

# X-ray film reject rate analysis at eight selected government hospitals in Addis Ababa, Ethiopia, 2010

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## Abstract

**Background:** Improper practices in radiography that lead to possible repeating of procedures predispose patients for additional cost, more waiting time, and excess dose of ionizing radiation, leading to various dose dependent and dose independent health problems including cancer. In the face of such problems and the scarcity of resources, improving the quality and efficiency of radiology services is imperative.

**Objective:** The purpose of this research was to identify the main causes of film faults as well as the pattern and magnitude of film rejection.

**Methods:** Using a prospective cross-sectional hospital based approach; eight public hospitals were selected in Addis Ababa through convenience sampling. Adult and pediatrics radiographs with film faults were reviewed using a standardized checklist of common causes of reject. The collected data were then entered into a database for analysis using descriptive statistics.

**Results:** Reject rate was calculated in eight governmental hospitals across all plain film examinations. The overall reject rate was 374 (3.1 %) in 12,165 x-ray exposures. Total reject rate by hospital showed 10.5% for Zewditu and 1.53% and 1.87% for Tikur Anbessa Specialized Hospital (TASH) and the Police Hospital, respectively.

**Conclusions:** Rejected films were found to have been caused by numerous factors including poor technical judgment, patient motion, and poor supervision of staff. Hence, strategies need to be developed within medical imaging departments to improve the situation. [*Ethiop. J. Health Dev.* 2012;26(1):54-59]

## Introduction

Medical x-ray exposures are the largest man-made source of ionizing radiation in many countries. Recent developments in medical imaging have led to rapid increases in a number of high dose x-ray examinations performed with significant consequences in individual patient doses and the collective dose of the population as a whole (1-3). It is believed that about 90 % of United States of America (USA) community dose originates from diagnostic radiology and nuclear medicine as sources of artificial ionizing radiation (2). The International Commission on Radiological Protection (ICRP) (4) recommends that such medical exposure should be kept as low as reasonably achievable (ALARA principle). One way of achieving this is through a quality assurance program, which includes procedures that help ensure satisfactory performance of radiographic x-ray equipment on a day-to-day basis. Quality assurance programs are primarily concerned with maintaining of X-ray imaging equipment at the optimum operational condition for providing the required diagnostic information. The World Health Organization (WHO) has defined quality assurance (QA) as an organized effort by the staff operating a facility to ensure that diagnostic images produced by the facility are of sufficiently high quality so that they consistently provide diagnostic information at the lowest possible cost and with the least possible patient exposure to radiation. Establishing acceptable criteria for the benefits, costs and risks associated with medical X-rays should thus form the basis for quality management and quality control

mechanisms for managing and operating, by the staff of the X-ray diagnostic departments. Unfortunately, this is absent in most Ethiopian hospitals. An initial approach in dealing with this situation would thus be analysis of the reasons for reject or repeat films. Repeat analysis is a helpful element to determine how big the waste of films is and where the sources of the error are. Repeat film analysis is a sort of subjective evaluation of image quality where these are judged to be of poor quality and are categorized according to their causes. Film reject analysis is an essential part of QA in any large X-ray department. Firstly, it will indicate weak areas of radiographic and radiological practice in the department. Secondly, reject analysis will enable one to note any improvement after quality assurance measures have been put into practice (3-6).

Radiologists and referring clinicians are concerned with the value of radiographs which can aid in diagnosis of disease or injury. The diagnostic value of a radiograph can be determined by specific anatomical structures that should be visible on the radiograph to aid in accurate diagnosis. A radiograph of diagnostic value provides quantitative information on the minimum sizes at which important anatomical details become visible on a radiograph. European Commission (EC) quality criteria (6) proposes characteristic features of imaged anatomical structures with a specific degree of visibility, their minimum dimensions in the image, at which specific normal and abnormal anatomical details and features should be recognized. It also describes criteria for

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radiation doses to patients and examples of good radiographic techniques; these criteria are intended to be used by radiologists reporting on radiographs to make personal visual assessments of the image quality. An important goal in radiography is to obtain the best diagnostic information by delivering the least radiation dose to the patient (5-7).

Effective use of radiology requires the application of two of the principles recommended by the International Commission on Radiological Protection (ICRP) in its dose limitation system: justification and optimization of X-ray exposures. Justification involves the professional judgment of the referring physician and radiologist, singly or jointly, as to whether a proposed medical procedure may be of a net positive benefit to the patient.

The main issue in the justification of X-ray procedures in Ethiopia is self-referral. Optimization means to balance the diagnostic information (image quality) and patient dose so as to maximize the ratio between the two; either to keep the information constant and minimize the dose or to increase information at a given dose. X-ray equipment design and maintenance have a major role to play in the overall optimization process. Equipment selection from a dose saving point of view, ease of maintenance and ensuring that adequately trained staff operates the equipment will contribute to the optimization process.

The role of reject analysis in providing relevant information that would help achieve an effective reduction in radiation exposure and unnecessary cost, while providing acceptable image quality is very vital in clinical radiology service. In this respect, reject analysis is a critical element in improving performance, and the analysis process has to use a well defined method that determines the cause of the problem. As a rule, the repeat rate of medical images should not be less than 3% or greater than 10% in a given month. Based on human nature and equipment failure, a repeat rate of less than 3% is not a realistic value for an imaging department. If the repeat rate is less than 3% the most likely explanation would be failure to account for all repeat films. If either the repeat rate or reject rate exceeds 10% in any given month, the reason would have to be identified and corrective action should be taken (1, 3).

Improper practice renders radiographs to possible repeat. Patients are often repeatedly exposed to radiation thus increasing their life exposure. The repeating process predisposes patients for more dose of ionizing radiation which can lead to various dose dependant and dose independent health problems including cancer, especially in the liable pediatric age group (9-15). In view of the growing call for radiological examinations, it is important that due consideration be given to the safety of patients and staff especially of developing countries like Ethiopia; where there are no laws regulating the use of radiation. It is important to make every effort to reduce

radiation exposure. Rejected films don't only damage tissue and incur additional expenses to patients, but thus also affect a facility's capacity not to deliver quality services. Moreover, patients are required to wait for a longer time in hospitals or appointed for next day to repeat the procedure and this entails additional cost and time. For these reasons, the objective of the present research is to identify the main causes of film fault, pattern and magnitude of film rejection at eight governmental hospitals in Addis Ababa, Ethiopia.

### Methods

This study was conducted between March and April 2010 in eight government hospitals in Addis Ababa. All pediatrics and adult radiographs with film faults during the study period constituted the study population. Thus, all X-ray films of patients from the eight hospitals that were taken during the study period were included. The study employed a cross-sectional design. The study hospitals (selected by convenience) were: Empress Zewditu Hospital (Zewd), Ras Desta Hospital (RD), Menelik II Hospital (Men II), Saint Peter Hospital (St Pet), Tikur Anbessa Specialized Teaching Hospital (TASH), Saint Paul Hospital (St Paul), Police Hospital (PH) and Yekatit 12 Hospital (Yek 12).

Data collection was done with the cooperation of the departmental staff, which included radiographers and darkroom technicians. Specially designed forms were used for data collection and were checked by the researchers on a daily basis, for films of poor image quality. The data included the following information: x-ray number, sex, type of examination, position/view, type of film used, the number and size of films used, the number and size of films rejected and reason for the rejections. The reasons for film rejection and consequent repetition were classified. Copies of the lists were prepared for daily use in a table form and were kept in each radiography room as well as in x-ray reporting rooms. Daily recordings were compiled by frontline senior radiographer's and senior radiologists initially in both the processing and reporting rooms after which agreement on findings by investigators was reached to avoid inter-observer variation.

The collected data were compiled at the end of each week and compiled in a computer for analysis at the end of the study period. Data were analyzed using descriptive statistics. Statistical analysis of differences in reject rates among hospitals was not done as x-ray exposure numbers were not the same for each hospital.

Ethical clearance was obtained from the Institutional Review Board of the College of Health Sciences, Addis Ababa University.

### 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.

**Reject rate (%)** =  $\frac{\text{Number of rejected films}}{\text{Total number of film used}} \times 100$

### Results

A total of 12,165 x-ray exposures for all types of examinations were made in 8 public hospitals in Addis Ababa over a period of two months (during March and April 2010). Of these, 374 (3.1%) x-ray films were rejected and considered for repeat exposures for a variety of reasons.

Total reject rates by hospitals showed the highest (10.5%) to be in Zewditu and the lowest (1.53%) to be in Tikur Anbessa Specialized Hospital (TASH).

Table 1 shows total x-ray films exposed and total x-ray films rejected for each radiological examination type by hospital. Chest x-rays (CXR) were the most frequent exposures in nearly all the hospitals. Reject rates for CXR were below 5% except Zewditu Hospital at 7.4%.

Abdominal exposures were limited in number but rejects were rather high at Zewditu at 56%, Menelik II at 13%, Ras Desta at 10%, and Yekatit 12 at 6%. St Peter Hospital did CXR examinations only. Rejects for skull x-rays (SXR) were high for six hospitals with the exception of St. Peter (not included for other examinations) and Yekatit 12 which had 4%. Extremity exposures showed rates below 5% for all hospitals. Spine x-rays had reject rates of 6% and 13% for Ras Desta and Zewditu hospitals respectively while the other five hospitals had rates within the accepted range. Pelvic exposures again showed reject rates of 19% and 14% for Zewditu and Yekatit 12 respectively. As the table shows, the same was true for Zewditu with a reject rate of 50% for exposures included in the category "others".

Table 2 shows the main causes of reject for each examination type by hospital. The most frequent cause of reject in nearly all hospitals and for almost all types of examinations was wrong patient positioning followed by light fog, and over/under exposure.

Table 3 shows the total cost of exposed and rejected films together with the proportion of wasted resources. The highest wastage was for chest size films (35cm by 35 cm) at 5%. The overall resource wastage was 3.6% of the total cost of all exposed films for the months of the study period.

Table 1: **Reject rate by exam type and by hospital, Addis Ababa, April, 2010**

Exam type	Ras Desta Hospital			St Peter Hospital		St Paul Hospital		Police Hospital		Men. II Hospital		TASH Hospital		Zewd. Hospital		Yek. 12 Hospital	
	Total films	Reject & %	No	Total film	Reject No & %	Total film	Reject No & %	Total films	Reject & %	Total films	Reject No & %	Total films	Reject No & %	Total films	Reject No & %	Total films	Reject No & %
cxr	713	24 (3%)		786	13 (2%)	1440	36 (3%)	597	5 (0.8%)	444	18 (2%)	1900	14 (3%)	537	40 (7.4%)	529	17 (3%)
ab	30	3 (10%)				20	0	65	3 (5%)	24	3 (13%)	210	2 (.0%)	34	19 (56%)	17	1 (6%)
sxr	60	13 (22%)				465	37 (8%)	35	0	135	8 (6%)	150	16 (10%)	75	8 (11%)	102	4 (4%)
ext	154	8 (5%)				498	9 (2%)	341	8 (2%)	297	11 (4%)	950	14 (2%)	164	7 (5%)	152	4 (3%)
sp	110	7 (6%)				119	4 (3%)	93	5 (5%)	62	0	260	11 (4%)	51	7 (13%)	73	3 (4%)
pel	82	1 (1%)				68	2 (3%)	43	1 (2%)	41	0	170	1 (.5%)	21	4 (19%)	21	3 (14%)
ot	-	-		-	-	-	-	-	-	7	0	-	-	20	10 (50%)	0	0
tot	1149	66 (5.74%)				2610	88 (3%)	1174	22 (1.8%)	1010	40 (3%)	3640	56 (1.53)	902	95 (10%)	894	32 (3.5%)

Key - cxr=chest x-ray, ab=abdomen, sxr=skull x-ray, ext.=extremities sp=spine pel=pelvic or=other tot=total

Table 2: **Main causes of film reject for each exam type, by hospital, Addis Ababa, April, 2010**

Hospital	CXR	Abd. X-ray	Skull X-ray	Ext X-ray	Spine X-ray	Pelvic X-ray	Others
Ras desta	WP 9 (37.5%)	UEXP 2 (66.6%)	WP 4 (30.76%)	WP 5 (62.5%)	WP 3 (42.85%)	WP 1 (100%)	-
St. Peter	OEXP 3(23%) WP 3 (23%) MF 3 (23%)	-	-	-	-	-	-
St. Paul	UFF 11 (30.55%) EXP 8 (22.22%) WP 7 (19.44%)	MF 13 (52%) WP 5 (20%) UEXP 5 (20%)	WP 24 (64.86%) LF 7 (18.91%) OEXP 7 (18.91%)	WP 4 (44.44%) OEXP 3 (33.3%) UEXP 2 (22.2%)	OEXP 2 (50%) WP 1 (25%)	UEXP 1(50%)	-
Police	LF 4 (40%)	UEXP 2 (66.66%)	-	WP 3(37.5%) OEXP 3 (37.5%)	WP 2 (40%) MB 2 (40%)	OEXP 1(100%)	-
Minelik II	WP 4 (40%) LF 2 (20%)	Ff 2 (66.6%)	WP 5 (62.5%) MB 2 (25%)	OEXP 6 (54.54%) UEXP 2 (18.18%)	WP 2 (66.66%)	OEXP 1 (100%)	-
TASH	WP 4 (28.57%) LF 3 (21.42%) OEXP 3 (21.42%)	WP 1 (50%) UEXP 1 (50%)	WP 6 (37.5%) UEXP 4 (25%) LF 3 (18.75%)	LF 8 (57.14%) WP 2 (14.28%)	LF 8 (72.72%)	UEXP 1 (100%)	-
Zewditu	LF 19 (47.5%) WP 10 (25%)	UD 9 (47.36%) LF 3 (15.78%) UEXP 3 (15.78%)	LF 4 (50%) UEXP 3 (37.5%)	OEXO 5 (71.42%) WP 1 (14.28%)	UEXP 3 (42.85%) LF 2 (28.57%) WP 1 (14.28%)	WP 3 (75%)	-
Yekatit 12	WP 9 (52.94%) MB 2 (11.86%)	WP 1 (100%)	UEXP 3 (75%) WP 1 (25%)	WP 2 (50%)	WP 2 (66.66%)	MF 2 (66.6%) WP 1 (33.33%)	-

Key: OXP=overexposure, UXP=underexposure, WP=wrong positioning, MF=misfiled, LF=light fog, FF=flat film, MB=motion blur, UD=under development

Table 3: Cost of total exposed and rejected films by size of film for abdominal, chest and spine exams. Addis Ababa, April 2010.

X-ray film size (cm)	No. of exposed films	Total price (Birr)	No. of rejected films	Total price (Birr)	% of wasted money
30*40	4217	55824.00	146	2808.00	5.0
35*35	6946	83352.00	145	1860.00	2.23
24*30	1022	7154.00	83	602.00	1.2
Total	12165	146,330.00	374	5270.00	3.6

### Discussion

The practice of standard exposures and meticulous observance of radiographic protocols underscore the attention given to quality of images and radiation safety of patients as well as cost efficiency in clinical practice. Analysis of reject data, therefore, becomes a simple yet powerful tool to provide information that help monitor and rectify problems regarding the above- mentioned facts in the provision of x-ray services.

As the information in our results showed, the total reject rate of all the hospitals studied was 3.1%. This figure is lower (4.46%) than that obtained from an earlier study done in two hospitals in Addis Ababa in 2005 (3). Overall, the figure is well within the internationally accepted range [9-14]. However, caution needs to be exercised in making comparisons such, for instances, as the method of determining repeat rate and duration of observation; the differences in the criteria for repeating films may have influences of their own. Films of marginal quality may have been considered acceptable for economic reasons. Problems such as lack of proper equipment maintenance, inadequate films and chemicals which are encountered may influence the decision for less repeat examination. Hence, caution should be made to avoid the potentially misleading notion that might lead to a false assumption that the practice of radiography is of the required quality. Further analysis into individual x-ray types and causes of reject had revealed information contrary to it in most of the hospitals. The contribution of students to the number of repeats was also apparent. According to the protocols for student supervision at each site, student-assisted cases are under the full control and supervision of the senior radiographer. However, the research team observed that in practice this was not always followed appropriately. In many instances, the senior radiographer would pass the case to the student and would not maintain supervision throughout. In some instances, it was noted that students were coaching other students, a practice that should be avoided (16, 17).

Analysis of total reject for each hospital showed varying values with the highest rate for Zewditu Hospital at 10.5% and the lowest for TASH and Police Hospital, having a value of 1.53% and 1.87% respectively. Both values appear to be at the extreme ends of the spectrum. Values below 3% should be under the spotlight as they would indicate failure to account for reject and repeat cases that are bound to occur in any busy radiology department and might even suggest deliberate

withholding of actual incident reports. Values above 10% would definitely indicate problems causing reject that would necessitate corrective measures (1, 3).

Adult and pediatrics CXRs were the most frequent exposures in all the hospitals studied but reject rates were normal in six hospitals with the exception of Zewditu which had 7.4% and Federal Police Hospital which had 0.8%. Since one figure is below the accepted range, explanations had to be sought for. Light fog, wrong patient positioning, motion blur and similar causes could explain the high figure for Zewditu while a possible under-reporting should be checked for the Federal Police Hospital.

Reject rates for abdominal exposures were again found to be quite high for Zewditu (56%), Menelik II (13%), and Ras Desta (10%). Exposure factors and manual processing factors were the main causes of reject. Skull x-rays on the other hand, showed yet again high reject rates for Ras Desta (22%), Zewditu (11%), TASH (10%), and St Paul (8%) with the main causes of reject being wrong positioning and light fog. Reject rates for extremity examinations were within the accepted ranges for all hospitals indicating relative ease of procedure in terms of technicality. In a similar manner, pelvic x-ray exposures showed high reject rates for Zewditu (19%) and Yekatit 12 (14%) with wrong patient positioning and misfiling as main causes. For x-ray examinations included in the "other" category as well, Zewditu Hospital again had a 50% reject rate caused by light fog, wrong positioning, underexposure and overexposure. In nearly all examination types, three hospitals (Zewditu, Rad Desta and Yekatit 12) showed results that needed vigorous corrective actions.

All the above explanations regarding the magnitude of rejects and their causes indicated that piece-meal analysis of examination types and individual hospitals revealed more candid information which would otherwise be missed if we were to rely on the overall reject rate obtained for all examinations and hospitals collectively.

Other studies elsewhere had shown almost identical causes of reject with wrong patient positioning as the most important factor (16-18). Similar studies in various countries have shown figures ranging from 2.2% (Czech) to 13.6% (Brazil) (2).

With regard to concern over patient safety, the long term impact of cumulative radiation is directly related to repeat

exposures resulting from reject episodes and minimization of radiation and optimization of procedures can only be attained by analysing x-ray rejects. Similarly, in terms of resource utilization, the proportion of rejected films amounted to 3.6% of the total cost of films exposed. For a healthcare system with scarce resources, losing such amount is not affordable. Moreover, the direct and opportunity costs incurred on patients, who have to appear for repeat procedures, cannot be overemphasized.

Our study has explicitly shown that the main causes of reject in almost all the hospitals studied appeared to stem from suboptimal human and equipment performance. So, these need serious attention and rectification.

Therefore, by reducing the rate of rejected films, the radiation dose to the public should be as low as reasonably achievable. Apart from the radiation dose to the public, radiographs which must be repeated, represent additional, non-billable costs as a result of increased film consumption, and equipment use as well as increased personnel time. Compounding the above undesirable financial impact on the department is an increased burden on the waiting room and support staff.

Such corrections should come through revisiting current radiography curricula, through regular knowledge and skills upgrading courses for professionals in practice, and through implementing mandatory quality assurance packages for both human and machine performance across all health facilities serving the public and all the teaching institutions that are producing trained manpower.

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