

Use Of Reject-repeat Analysis In Patient Radiation Dose Optimisation In Diagnostic Radiology

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ABSTRACT

Background: In conventional radiography units, rejected x-ray films often ended up being repeated, thus adding further radiation dose to patients. Reject-repeat analysis has been shown to be one of the techniques used in optimization of patient dose in radiography.

Objective: To audit x-ray film reject-repeat in the department of Radiology, Aminu Kano Teaching Hospital (AKTH), Nigeria, in order to establish a base line with which subsequent patient radiation dose optimization programme could be based.

Methods: The study used records on the number of radiographic examinations performed and the number of repeated films in the department of Radiology, AKTH, between January to August, 2007. Reasons for reject/repeat were classified into four groups : Exposure problems, Film handling problems, Patient's fault and problems due to positioning.

Results: A total of 8140 x-ray examinations were performed within the study period and the repeat rate was 7.1%. The major reason for repeat was related to poor patient positioning which accounted for 70% of the total repeats. Improper film handling, exposure problems and patient's fault recorded 23%, 6.1% and 1.4% respectively.

Conclusion: To optimize patient dose in radiography, there is a need for further research to find out the actual cause of poor positioning problems from the side of radiographers. There is also a need for conversion from the conventional wet processing to computed radiography/day light processing of x-ray films in our radiography units.

Keywords: Radiation exposure, Reject-repeat, X-ray film.

INTRODUCTION

X-rays are electromagnetic radiations emitted when fast moving charged particles (electrons) are stopped as in x-ray tube. These x-rays are penetrating to the extent that they can pass through human body and cannot be absorbed completely. They are ionizing radiations that can produce charged particles (ions) in materials that they strike.

One of the aims of radiation protection is to reduce radiation dose to a value which is as low as reasonably achievable (ALARA) consistent with achieving the maximum benefit, which the use of ionizing radiation can produce. In its recommendation 26, the (International Commission on Radiological Protection) ICRP states that radiation protection is concerned with protection of individuals such as patients and staff , their progeny and mankind as a whole.¹

X-ray films that are rejected by the reporting radiologist or sorting radiographer due to poor image quality in a typical radiology department usually end up being repeated and this constitutes additional source of radiation exposure to patients. In order to facilitate optimization of patient dose, the dose needs to be quantified and the two dose assessment quantities frequently used are entrance surface dose (ESD) and dose area product (DAP).² DAP meters are traditionally used for fluoroscopic and more complex examinations, whereas ESD is used for simple plain radiography examinations. ESD is traditionally measured using thermoluminescence dosimeters (TLD's) or using complex mathematical formulae in a computational methods.³ Apart from the above quantification techniques, appropriate use of radiation dose reduction techniques in radiography usually assessed through routine x-ray film reject-repeat analysis auditing programme has been shown to be useful in optimization of patient dose.⁴⁻⁷

This study was carried out to audit the X-ray film reject/repeat over a period of time in the department of radiology, Aminu Kano Teaching Hospital (AKTH) in order to establish a base line with which subsequent radiation dose optimization and cost reduction programmes could be based.

MATERIALS AND METHODS

Records on the number of all radiographic investigations carried out in the department of radiology, AKTH, between January to August 2007 were retrieved and classified by the type of the examination performed based on the anatomical region of the body imaged. The total number of films per type of examination rejected and repeated on account of poor quality were also retrieved. Reasons for repeat were classified into four groups : film handling faults, patient's fault (such as inability to obey or understand instructions), exposure problem and positioning problem. Films are usually repeated on the order of the reporting radiologist or the sorting radiographer, usually a senior radiographer.

Views taken and included here are usually the routine ones, such as PA chest, AP and Lateral skull, AP and Lateral neck, AP and Lateral spine, AP and Lateral extremities, AP and both obliques of jaws and OM, frontal and Lateral views for the sinuses. Special views such as obliques and modified views were not included in this study.

Conventional manual and automated wet processing methods using dark room system, was used in processing the films. The equipment used

are either static (Easy Diagnost, Philips) or mobile (Watson, rotating anode) units. The later equipment was utilized when doing extremities, while children and the rest of the investigations were done with the static equipment.

RESULTS

A total of 8140 x-ray examinations were performed within the 8months study period. The most commonly performed investigation was chest x-ray 59.7% (4860 out of 8140), followed by extremities 14.9% (1214 out of 8140). The least performed are the x-ray pelvis and abdomen (1.8 and 1.6% respectively). 574 examinations were repeated in this study with overall repeat rate of 7.1% (574 out of 8140).

Chest x-ray being the most frequently performed study has the highest repeat rate of 81% (465 out 574) followed by extremities 5% (29 out of 574). The highest number of repeat was recorded in the month of February (Table I).

Repeat radiographs due to problems related to patient positioning ranked highest 69.5% (399 out of 574) among other reasons for repeat. This is followed by factors due to film handling 22.9% (132 out of 574). In children below 5years of age, positioning problem is the major cause for repeat. Most repeats were recorded in adult age group (Table II).

DISCUSSION

Justification of radiological requests, standardization of procedures and optimization of protection measures are the key principles in the protection of individuals exposed to ionizing radiation for diagnostic purposes. The overall repeat rate of 7.1% reported in this study is within the range quoted by different authors under different settings⁵⁻⁷ while using conventional means of film processing. For the fact that chest x-ray is the most frequent examination performed in this study, it is also not surprising that it accounted for most of the films that are repeated.

Digital technology has perfected all facets of human life including radiography where images are captured, transferred and interpreted in their soft copies. Most developing countries still rely on the use of hard copy images⁸ with its attendant numerous sources of poor image quality, such as in the area of film handling in the conventional dark room system. Cold weather which is commonly experienced at its peak in the months of January and February in the area of this study is known to cause

poor image quality in the conventional wet dark room system. This may perhaps explain the highest rate of repeat noted in the month of February in this study where wet method of film processing was used throughout the study period.

Geometrical and collimation defects which often result in off-centered and thus malpositioned radiographs remain an unsolved problem both in conventional and digital radiography systems.^{5-7, 9-11} In this study like many other similar ones, positioning problem accounted for 4/5th of all the repeated films and it is thought to be related to the type of equipment used, that is either mobile equipment with no attached bucky or a static unit with the bucky standing most often separate from the main unit. To solve this problem, it is necessary to have a design which will ensure that the x-ray tube is always connected to the cassette holder in a rigid and stable way, providing precise and simple centering of the x-ray beam.

It was probably in view of this background among other things that the World Health Organization (WHO) in 1985 developed the Basic Radiological System (BRS) modified a decade later to become the WHIS-RAD (World health imaging system for radiography) whereby the x-ray is supported on a column with a tube-arm on a single floor-column with a rotating arm that supports the x-ray tube and the cassette holder. This model requires minimal attachment to the wall and is easy and quick to install. No separate chest stand is needed.¹² The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) emphasized that, risks from exposure to ionizing radiation are dependent on the age of the patient at which exposure occurs, and that exposures during childhood results in a likely two-to-three fold

increase in life time risk for certain detrimental effects, compared with that in adults.¹³ Throughout this study, local policy of imaging children using high powered static x-ray units that have very short exposure time were strictly used. This translates to the low rate of repeat seen in the age group 0-15years (0.2%) due to patients fault (motional blurring) in our study (Table II).

Pervious reports have shown marked reduction of repeat and hence reduced patient dose on conversion from conventional to digital system,¹⁴ which has a high exposure tolerance. Thus, where affordable, it is hereby recommended for radiography units in developing nations.

From the foregoing, it is obvious that to achieve significant patient dose reduction, there is a need for radiography units in developing countries to start thinking of shifting from the old wet system of film processing to computed radiography (CR) system, which is relatively cheaper and less complex for the available infrastructure in developing countries. Also, where digital system is not affordable, we advocate the incorporation of the WHIS-RAD system of the WHO as part of the radiography equipment packages of our tertiary hospitals. This is in addition to a call for adequate training of radiographers and further research on the causes of poor positioning in our day-to-day radiography.

Reject-repeat analysis is a useful pointer to the sources of additional radiation exposure to patients and excess departmental wastages and costs. The knowledge of these sources could assist radiography departments in mapping out future patient dose optimization and cost reduction programmes.

Table I : Monthly Repeat Cases Per Type Of Examination

S/N	Type of Examination	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Total
1.	Chest	69	70	59	46	47	52	64	58	465
2.	Sinuses	1	6	7	1	1	1	0	3	20
3.	Jaws	2	0	2	1	2	0	1	0	8
4.	Skull	1	1	0	2	3	0	2	1	10
5.	Post N/Space	1	1	3	0	1	0	1	3	10
6.	Spine	1	10	0	1	1	0	3	1	17
7.	Abdomen	1	2	1	0	0	0	1	0	5
8.	Pelvis	1	1	0	0	0	0	0	1	3
9.	Contrast Examinations	2	2	1	0	0	1	0	1	7
10.	Extremities	0	0	5	2	5	4	7	6	29
	TOTAL	79	93	78	53	60	58	79	74	574

Table II : Reason For Repeat By Age

Age Groups (Yrs)	Exposure (%)		Positioning (%)		Reason For Repeat Patient's Fault (%)		Film Handling (%)		Total
0 – 5	8	(1.4%)	29	(5.1%)	0		8	(1.4%)	45
6 – 10	1	(0.2%)	12	(2.1%)	1	(0.2%)	3	(0.5%)	17
11 – 15	0		10	(1.7%)	0		3	(0.5%)	13
>15	26	(4.5%)	348	(60.6%)	7	(1.2%)	118	(20.6%)	499
TOTAL	35	(6.1%)	399	(69.5%)	8	(1.4%)	132	(22.9%)	574 (100%)

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