THE LEVEL OF COMPLIANCE OF SELECTED NIGERIAN X-RAY DEPARTMENTS TO EUROPEAN GUIDELINES ON GOOD RADIOGRAPHIC TECHNIQUES

Bamidele L.[1] & Nworgu O.D.[2]
[1]Department of Mathematics & Statistics, Osun State College of Technology, Esa-Oke.
[2]Department of Physics, University of Benin, Nigeria
E-mail: bam07ng@yahoo.com

ABSTRACT
European directive (particularly the directive 97/43/EURATOM) and the various publications of Commission of European Communities (CEC) may be considered as landmarks of the new approach to the problems of dose reduction and quality in diagnostic radiology. The CEC publication includes examples of good radiographic technique for a number of common X-ray examinations, which if these guidelines are followed, compliance with dose and image quality criteria as specified in the document should be demonstrated. Studies in some countries have shown that a number of X-ray departments are not using optimum techniques. This study aimed at examining level of adherence of some selected hospitals in Nigeria to the CEC guidelines. Four hospitals were considered in the study, three of which are University Teaching Hospitals and Public Hospital. The following details on techniques and equipment were recorded for chest, abdomen, pelvis, skull and lumber spine examinations of standard sized patients: tube potential (kVp), focus-to-film distance (FFD), automatic exposure control (AEC), film-screen combination. From the study, varying level of adherence to guidelines were evident, with no hospitals demonstrating 100% compliance.

1. INTRODUCTION

The radiation protections of patient undergoing medical X-ray examinations is governed by principle of justification and optimisation. It is concerned with the control of the manner in which sources of ionizing radiation are used so that in the use of the sources, members of the public are not irradiated above acceptable levels [1]. Hence, good radiographic technique is necessary to reduce level of exposure and risks from diagnostic procedure.

In order to achieve appropriate radiographic techniques the Commission of European Communities issued the "European Guidelines on Quality Criteria for Diagnostic Radiographic Images", a publication which includes examples of good radiographic techniques for a number of common X-ray examinations; that if adhered to, should demonstrate good compliance with image and dose criteria [2]. In Nigeria, to promote the optimization principles, it is necessary for X-ray Departments to examine their work practices, assess the level of adherence to CEC guidelines, identify areas where less than optimal techniques exist, and implement recommendations.

Studies in Ireland, England, Germany, Greece and Sudan have shown that a number of X-ray Departments are not using optimum techniques [3],[4],[5],[6]. In the present study the radiographic techniques employed in six X-ray departments of four public hospitals in Nigeria were examined. Variations in techniques were recorded and compliance with CEC guidelines were examined.

2. MATERIALS AND METHOD

The study was conducted in four public hospitals in southern part of Nigeria. They are Ladoke Akintola University of Technology Teaching Hospital (LAUTECHTH) Osogbo, Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Wesley Guild Ilesa, University of Benin Teaching Hospital (UBTH), Benin City and Central Hospital, Benin-City.

A total of five hundred and eighty (580) patients comprising 319 males and 261 females referred to X-ray departments between September 2008 and May 2009 were investigated. For each patient and X-ray Unit, the following parameters were recorded: sex, age, weight, Focus-to-Film Distance (FFD), anatomical area examined, film-screen combination, tube potential (kVp), and product of tube current and time (mAs).

Four routine types of (7 projections) of X-ray examinations were studied, they are: Posterior-Anterior (PA) Chest, Anterior-Posterior (AP) Abdomen, AP/PA Skull, Lateral Skull, AP Pelvis/Hip, AP Lumbar Spine, LAT Lumber Spine. Six X-ray machines from six X-ray rooms were considered: they included a 3-phase Siemens machine (at OAUTHC Ilesa), a 3-phase Phillips machine and 3-phase Neo diagnomas (at LAUTECH, Osogbo), a 3-phase Toshiba machine and a 3-phase Watson Stylos machine (at UBTH Benin-City) and a 3-phase Siemens machine (at Central Hospital, Benin-City).

All six X-ray rooms in the four hospitals were equipped with the three-phase X-ray machines using equivalent total filtration of 2.5mmAl. Quality Assurance (QA) tests were performed on each X-ray machine to determine the linearity and reproducibility of X-ray tube output. The tests performed showed that the kVp were within the acceptable limit of 10%.

3. RESULTS

The comparison for techniques employed in the four Nigerian hospitals with CEC Guidelines is shown in Table 1 below No hospital exhibited 100% compliance with CEC guidelines. Cases were observed in one hospital where FFD as low as 90cm was used for chest PA examination and also an FFD as low as 80cm was used for abdomen examinations.

Table 1: Comparison of Techniques Employed with Commission of European Communities (CEC) guidelines

Examination	Total no. of Departments	FFD		Use of AEC		Nominal Film Screen System Speed	
		CEC Guideline in (cm)	No. of Departments not achieving CEC guidelines	CEC Guideline	No. of Departments not achieving CEC guidelines	CEC Guideline	No. of Departments not achieving CEC guidelines
Chest PA	6	180(140-200)	2	Yes	6	400	6
Skull AP/PA	6	115(100-150)	2	Yes	6	400	6
Skull LAT	6	115(100-150)	2	Yes	6	400	6
Abdomen	6	115(100-150)	1	Yes	6	400	6
Pelvis/Hip AP	6	115(100-150)	1	Yes	6	400	6
Lumber Spine AP	6	115(100-150)	1	Yes	6	400	6
Lumber Spine LAT	6	115(100-150)	2	Yes	6	400	6

The figure in parenthesis indicate the minimum and maximum acceptable FFD distances.

Key: **FFD** - Focus-to-Film Distance **AEC** - Automatic Exposure Control
AP - Anterior-Posterior **LAT** - Lateral

All the four hospitals used a nominal film-screen speed of 200 for all examinations. These speeds were less than those suggested by the CEC.

Examination of the Mean Tube Potential chosen demonstrated inadequate levels for some projections. All departments employed values lower than 125kVp recommended in the CEC guidelines for Chest examination. They employed lower tube voltages within the range of 52kVp to 94kVp. For Pelvis/Hip examination, one hospital used tube potential of 100kVp which is higher than the value recommended in CEC Guidelines. Also for Lumber Spine AP, Lumber Spine LAT and Abdomen, five departments employed Tube Potentials within the range recommended in CEC Guidelines but one of the departments used tube potentials of 103kVp, 107kVp and 102kVp respectively, which are much higher than the recommended values. The Tube Potential (kVp) selected for each projection across all departments compared with the Commission of European Communities Recommendations is shown in figures 1-7.

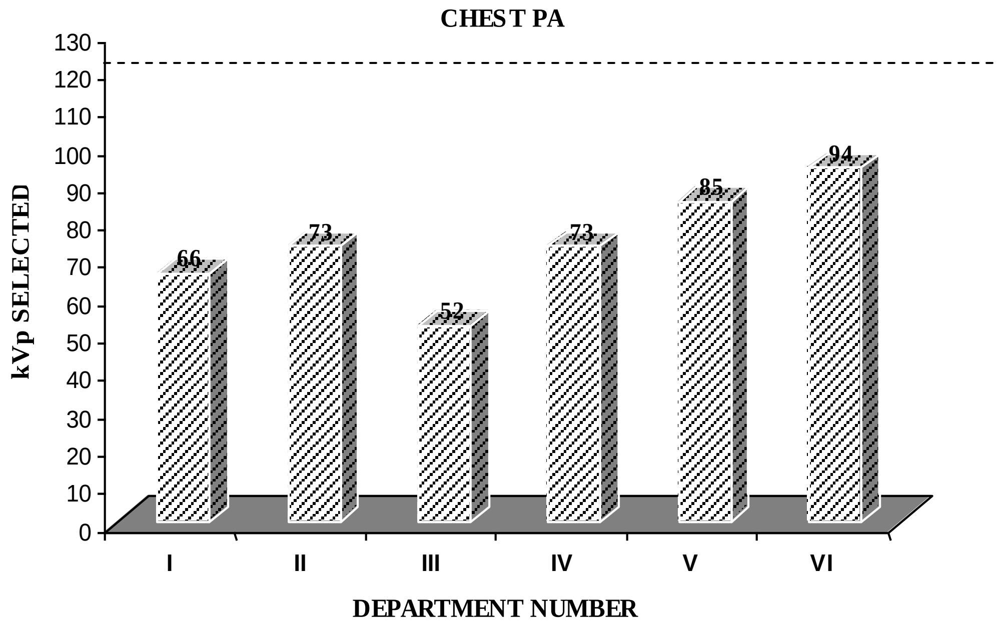

Fig. 1: Tube Potential (kVp) selected for Posterior-Anterior (PA) Chest Projection across all departments compared with the Commission of European Communities Recommendations in dotted lines.

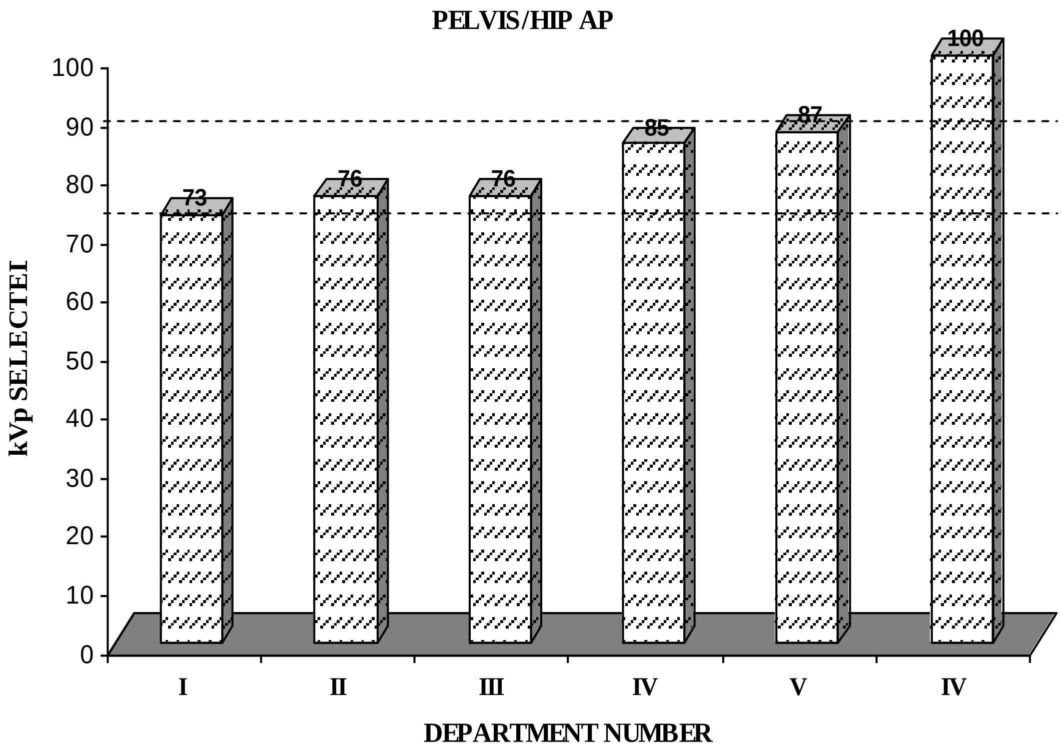

Fig. 2: Tube Potential (kVp) selected for Anterior-Posterior (AP) Pelvis/Hip Projection across all departments compared with the Commission of European Communities Recommendations in dotted lines.

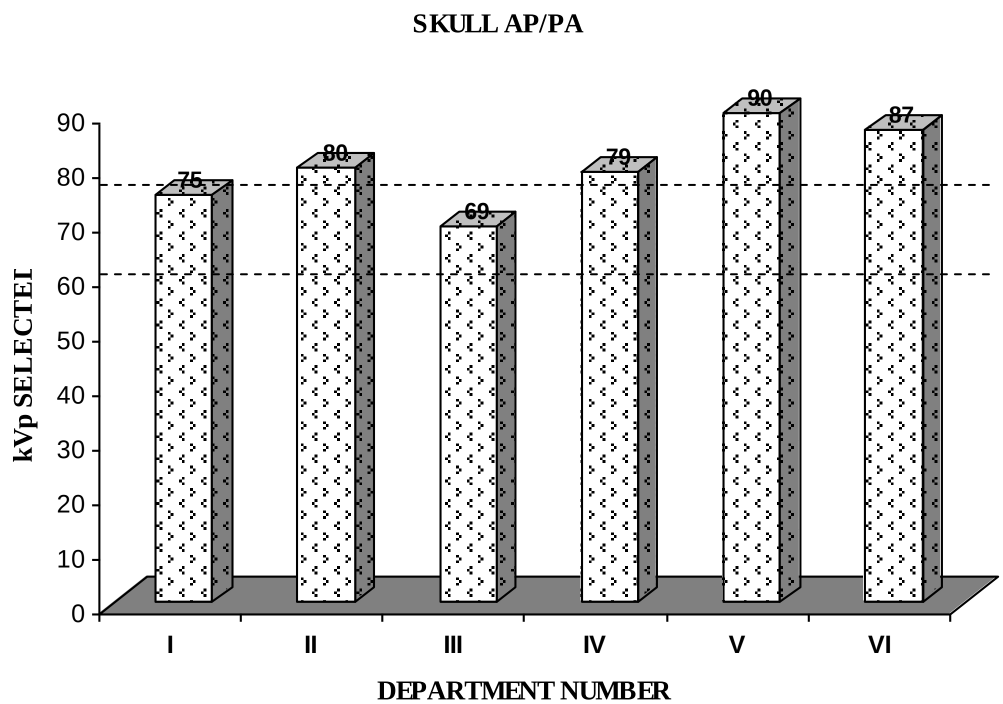

Fig. 3: Tube Potential (kVp) selected for Anterior-Posterior/Posterior-Anterior (AP/PA) Skull Projection across all departments compared with the Commission of European Communities Recommendations in dotted lines.

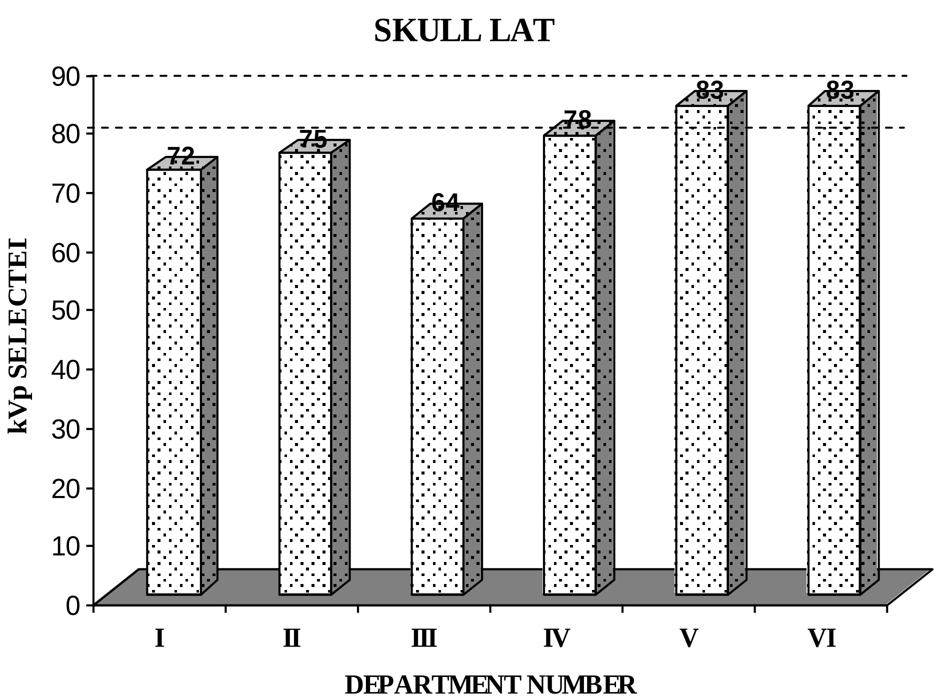

Fig. 4: Tube Potential (kVp) selected for Lateral (LAT) Skull Projection across all departments compared with the Commission of European Communities Recommendations in dotted lines.

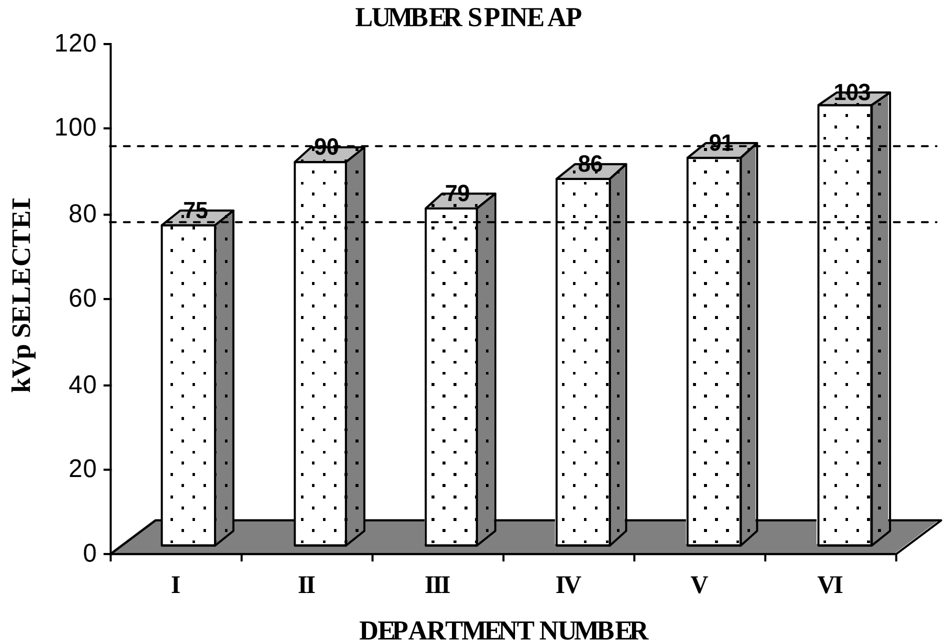

Fig. 5: Tube Potential (kVp) selected for Anterior-Posterior (AP) Lumber Spine Projection across all departments compared with the Commission of European Communities Recommendations in dotted lines.

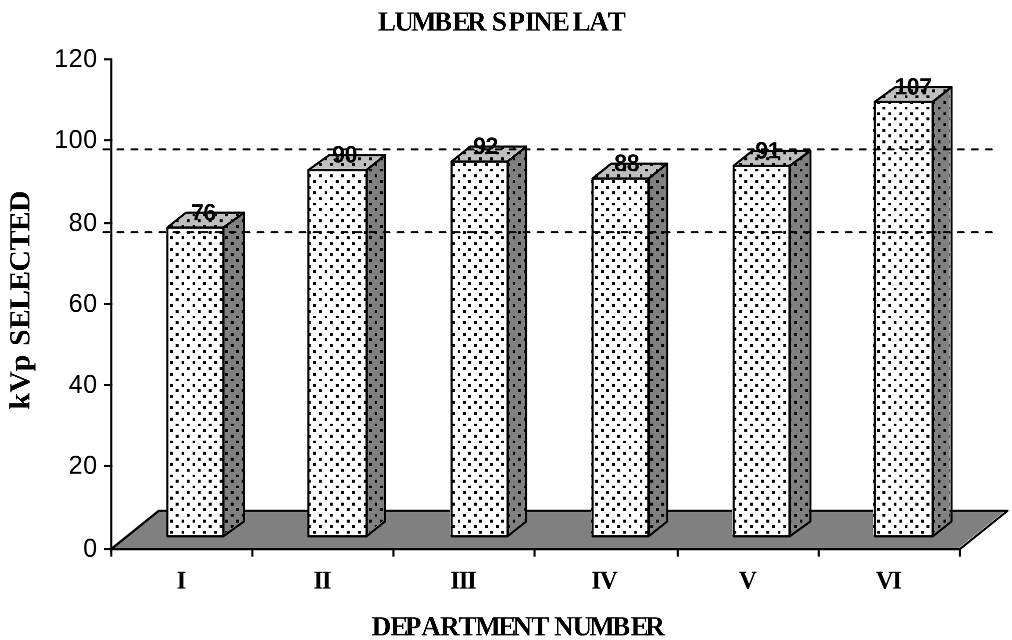

Fig. 6: Tube Potential (kVp) selected for Lateral (LAT) Lumber Spine Projection across all departments compared with the Commission of European Communities Recommendations in dotted lines.

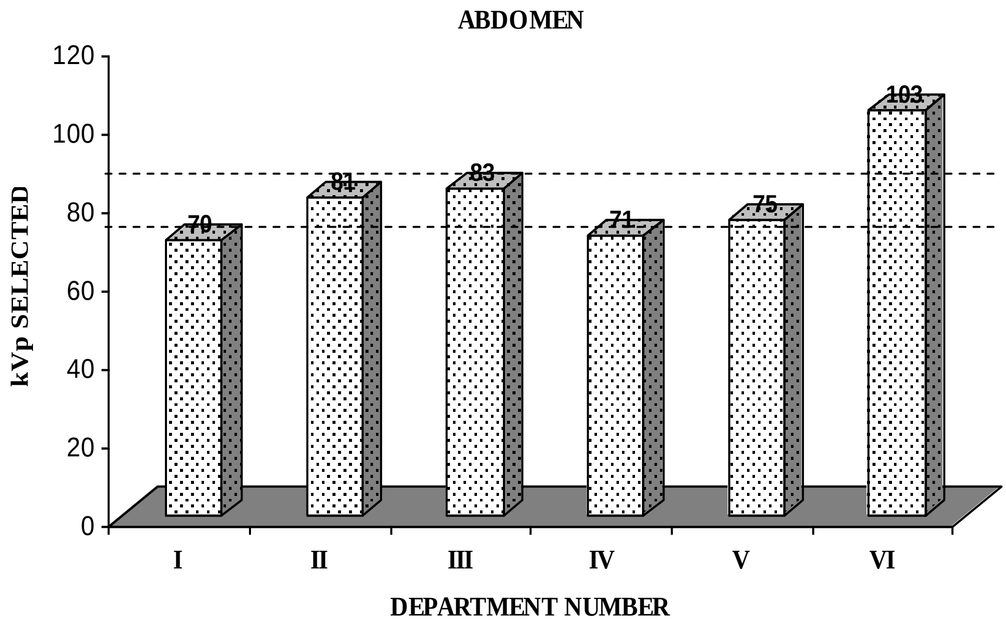

Fig. 7: Tube Potential (kVp) selected for Abdomen Projection across all departments compared with the Commission of European Communities Recommendations in dotted lines.

4. DISCUSSION OF RESULTS

The European and other international organizations are emphasizing the importance of appropriate Quality Assurance (QA) programme in diagnostics radiology in order to optimize the dose given to patients during X-ray diagnostics examinations. The Commission of European Communities described examples of good radiographic technique in its publication. Although, this publication is not intended to be a definitive set of instructions, guidelines are provided which, if adhered to should promote the optimization principle of producing images of good diagnostic efficacy at the lowest radiation dose. Previous studies have shown that adherence to CEC Guidelines have led to reductions in effective dose by up to 50% with no change in image quality.

In this study, examination of the techniques employed, namely FFD, tube potentials (kVp), AEC usage and choice of film screen speed combination in the departments under consideration showed varying levels of compliance with the CEC guidelines.

In the use of optimum FFD, all the departments showed varying levels of compliance with one department using FFD as low as 90cm for chest radiography and another department employed an FFD of 80cm which is lower than minimum level described in CEC Guidelines. The use of optimum FFD is considered very important, since a direct relationship between shorter FFD, higher patient's dose and decreased in geometric unsharpness is well established [7], [8].

The Tube Potentials (kVp) employed by the departments under consideration were inconsistent with the CEC Guidelines. All the departments employed tube potential below 125 kVp recommended in CEC Guidelines for Chest examination. Also one of the departments employed a high tube potential (≥ 100kVp) for Lumber Spine AP, Lumber Spine LAT and Abdomen respectively. The optimal tube potential in Chest radiography has received a considerable amount of discussion in the radiological literature [9], [10]. It has been shown that increasing the tube potential in Chest radiography from 60kVp to 90kVp will result in an Entrance Surface Dose (ESD) saving of 60% [11]. Also the use of high voltage technique for the Chest has been calculated to reduce effective dose equivalent by 20% [11], [12]. Therefore, the use of low tube potentials should be discouraged.

In this survey, all the departments used 200 nominal film-screen combination, this may be longest contributing factor for the higher ESD recorded in some departments since reduction in ESD with increasing speed of image receptor has been demonstrated in the UK [13], [10]. In the UK, the percentage of rooms with a mean speed greater than 200 rose from 23% for the 1986 NRPB survey [11] to nearly 80% for the 1996 UK Survey [13]. The change to a faster film-screen combination was probably the main factor in reducing the ESD by 30%-40%.

It is worthy to note that none of the departments in the study complied with CEC Guideline in AEC usage as all departments employed manual selection of the exposures. These may be due to equipment limitations.

The mean entrance surface dose for all the examination have been calculated using the recorded exposure factors. It was observed that dose values were within the recommended guidance level except in one hospital where a higher dose value of 0.4mGy was recorded for Chest AP, which is higher than the recommended value.

5. CONCLUSION AND RECOMMENDATION

In this study, varying levels of compliance with the CEC Guidelines on good radiographic technique were observed in all departments for Chest PA, Skull AP/PA, Skull LAT, Abdomen, Pelvis/Hip AP, Lumber Spine AP and Lumber LAT. All departments demonstrated non-adherence for at least one CEC recommendation, with no hospital demonstrating 100% non-compliance. Complete compliance to CEC Guidelines should be aimed at by all the departments for dose-reduction, particularly by paying close attentions to choice of FFDs optimum tube potentials and total filtration. These would facilitate lower radiation dose without affecting image quality.

6. ACKNOWLEDGEMENT

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