ORIGINAL ARTICLE

QUALITY CONTROL IN RADIOLOGY UNITS OF TERTIARY HEALTHCARE CENTERS IN NORTH EASTERN NIGERIA

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ABSTRACT

Background of the Study: Apart from deterioration due to aging, very often lead aprons are damaged due to poor handling. Without quality control these lead aprons will, with time contribute significantly to radiation burden of the wearer.

Purpose: The purpose of this study was to evaluate the protective feature of lead aprons used in radiology department performed at federal public hospitals by analysing quantitative and qualitative variety of methods including objective quality control.

Materials and Methods: Forty seven (47) protective lead aprons used in Radiology departments was analyzed. All aprons were identified and registered according to types, thickness of the lead inside the aprons or its equivalent, by how long it has been used, its storage conditions and cleanliness. Radiographs of the aprons were taken using X-ray units and (35cm X 43cm or 35cm X35cm) films or phosphor storage plates. The radiographs were evaluated in terms of holes, cracks and other defects that were contained in their structures. Measurement of sizes of defects were taken using ruler and compared with standard rejection criteria.

Results: regarding their internal structures, 31 (65.96%) aprons were not defected (free of defect) and 16 (34.04%) were defected. Cracks accounted for 9(56.25%) and hole 7(43.75%) of the total 16 defected lead aprons. And regarding quality control, only 9% of the aprons were periodically checked on annual basis and 72% of the lead aprons were not checked at all. It was also observed that 31(66%) of the lead aprons were clean, 10(21%) of the aprons were slightly dirty and 6(13%) were quite dirty.

Conclusion: Radiation protection, storage and hygiene practice of a substantial number of aprons were ineffective and inappropriate. Hence, this implies lack of commitment and compliance to lead aprons' quality control (QC) at the centres studied.

Keywords: Lead aprons, Quality control, Radiation protection and Evaluation.

INTRODUCTION

It is widely known that radiation exposure may cause deterministic and stochastic effects (e.g cancer and genetic effect). However it is not always possible to estimate how stochastic effect will affect the organism [1]. A stochastic effect is one in which the probability of the effect, rather than severity, increases with dose. It is the assumption that risk increase with dose and there is no threshold dose below which it ceases to exist [2].

It is necessary for radiation workers to take care of their own health first in order to offer proper health service to the patient. There are three principal methods by which radiation exposure to personnel can be minimized; Time, Distance and Shielding. In order to keep the radiation dose received by the radiation personnel under normal working condition as low as reasonably achievable (ALARA), lead apron and thyroid shields are valuable [3]. Lead apron is an expensive protective material that should be kept in good condition for as long as possible.

Apart from deterioration due to aging, very often lead aprons are damaged due to poor handling, such as tears, holes, thinning creases and cracks [4].Without routine control these lead aprons will, with time contribute significantly to radiation burden of the wearer [3]. Lead aprons used in medical facilities should be tested annually or as required under existing regulation or accreditation programs and when damage is suspected as a quality control [5].
It is against this backdrop that this study is aimed at evaluating the protective features of lead aprons used in radiology departments in federal government hospitals in northeastern Nigeria.

MATERIALS AND METHOD

A cross Sectional, prospective study design was adopted for this research. A Population study of forty-seven (47) lead aprons was used, due to the limited number of available aprons in area of study. This consisted of all lead aprons used in radiology department at federal government hospitals in northeastern Nigeria. The hospitals are tertiary-care centres with various departments and well trained personnel in different aspects. They serve patients from within the states, region as well as neighboring countries. All lead aprons that were used in the departments met the inclusion criteria while those not in use and non-lead aprons were excluded from the study. Ethical approval was obtained from the various departments.

Instruments

Forty seven (47) protective lead aprons, X-ray units (Models; Dynamax HD 50D, GE Haulum Medical System 5189248, Siemens Mobilett Plus 6215300x037E, IMD Basic 4006, GE Medical system HF- 525, GE Medical system MS-185Pioway X -ray machine DX51-20.40/100 and GE Haulum) and (35 X 43cm or 35X35cm) films or phosphor storage plate, Ruler and data capture sheets.

Method of data collection

Forty seven (47) protective lead aprons used in Radiology departments were analyzed. All aprons were identified and registered according to type, thickness of the lead inside the aprons or its equivalent and by how long it has been used.
Qualitative evaluation (Visual Inspections) was performed to check the Surface covering for tears or signs of deterioration, feeling for crack, cleanliness, apron hanger devices (storage) and all seams where appropriate as in Lioyd,[5].

Then, quantitative assessment was performed; radiograph of the aprons were taken using X-ray units and (35cm X 43cm or 35cm X 35cm) films or phosphor storage plate. The parameters used were 70kVp, 20mAs and 110cm focus-film distance (FFD). The radiographs were evaluated in terms of holes, cracks and other defects that were contained in their structures and measurement of sizes of the defects were taken using ruler as used by Oyar and Kislaliglu,[1].

Method of data analysis

The data was classified according to defectiveness (defective or not defective), Rejection Criteria present (i.e.) need for replacement (rejected) or not present (accepted) as shown in table 4. Adopted from [6,7]. And also assessed base on cleanliness (clean, slightly dirty and quit dirty), and protection conditions (if the apron is been racked properly or not). Data was analysed using Microsoft Excel 2007 where frequency and percentages were generated and results presented in tables and figures,.

Table1: Rejection criteria for defects in lead
(Duran and Phillips, 2003)

Type of Apparel	Regions	Total or Aggregate Area
Lead apron with separate thyroid shield	Whole-body	10 cm^2
	Reproductive region	0.2 cm^2 or 20 mm^2
Lead apron with built-in thyroid shield	Neck region	1 cm^2

RESULTS

Forty-seven (47) lead aprons were evaluated, 12

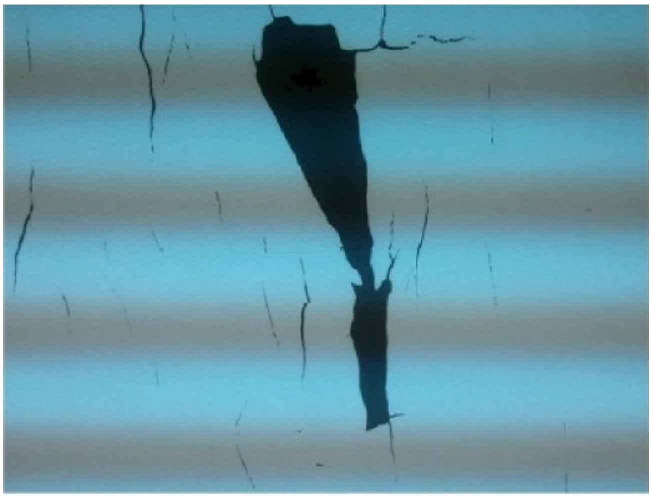
(25.5%) of the lead aprons were from Teaching hospitals, 32 (68.1%) were from Federal Medical Centres and 3 (6.4%) were from Federal Neuropsychiatric Hospital. Of the 47 lead aprons 14 (29.8%) were 0.5mm lead equivalent, 31 (66.0%) were 0.35mm and 2 (4.3%) were 0.25mm. 14 (29.8%) of all the lead aprons were new (less than one year) while the remaining 33 (70.2%) were more than one year. Of all the 47 lead aprons, none had the build in thyroid shield, as shown in table 2.

Table 2; General Information on the Overall features of the Lead Aprons Evaluated

GENERAL INFORMATION n =47	
VARIABLE	n (%)
HOSPITALS	
Teaching Hospitals	12 (25.5%)
Federal Medical Centres	32 (68.1%)
Federal Neuropsychiatric Hospital	3 (6.4%)
LEAD EQUIVALENT (mm)	
0.5	14 (29.8%)
0.35	31 (66.0%)
0.25	2 (4.3%)
STATUS	
New (less than one year)	14 (29.8%)
Old	33 (70.2%)
TYPE OF LEAD APRON	
With build in thyroid shield	0 (0%)
Without thyroid shield	47 (100%)

Quantitative assessment, shows that 31 (65.96%) of the total lead aprons were not defected (free of defects), while 16 (34.04%) accounted for defected (showing various degree of defects ranging from; cracks, holes or both on their internal structure). The highest, intermediate and lowest frequency of the defected and non-defected were 0.35mm, 0.5mm and 0.25mm lead equivalents respectively, as shown in table 2

Figure 1 Radiograph showing Cracks defect on lead apron.



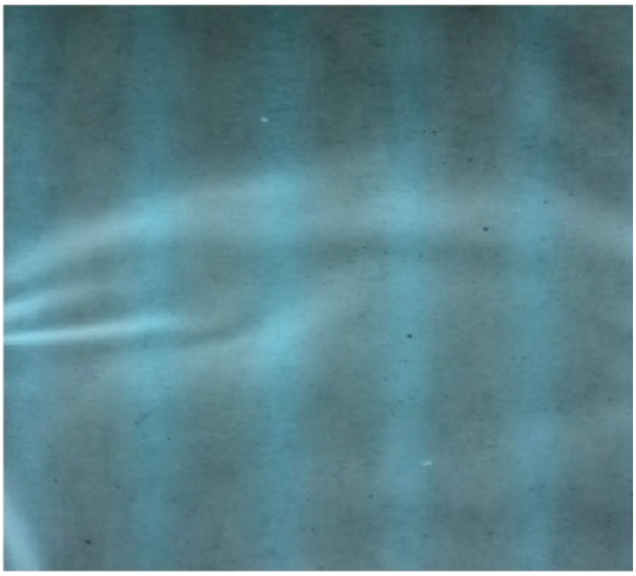


Figure 2 Radiograph showing hole defect on lead apron

As shown in table 3, the common defects found by the quantitative assessment on the lead aprons were cracks and holes. 9(56.25%) of the total 16 defected lead aprons were cracks, which also accounted for 4 (44.44%) and 5(71.43%) of accepted and rejected defect (defect that met rejection criteria) respectively. Holes were represented by 7(43.75%) of the total defects, 5(55.56%) and 2(28.57%) of accepted and rejected defects respectively.

Figure 3 Radiograph of lead apron without any defect.

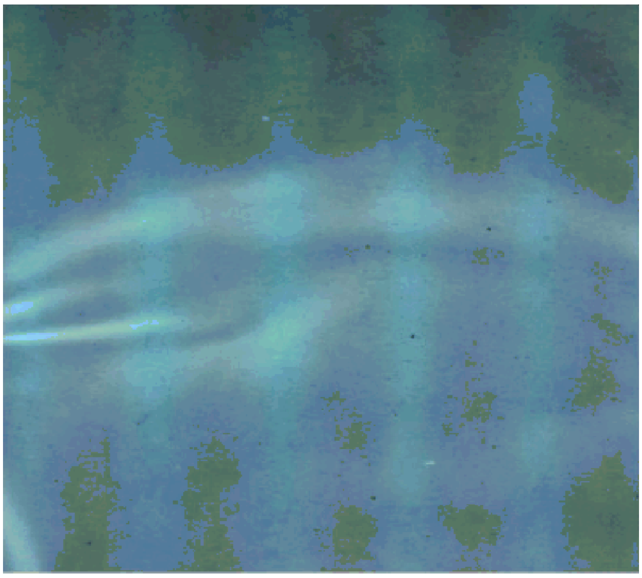


Table 3

Protective feature of lead aprons with respect to lead equivalent.

Figure 4 shows that 9% of the evaluated lead aprons were periodically checked (quality control) on an-

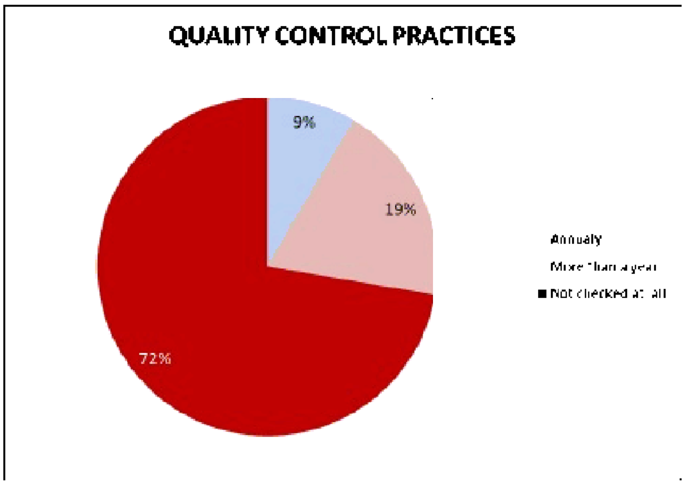
LEAD APRON'S STATUS	NUMBER OF LEAD APRONS			TOTAL
	0.35mm (lead eqv)	0.5mm (lead eqv)	0.25 mm (lead eqv)	
DEFECTIVE	12 (25.53%)	4 (8.51%)	0 (0%)	16 (34.04%)
NOT DEFECTIVE	19 (40.43%)	10 (21.28%)	2 (4.26%)	31 (65.96%)
TOTAL	31 (56.96%)	14 (29.79%)	2 (4.26%)	47 (100%)

nual basis, 72% represent the lead aprons that were not checked at all, and lead aprons that were checked but not periodic and in more than one year accounted for the remaining 19%.

Table 4: Types of defects fund in the lead aprons with rejection criteria.

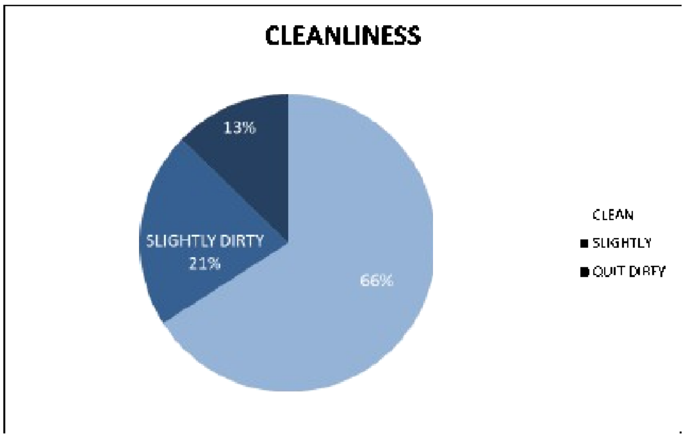
Figure 4. Pie chart showing periodically checked lead aprons.

TYPES OF DEFECT	ACCEPTED	REJECTED	TOTAL
Crack	4 (44.44%)	5 (71.43%)	9 (56.25%)
Holes	5 (55.56%)	2 (28.57%)	7 (43.75%)
TOTAL	9 (100%)	7 (100%)	16 (100%)



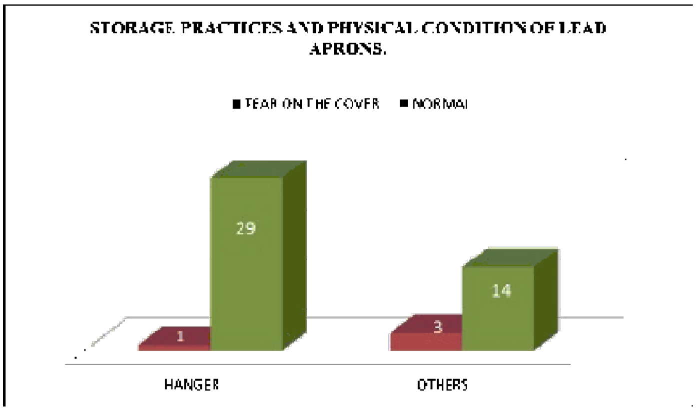
In qualitative assessment, It was observed that 31 (66%) of the lead aprons were clean, 10(21%) of the apron were slightly dirty and 6(13%) were quite dirty as shown in figure 5.

Figure 5: Pie chart showing cleanliness conditions of lead aprons



Qualitative result regarding the storage and physical condition of aprons, found that 30 of 47 total aprons were stored in good condition using hanger, and only 1 has tear on the cover. And 17 were stored using other methods, as shown in figure 6.

Figure 6 chart showing storage method of lead aprons and their physical conditions.



DISCUSSION

Lead apron is a protective garment that is designed to shield the body from harmful radiation, usually in the context of medical imaging [8].At least once annually, Quality control is necessary to ensure that the lead aprons provide optimal protection when positioned appropriately [9].

Following the evaluation of 47 lead aprons, the result in table 6 shows 31(65.96%) were normal in terms of internal structure (without defect). And 16 (34.04%) were defected, of which 9 were usable, only 7 aprons representing 14.89% of the total aprons met the rejection criteria as shown in table 7. This result differ from the one conducted by Oyar and Kislaliglu,[1] which shows high percentage of defected aprons 58(68.2%), the difference may due to sophisticated equipment used for their study.

In the study conducted by Oyar and Kislaliglu, [1] they found that crack was the major defect with frequency approximately double to that of holes. The result in this study, also found the same but the crack accounted for (56.25%) of the defects with no much difference from that of holes (43.75%) as shown in table 7.This difference could be attributed to the difference in storage pattern of lead aprons as some of the centres studied do not have recommended hangers for lead aprons as shown in figure 6.

Even though there is much emphasis on quality control in different publications, such as CRCPD, [9]; WHO,[5], there is lack of commitment to lead aprons' quality control at the hospitals where the study was conducted, as shown in figure 4; 72% of the total aprons were not checked at all, only 9% of the aprons were checked regularly.

Hygiene practice (cleanliness) was highly observed in the hospitals where the study was carried out, as in figure 5; 66% of the total aprons were clean, only 13% aprons that were quit dirty.

CONCLUSION

We have been able to establish from this study that, substantial number of lead aprons used in the study setting was defected and the common defects found on the lead aprons were cracks and holes. Radiation protection, storage, physical condition and hygiene practice of a considerable number of aprons were ineffective and inappropriate. Hence, there is lack of commitment and compliance to lead aprons' quality control (QC) at radiology units. This can be improved by regular monitoring by regulatory agencies such as the Nigerian Nuclear Regulatory Agency to ensure compliance.

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