9	3.7	2.4
Pediatric CXR	1053	247	34	1	18x24	2.6	2748.3	715.1	88.7	2.6	3.2	0.4
Abdomen	111	364	20	3	35x43	9.5	1054.5	3458	190	28.3	18.0	8.2
Skull	350	340	52	1	24x30	4.4	1522.5	1479	226.2	4.4	14.8	2.9
Ext	974	312	24	0	30x40	7.5	7305	2340	180	0	2.5	0
Spine	187	333	24	4	40x40	7.3	1355.8	2414.3	174	29	1283	1.2
Total	4470	1870	221	15			27717.8	12296	1371.5	110.4	4.94	0.9

Discussion

Accurate exposure 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.

Under-exposure 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. Because children are growing more rapidly, there are more cells dividing and a greater opportunity for radiation to disrupt the process. 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 (27.5%) with the main reason for reject being over exposure (22.8%) which could either be due to machine fault, or operator's technical limitations, and our finding corresponded 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 Duna and Rogers (6).

Pediatric chest x-ray had a reject rate of 16.4% with the main reason for reject being patient motion giving a self evident explanation frequently, but 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 25.6%, with over-exposure being the main reason.

Extremities and abdominal x-ray showed 11.11% and 8.70% reject rates, respectively, although under-exposure, was the main reason for reject in extremities, while other reasons were for abdomen. Individual reject rates in our study were much higher than similar studies conducted elsewhere (6, 7).

The parallel review of the private hospital data analysis showed a similar pattern to that of the public hospital, but at a much lower reject rate and with no reject for extremities surprisingly. The findings reflect that the low reject rates may not be entirely due to adequate quality of performance, but an acute awareness and tendency to save as much resource as possible by way of qualifying substandard films as adequate (Experience shared by investigators who have witnessed a situation in their private practices). Patient motion and positioning were the main reasons for adult, pediatric chest and abdomen as well as skull, and spine, respectively as shown on the tables. However, comparison and a reliable conclusion can not be inferred owing to small sample size taken from the private hospital.

The overall reject rate was 4.94%, which is just under the World Health Organization criteria of 5% (8) although, the Conference of Radiographic Control Programme Directorate (CRCPD's) committee on QA raises reject rates up to 10% (9).

Comparison with other figures from other causes show that individual rejects by type varied from 2.2 % (Czech) to 11.02% (Ghana) and 13.6% (Brazil) with many others falling between there ranges (2).

A study conducted in the United Kingdom (6) advocates that prior viewing of radiography may reduce reject rates significantly; while other studies conclude that ineffective in-house QA programs and in adequate regular training programs 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 (7, 8-11).

Our study mainly found that overexposure and to a lesser extent underexposure as well as patient 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.

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