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Assessment of Radiographic Film Quality in Four Governmental Hospitals in Sidama Zone, SNNPR

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Abstract

Clinically unjustified, avoidable repeated or un-optimized X-ray examinations may unnecessarily lead to increased risk of adverse health effects hence need to be minimized. Hence the objective of this study is to assess the extent of radiographic film quality using the rejects film analysis (FRA), determine major causes of film reject and estimate wasted money. Cross-sectional study was thus, conducted at four governmental hospitals in the Sothern region of Ethiopia to assess radiographic film quality between February and March 2016. Out of 2,343 exposed films, 106 rejected films representing various types of radiologic examinations were collected from Hawassa University Referral Hospital (HURH), Adare Hospital (ADH), Bona District Hospital (BDH), and Yirgalem Hospital (YH). The types of films and causes of repeats were analyzed. It was found that out of all films studied, the overall reject rate was 3.5%, 5.63%, 10.6%, & 2.8% for HURH, ADH, BDH, and YH respectively. The film reject rates were within those reported in the literature except for ADH. The main causes of reject in the hospitals were found to be mal-positioning 28.9% (ADH), 24% (YH), and 21% (HURH) except for BDH for which the major cause of reject was processing error (30%). The second cause of reject was exposure faults, 26% (HURH), YH (20%), 25% (BDH); whereas patient motion at ADH (27.8%). There was also wastage of 1497ETB (3.95%) or (17964ETB/Yr). On job training of technicians, revision to the current medical radiology technology curriculum related to positioning course, was recommended to save the cost and subsequent reduction of radiation to the general population.

Keywords: Repeat rate; Reject rate; Film reject analysis; Artifacts; Exposure factors; Positioning

Introduction

Worldwide, X-rays are one of the important diagnostic modalities used in the healthcare services despite being associated with some radiation exposure to the patients [1]. Recent developments in medical imaging have led to rapid increases in a number of high dose X-ray examination performed with significant consequences in individual patient doses and collective dose of the population as a whole [2]. It is believed that about 90% of USA community dose originates from diagnostic radiology & nuclear medicine as a source of artificial Ionizing Radiation [3].

X-rays are known to cause malignancies, skin damage and other side effects and therefore are potentially dangerous. With multiple exposures there is a potential for biological effects. It is therefore the small doses encountered in diagnostic procedures, contributing to the stochastic effects, which are a matter of concern. It is therefore essential and mandatory to reduce the radiation dose to patients in diagnostic radiology to the barest minimum [4]. Ionizing radiation does have detrimental effects hence the need to reduce exposure during X-ray examination as low as possible.

Studies have shown that there is a large scope for dose reduction not necessarily associated with high investments and that simple low-cost method could be used for dose reduction without loss of diagnosis information [5]. Retake analysis is a sort of subjective simple method to evaluate the image quality and hence decreasing the patient dose been proved by many studies [6]. It 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 [7,8].

Reject film analysis is an important component of a Quality Assurance (QA) program [9,10]. It involves the periodic critical evaluation of radiographs which are used as part of the imaging service but do not play a useful part in the diagnostic process [11,12]. If optimum performance

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is to be achieved, assessment of image quality must be made to balance against patient dose. World Health Organization (WHO) has recommended a permissible reject rate of 5%, However, Conference of Radiographic Control Program Directorate (CRCPD'S) committee on Quality Assurance (QA) recommend a higher reject rate of 10%.

As the level of radiation exposure and the absorbed dose increases, the probability of stochastic effects increases almost linearly [13]. Besides the health-related risks which may arise from repeat exposures, the cost to the health care facility also needs to be considered. The consequence of repeat X-ray examinations is an increase in the operational costs of imaging departments. Not only are time and human resources wasted, but with screen film radiography X-ray films, processing chemicals are squandered when the radiographic images taken are discarded, thus negatively affecting budget. In the face of such problems and the scarcity of resources, improving the quality and efficiency of radiographic services is imperative.

A growing global radiation protection concern in diagnostic radiology is justifying the patient doses incurred during X-ray examinations. The concern originates from the fact that, when considering stochastic effects, even small radiation doses carry some risks. Therefore, clinically unjustified, avoidable repeated or un-optimized X-ray examinations may unnecessarily lead to increased risk of adverse health effects and hence need to be minimized [14]. Among these, un-optimized X-ray examinations are difficult to manage, especially in situations having little experience. Considering the case of medical imaging where 10% of the films are wasted at screening at darkroom and Radiographer's level and 10% are of reject quality or perceived by the radiologist and even much more without concern for loss [14]. Practices are aimed simply at keeping all radiation risks to health As Low As Reasonably Achievable (ALARA principle) social and economic consideration be taken in to account under the constraint that no individual will be subjected to undue risk [10].

In Ethiopia, quality assurance for imaging equipment is provided by the regulatory body, Ethiopian Radiation Protection Authority (ERPA) in two years interval. Since, there are no established national reference dose levels in the country; it needs additional simple cost-effective element of QA like film reject analysis which can easily implemented at the radiographers level in the radiology departments to identify factors responsible for deterioration of radiographic images from which corrective solutions may be realized.

Studies conducted in Addis Ababa [8,15], has shown that there were hospitals with higher reject rates above the limit which required long term the implementation of the FRA program in the respective hospitals and the importance of this cost-effective method as a QC tool has been proved by different studies. In addition to observed increasing number of repeats with different faults from experience in the hospitals understudy, there was no any study conducted generally in the Southern region on status of radiographic film quality and there is no established quality assurance program on the X-ray departments of the selected hospitals.

Due to different level of qualifications of operators, different film processing mechanisms, where Digital Radiograph (DR) is only used in Adare Hospital, operational costs are still high, since many of the non-diagnostic X-ray images are printed, contributing to film wastage. The cause of film rejects and the overall reject cost is not known in these hospitals under study. Rejected films don't only damage tissue and incur additional expenses to patients, but 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. It is therefore important to assess radiographic film quality and identify the possible causes of film rejection and the overall reject costs so that solutions on how to reduce film wastage, can be provided. Therefore, the purpose of this study was to assess level of radiographic image quality and causes of film reject at four governmental Hospitals in Sidama zone, Southern Ethiopia.

Materials and Methods

The study was conducted in the Southern part of Ethiopia, Hawassa, Yirgalem, and Bona towns, which are 272 km, 317 km, 392 km, from Addis Ababa respectively.

The radiography department of all the hospitals offers the following services; routine x-ray imaging using conventional X-ray tube, fluoroscopy, manual processors except for Adare Hospital. On average, 120 exposures will be made in all the four selected hospitals.

The study employed descriptive, cross-sectional study research design. The study was conducted between February and March, 2016 in four governmental hospitals in Hawassa, Yirgalem and Bona in Sidama Zone of Southern region of Ethiopia.

All routine X-ray films of patients from the four hospitals during the study period were included during the study period b/n February and March, 2016. Films from special procedures areas (cardiovascular and neurological) were excluded from study. The hospitals were Hawassa University Referral Hospital (HURH), Bona District Hospital (BDH), Yirgalem Hospital (YH) and Adare Hospital (AH) selected by convenience due to large patient flow. But, no copy or subtraction films were included in the reject count or total film count, films from special procedure areas (cardiovascular and neurological), and clear films and films used for quality control during the study period were not included in the reject count or the total number of films used. All pediatrics and adult radiographs with film faults during the study period constituted the study population. Thus, all rejected X-ray films of patients from the four hospitals that were taken during the study period (Feb 15 to March 15, 2016) were included.

For this study, the causes of film reject for films having no any diagnostic value were assessed considering all the films exposed during the study period.

Before starting collecting the data, the number of unexposed films in the processing area (including in the cassette) and in each imaging room were recorded, the reasons for film rejection and consequent repetition was classified during the routine radiographic practice. Data collection was done and categorized, with the cooperation of departmental staffs at the respective X-ray departments, which included radiographers, technologists and darkroom technicians using specially designed forms for data collection and were checked by the researchers on a daily basis, for films of poor image quality. Films were sorted by exam categories like, CXR, Abd X-ray, Skull, Ext, Spine, Pelvic X-ray and other. 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.

Adult and pediatric radiographs with film faults were reviewed using a standardized checklist of common causes of reject. Different boxes labeled for each room were used to daily collect rejected films.

Table 1: Distribution of number of films used & reject rate by exam type and Hospital, Hawassa, April 2016.

Exam type	Hospital								
	HURH		YH		BDH		ADH		
	Total films	Reject No (%)	Total films	Reject No (%)	Total films	Reject No (%)	Total films	Reject No (%)	Total No.
CXR	861	21 (2.44)	391	12 (3.3)	149	10 (6.7)	160	6 (3.8)	**1561**
Abd	36	3 (8.33)	19	2 (10.5)	9	2 (22.2)	27	2 (7.4)	**91**
Skull	63	7 (11.1)	40	2 (5)	7	1 (14.3)	50	2 (4)	**160**
Ext	138	4 (2.9)	5	-	14	3 (21.4)	49	3 (6.1)	**206**
L.S	68	6 (8.8)	-	-	3	3 (100)	7	-	**78**
T.L	28	3 (10.7)	-	-	4	1 (25)	11	2 (18.2)	**43**
KUB	48	3 (6.2)	32	3(9.4)	-	-	8	2 (25)	**88**
Cervical	30	-	9	1(11.1)	3	-	8	1 (12.5)	**50**
Pelvic	40	-	-	-	-	-	-	-	**40**
Other	21	-	5	1 (20)	-	-	-	-	**26**
Total	**1333**	**47 (3.53)**	**501**	**21 (4.2)**	**189**	**20 (10.6)**	**320**	**18 (5.63)**	**2343**
Reject rate	**3.53%**		**2.80%**		**10.60%**		**5.63%**		

CXR: Chest X-Ray; Abd: Plain Abdomen; Ext: Extremity; LS: Lumbar Sacral; TL: Toraco Lumbar; KUB: Kidney Uretus Bladder track

Specially designed data forms were used for data collection and were checked by the researcher on a daily basis, for films of poor image quality. The data sheet includes the following information: X-ray number, sex, type of examination, position/view, and type of film used the number and size of films used the number and size of films rejected, cost and reason for the rejections.

Radiation consistency test was run in parallel with reject film analysis as processing or radiation output irregularities may be causing some of the problems and all the films in the hospitals have equal probability to be categorized in to the given causes of rejection. In order to reduce the potential problems, all concerned radiographers or MRT were fully explained why the analysis is being carried out, how and when it will be carried out and the benefit so that, they will cooperate fully and reject film records will always be kept up to date. Also, in order to get the correct cause of film fault, the data filled by the radiologists and data collectors were cross-checked in addition to short training provided on how to collect data. The quality of the films value judgment was based on investigator's assessment and comments from the radiologists if repeat exposure is needed or not. If doubt arises about the reason for rejection or radiographic quality (good, fair or none) the opinion of another consultant radiologist or that of senior radiographer was sought.

Data was 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. Number of reject films by faults & by rooms, overall cost of reject films, reject films as percentage of films used were calculated by inserting the data in to the data base (SPSS-20 software). Films were collected and serialized for purpose of capturing data. Analysis was done using descriptive statistics, tables, bar charts, and percentage by film size.

Determination of reject rate

The film reject rate was determined by using the formula:

Number of rejected films/Total number of films used 100%

The collected data was compiled at the end of each week and feed in to a computer for analysis at the end of the study period. Data was analyzed using descriptive statistics.

A reject rate of 10% or more was considered unacceptable and needs corrective actions according to recommended standards by international organizations like IAEA. A reject rate of 5% to 10% justifies continued monitoring.

The details of film type and size were used to estimate the cost of films. The annual cost of reject films was also estimated by multiplying the cost of rejects in the study time (4 weeks) by 52/4. The estimation of the cost of other factors like X-ray machine depression, chemicals, and radiographer working hours was not done.

Permission was sought and obtained from the institutes research boards of the college of medicine and health sciences. The patients were those, referred by their attending clinicians and the examinations were done for the benefit of the referred patients. No repeats were taken for the purpose of this study. No patient identifying details was considered or recorded.

Results

In conventional radiography, film reject analysis is described as the critical evaluation of radiographs that have been rejected as being of insufficient quality to enable a radiological opinion to be given. By analyzing these rejects it is possible to identify problem areas and to introduce corrective measures.

As shown in Table 1, out of 2,343 exposed radiographs, chest constitutes the maximum number 1,561 (66.6%) with 861 (55.2%) & 391/ (25.1%) examined at HURH and YH respectively, followed by extremities 206 (8.8%) out of which 138 (70%) is from HURH, thirdly, skull 160 (6.8%), spine 121 (5.2%). In addition, the number of the rejected radiographs in a particular radiographic examination was compared with the total number of exposures in that specific examination to find out the reject percentage.

From Table 1, it was found that chest exam accounted for the maximum 49 (46.2%) of rejects followed by Skull: 12 (25.5%) and Extremities; 10 (21.3%) together responsible for over 90% of the rejected radiographs in all Hospitals. Pelvic X-ray was only

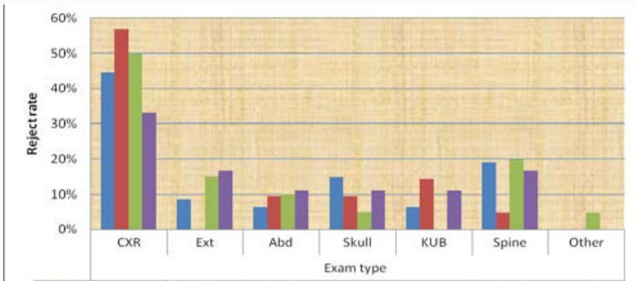
Table 2: Major causes of film reject for five common exam types along the four hospitals.

Hospital	Exam Type with major causes of reject				
	CXR	P.abd	Skull	Ext.	Spine
HURH	Positioning -28.13%	Positioning -40%	Positioning -23.10%	Position. -28.60%	Position. -28.60%
	TCut film -15.63%	Cut film -40%	Cut film -15.40%	OExp. -28.60%	OExp. -28.60%
	Movement	UEX	UEX	Processing	Processing
	-12.50%	-15%	-15.40%	-28.6	-28.6
	Processing -12.50%	-	OEX -15.40%	Artifact -14.30%	Artifact -14.30%
	UEX+Artf -18%	-	-	-	-
BDH	Processing -55.60%	Movement -50%	Movement -100%	Processing -68%	UExp. -100%
	UExp **-22.20%**	Poor prep. -50%	-	Artifacts -32%	-
	Movement -11.10%	-	-	-	-
	Artifact -11.10%	-	-	-	-
YH	Positioning -33.30%	OEXp -100%	Beam alignment -100%	-	-
	Artifacts -33.30%	-	-	-	-
	OExp. -16.40%	-	-	-	-
	Other -16.40%	-	-	-	-
ADH	Positioning 3/6 (50%)	Positioning 2/2 (100%)	Movement 2/2 (100%)	Position 1/3 (33.3%)	Artifact ½ (50%)
	Movement 2/6 (33.3%)	-	-	Movement 1/3 (33.3%)	Other ½ (50%)
	UEXp 1/6 (16.7%)			OEXP 1/3 (33.3%)	-

Table 3: Percentage distribution of wasted money per rejected films.

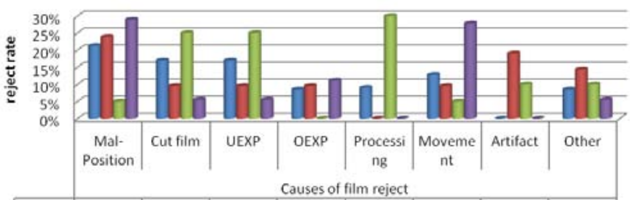
Film size(cm)	Total exp.	Total price(ETB)	No. rejected	Reject rate (%)	Price per film (ETB)	Total price (ETB)	% of wasted money
30*40	**327**	**6474.6**	**25**	7.6	19.8	**495**	7.65%
	252	HU 4989.6	HU 12	4.8		237.6	
	45	YH 891	YH 5	11.1		99	
	30	BH 594	BH 8	26.7		158.4	
35*35	**1247**	**26561**	**30**	2.4	21.3	**639**	2.41%
	700	HU 14910	HU 12	1.71		255.6	
	391	YH 8328.3	YH 8	2.5		170.4	
	156	BH 3322.8	BH 10	6.4		213	
24*30	**390**	**4446**	**27**	6.9	11.4	**307.8**	6.93%
	342	3898	HU 18	5.3		205.2	
	45	517.5	YH 6	13.3		68.4	
	3	34.2	BDU 2	15.4		22.8	
18*24	**48**	**377.3**	**7**	14.6	7.86	**55**	14.6%
	39	306.5	HU 5	12.8		39.3	
	9	70.74	YH 2	22.2		15.72	
	0	0	BH 0	0		0	
Total	**2325**	**37858.9**	88	3.80%		**1497**	3.95%

performed at HURH 40 (17.1%) of all exams with no reject during the study period. As indicated in Table 3, at HURH the major cause of reject films was bad positioning. It is the highest for most of the examinations, P.abd (40%), Ext (28.6%), CXR (28.13%), and Skull (23.1%) respectively. Cut film is the second frequent cause of reject for plain abdomen (40%), KUB (25%), and L.Spine (23.5%), CXR (15.6%) respectively. Where, incorrect exposures (UEXp & OEXp) constitute skull (30.8%), L.S (29.4%), Ext (28.6%) as the cause of reject. At BDH, for CXR processing related errors constitute the highest cause of reject CXR (55.6%), and Ext (68%) exams. For P.abd (50%), skull (100%), CXR (11.1%) patient motion was the major cause of rejected films. UEXP contributes for the cause of all the L.S exams and most of the T.L rejects (70%) was due to processing errors in BDH hospital.



	CXR	Ext	Abd	Skull	KUB	Spine	Other
HURH	45%	9%	6%	15%	6%	19%	0%
YH	57%	0%	10%	10%	14.50%	4.80%	
BDH	50%	15%	10%	5%	0%	20%	4.80%
ADH	33.30%	16.70%	11.10%	11.10%	11.10%	16.70%	

Figure 1: Percentage reject rate for six common examinations in each hospital, April 2016, Hawassa.



	Mal-Position	Cut film	UEXP	OEXP	Processi ng	Moveme nt	Artifact	Other
HURH	21%	17%	17%	9%	9%	13%	0%	8.51%
YH	24%	10%	10%	10%	0.00%	9.52%	19%	14.30%
BDH	5%	25%	25%	0%	30%	5%	10.00%	10%
ADH	28.90%	5.50%	5.50%	11.10%	0.00%	27.80%	0%	5.50%

Figure 2: Percentage distribution of reasons of film reject in each Hospital, April, 2016. Hawassa.

At Yirgalem Hospital, CXRs (33%) were due to bad positioning, where 33.3% of CXR rejects were due to artifacts (related to processing) and OEX accounted (16.4%) for the rejects. For plain abdomen, skull, and KUB examinations, over exposure (100%) & cut films (beam not aligned) (100%), and poor patient preparation were the causes of the rejected films in the hospital respectively.

From Table 2, among the various reasons of film rejects at Adare Hospital, faulty positioning of patient constitute the highest for CXR (50%), P.abd (100%), KUB (50%), respectively. Patient motion (movement) was also the major cause of repeat for skull (100%), Ext (33.3%), CXR (33.3%) exams respectively. Also, cut films constitute the highest cause of reject for Pelvic (100%) and KUB (50%) examinations. Besides this, incorrect exposures OEX caused film rejection accounting for 16.7% (CXR), and 33.3% (Ext) examinations.

Bad positioning was the major cause of rejects for most of the rejected CXR examinations. HURH (28.13%), YH (33.3%), ADH (50%). But processing error is the major cause at BDH (55.6%). Cut film (15.63%), UEX (22.2%), Artifacts (33.3%), Movement (33.3%) were the second causes of CXR rejects respectively.

Figure 1 above shows that CXR is the common exam type repeatedly rejected at all the four hospitals, constituting the highest reject for this exam at YH (57%), and the lowest at ADH (33.3%). Spine (19%), KUB (14.5%), Spine (20%), Ext & Spine (each 16.7%) X-ray are the second type of exams rejected commonly at HURH, YH, BDH and ADH respectively. KUB (6%), Ext (0%), KUB (0%), were the least rejected X-rays at HURH, YH & BDH respectively. It shows there is variation in reject rate for each exam along the four hospitals. There were also additional exam types rejected at BDH (4.8%) which were not observed in the other three hospitals.

As indicated in Figure 2, the major cause of film reject at HURH are bad patient positioning, constituting 10 (21.3%), Beam alignment error (17%), and under exposure (17%), out of the rejected radiographs during the study period (47). The result from this graph indicates that the cause of film reject in the hospital is basically due to problems related to technologists' capacity. The major cause of film rejects at YH was bad positioning (23.81%), and artifacts (19%), in addition beam alignment problems take the third pale (14.3%). Processing related errors were not a problem in the hospital.

In addition, the result shows the main cause of film repeat at Bona Destrict Hospital (BDH) were processing error (30%) and under exposure (25%). But there was no film reject due to over exposure in the hospital. There are also films rejected due to other factors related to patient preparation and unknown reasons (10%).

Also, it can be seen that the main cause of film rejects at ADH were, Mal-positioning (38.9%), patient movement (27.8%), and beam alignment/cut films (11.1%). There were no films rejected due to artifacts and processing error in the hospital which can be related to the digital film processing used in the hospital.

As indicated in Table 3, on average 3.95% of the money was wasted in the hospitals per month due to film rejects. Considering the film size, the percentage of the wasted money is highest for 18 cm × 24 cm film size (14.6%) out of which 10.4% of the money was wasted at HURH. The second film size for which largest percentage of money wasted was 30 cm × 40 cm, for which 7.65% of the money used for this film size was wasted per month. Wastages in costs of processing chemicals, patient waiting time, human resources and other resources were not considered here which could raise the percentage wasted money.

Discussion

Reject film analysis is an important part of quality assurance program in a radiology department providing radiography services to ensure reduction in the factors responsible for film rejects and thus to reduce the cost, work load and radiation exposure to patients and personnel.

Out of the total 2,343 exposed radiographs within the study period, CXR was the frequently performed exam type with exposure rate of 1,561 (66.6%) in all of the hospitals, Ext 206 (8.8%), Skull 160 (6.83%) out of all exposures. There was also variation in film reject rate along the hospitals, although the average reject rate is within acceptable range, the result at BDH (10.2%) was above the limit which requires implementation of the corrections. The main causes of film rejects in the hospital were due to processing and under exposure. The results of the present study are similar to the report by [8,15], with reject rates of 4.94% (maximum of 10.5% at Zewditu Hospital), and 3.1% respectively. It was below the WHO criteria of 5% for HURH (3.5%) [10] and YH (2.8%). The small reject rate which is not realistic due to human nature and equipment failure at YH could be related to failure not to account for all the rejected films during data collection.

The results of the causes of film reject per exam type showed that there was a big variation for the causes of reject per exam type. Except for BDH, CXR were rejected because of wrong positioning accounting HURH (28.13%), YH (33.3%), ADH (50%). Pelvic and Lumbar exam were the type of exam with least reject in most of the hospitals. But, at BDH CXR were rejected mainly due to processing error (55.6%).

Previous studies reported the highest reject rate for CXR (27.5%) with over exposure (28.8%) as the main reason of rejection which could be attributed to performance of the X-ray machines [8], technical skill and training, followed by Skull radiographs (25.6%). Similar results were found by which it reported positioning as the main cause for CXR film rejects [16]. Faulty exposures (84%) and faulty positioning were reported to be the causes of CXR in the report in India by [17].

The result of our study revealed that CXR which contributed for most of the rejects, could be related to competence of the technicians or ignorance of the staff by letting the dark room technicians who can do chest radiographs through experience or newly employed radiographers who are made to do the chest exams in most of the hospitals.

In the three hospitals except for BDH, wrong patient positioning was the main reason for film reject, ADH (28.9%), YH (24%), HURH (21%). Exposure faults contribute to the second cause of film rejection in most of the hospitals; accounting for HURH (26% with UEXp (17%), YH (20%), BDH (25%, OEXp) but patient motion was the second cause at ADH (27.8%). The current results are in conformity with previous studies which reported that exposure faults & patient positioning are among the main reasons for repeat of the examinations [18-21]. The reject rates found in this study is comparable with these studies which reported a reject rate of 7.6% to 27.6%.

Thirdly, cut films were the causes of film reject at HURH (17%) and BDH (25%). Studies have shown that most radiographs are rejected because of wrong patient positioning, patient or equipment motion and also the selection of the wrong exposure factors [22]. There is no doubt that radiographic errors as well as poor equipment performance can contribute significantly to the need for film retakes.

Processing problems at BDH, for CXR exams might be related to untrained DR technician in the room, low experience, absence of regular QC, which could also be a problem with the processing errors related to uncontrolled temperature of fixing and developing chemicals, fixing and developing time, and regular monitoring of chemical concentration. It was shown on the study in Sudan by that for the film repeat related to processor error implementation of corrective actions after FRA resulted in reduction in repeat rate by factor of 4.23 [21].

Also, a reject rate of 5% to 10% at ADH justifies continued monitoring where as a reject rate of more than 10% at BDH (10.6%) is unacceptable which is above both WHO's recommended permissible limit (5%) and CRCPD's limit (10%). Therefore, the dose to the patients and the public should be kept ALARA by reducing the repeat rate.

Also, radiographs which must be repeated represent additional costs as a result of increased personnel waiting time. The unnecessary percentage of wasted money due to rejects, results in an increased burden on the waiting room and support staff. Since the results of a RAP indicate the effectiveness of the QAP, representing the overall quality efforts of everyone, the results of the RAP from the current study should be communicated to all of the technologists in terms of the overall reject rate at their institution, and perhaps relative to the national averages where appropriate. In addition, such results can also be used to demonstrate the effective efforts of all personnel in the department in reducing the number of rejected or repeated films.

The results of the current study also suggested that the highest percentage of the money wasted (14.6%) was observed to be that of 14 cm × 24 cm film size. This could be because of large number of films for the lower age group in the study. The overall percentage of the money wasted was 3.95% (17964ETB/Yr) for the three hospitals using manual film processing. It is big amount of money compared with the result obtained by the study in Addis Ababa by (4.95% or 10972ETB/Yr) which indicates there a big gap in resource utilization [8,15]. In developing countries like Ethiopia, where there is no enough budget and resources, this would be the case for most of the Ethiopian hospitals. Also, if the costs of chemicals and other resources were considered this would be a higher figure. Ineffective QAP and inadequate regular staff training form a possible explanation for observed waste films which could have been avoided.

Presence of simple QAP like FRA in all the hospitals in Ethiopia in addition to introducing/replacing digital radiography by computerized radiography, could contribute to reduction in wasted money, and patient dose, which was also supported by different studies in the literature.

As shown in the literature, there is clear evidence that reject analysis is efficient tool for optimization of radiation protection of the patient. Without a need of costly QC tools, it can be used to improve quality of diagnostic radiology department, reducing unnecessary patient exposure and reducing costs.

Awareness and motivations of staff by proper training will play an important role in patient dose reduction. Such technique is of particular importance to radiology department in developing countries.

It has been established that, poor image quality produced by the X-ray unit results in inadequate information on anatomical site pathology for radiologists to interpret results of the examination. It therefore provides an extra cost for patients and finally unnecessary exposures which could be harmful to the patient and could also have been avoided. Quality image radiographs are found to depend on quality control measures, proper selection of technique factors during exposures and patient position. The study indicated that radiography errors (bad positioning & cut films), and wrong exposures are related to competence of the technicians and equipment problems. This could be because of the regular quality control habits of the equipment and on job training for technical personnel related to quality assurance programs. It is therefore recommended that; a review of the rejected films should be made on periodic basis as part of the overall quality assurance program of the hospitals in order to identify the magnitude of the problem and also to determine the causes.

Conclusion

An analysis of the reasons for film rejects at the four governmental hospitals in the study between March & April, 2016 showed that bad positioning, exposure faults and beam alignment problem were important problems of film reject in the hospitals. It has shown that the main causes of reject in almost all the hospitals was due to human and equipment errors which needs a serious attention. These errors made a significant contribution to the high prevalence of poor image quality and radiation exposure. This influence on film rejection were observed significantly in CXR examinations and apparently an evidence of improper patient instruction, the difficulty in selecting appropriate exposure factors was observed to be a source of majority waste films which implies unjustified dose to patients. The big reject rates in the pediatric age group require serious need for justification of practices in the departments. Equipment problems related to cut films and exposure fault require continuous quality assurance practices, which could be achieved through simple FRA. The wrong positioning causes related to competence of operators, needs a serious attention for implementation of on job training to upgrade their knowledge related to positioning.

Limitations of the Study

Problems were encountered with the integrity and consistency of the data that was collected from the hospitals. These problems resulted from the combination of factors. The natural tendency to mask poor quality practice or the lack of consistency of the staff to follow the procedure to mark or classify rejected images.

The same people should analyze the films each time since different individuals will have different criteria for judging a good film, whether a good film is too light or too dark, whether a film was retaken due to motion or position, and so on. May be in some institutions, technologists take their repeat films home with them for disposal while film reject analysis was going on. In addition, staff members do not cooperate fully and reject film records may not always kept up to date. It was difficult to get the digital data of rejected films at Adare Hospital which could easily be deleted by operators affecting the sample.

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