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Radiology: Developing an Exposure Chart for A Minxray Hf120/60hppwv/Powerplus^{tm}(Mobile X-Ray Machine)

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Abstract

Objectives: *The objective of this study was to develop a standard exposure chart for a MINXRAY HF120/60HPPWV/PowerPlus^{TM}which could be comfortably utilized for most mobile x-ray machines. It was highly relevant due to an alarming increase in trial method of exposure factor selection at most radiodiagnostic centres in the region.*

Methods: *This particular study considered 504 patients who presented for various radiographic examinations at a tertiary healthcare institution in Nigeria in preparing a standard x-ray exposure chart. A comprehensive list of exposure factors (Kvp, mA, s, grid, filtration) which provided useful diagnostic images was documented afterwards. Literatures on patient and exposure factorswereextensively reviewed inorderto obtain exposure factors for the different body parts.The utility of the chart was tested afterwards on the MINXRAY HF120/60HPPWV/PowerPlus^{TM}and another Powerplus 1260 mobile xray machine.*

Results: *A total of 504 patients were considered for this study. This included both adults and paediatric patients with 303 patients (60.11%) presenting with chest x-ray requests, 43 patients (8.53%) were for lateral oblique mandible x-ray and 24 patients (4.76%) were for ankle x-ray. Exposure chart generated was further tested on 214 patients who presented for various radiographic examinations and 95.33% accuracy was noted as there were 210 good quality radiographs and 10 poor quality radiographs.*

Conclusions: *This particular study has provided two exposure charts for a MobileXray machine. The first exposure chart for adult patients and a second exposure chart for paediatric patients.*

Advances in knowledge: *This study has developed a comprehensive x-ray exposure chart which can serve as a quintessential template for mobile xray machines worldwide.*

Keywords: Exposure factors, Kilovoltage, Tube Current, Exposure time

I. Introduction

The discovery of x-rays in 1895 by Wilhelm Conrad Roentgen (1845-1923) has been described as a remarkable achievement in the field of science[1]. Over the years, different types of diagnostic x-ray machines have been manufactured and the need to provide standard exposure chart which ensures that exposures are as low as reasonably practicable remains pertinent. Now, in order to reduce repeat rates and prevent unnecessary exposure of patients and radiation personnel to radiation, it is imperative to develop exposure charts or guides for all x-ray machines.

Why the need for exposure charts? In recent times it has been observed that most centres in Nigeria undertake radiographic examinations without exposure charts and this promotes a trialand error radiographic practice[16,18, 19]. The aim of this study was to provide a mobile xrayexposure charts and evaluate their utility within a tertiary healthcare institution in Nigeria.

An exposure chart or guide contains exposure factors which are the essential components of an X-ray Machine combined by a radiographer in order to produce radiographic images of the human anatomy. Each time a radiograph is to be produced, a set of exposurefactors has to be chosen to give the type of image required.The choice of these factors will depend on the region being examined, including its thickness, density, pathology, etc. The exposure factors to be selected are:

1.Themilliampere seconds (mAs);
 a. Exposure Time (seconds)
 b. Tube Current (mA)
2. The kilovoltage;

3. The FFD
4.Filtration and
5. Secondary radiation grid which is not part of the X-ray machine.

The exposure factors chosen will differ for different types of image-acquisition device and will depend on whether a grid is being used.[1]

II. Exposure Factors Considered In Conventional Xray Imaging

1.Milliampere Seconds

This indicates the intensity or simply, the amount of radiation being used. If the radiation has enough energy to penetrate the body, then it will be detected by the image-acquisition device and will determine the image density or, again put simply, the image ‘blackening’. The mAs is actually the product of the X-ray tube current (mA) and exposure time (seconds)[1].These are further explained below;

A.X-Ray Tube Current (Ma)

The unit of measurement for electric current is the Ampere (A). One thousandth of an Ampereis a milliampere (mA). The number of X-rays produced depends on the number of electronsthat strike the target of the X-ray tube. The cathode filament produces electrons and thenumber of electrons depends directly on the heating current applied to the cathode filament.The greater the number of electrons, the greater is the current flow (mA) across the tube andthe greater the number of X-rays produced.The amount of the current passing across the X-ray tube is in the milliampere range (50mA to1200mA). Changing the X-ray tube current does not affect the penetrating power and the greater the x-ray tube current, the greater the intensity of the xraybeam[3].There is a linear relationship between mA and the amount of X-rays produced. If the mA isdoubled, the amount of X-rays produced is also doubled. For example: If 100 mA produces 500 X-ray photons in one second, 200 mA will produce 1000 X-ray photons in one second (an X-ray photon is a bundle of X-ray energy)

B. Exposure Time (Seconds)

The number of X-ray photons produced depends on the number of electrons that strike thetarget of the X-ray tube. Another way of increasing the number of electrons is by increasing the time of the exposure while the mA remains constant[3].

For example: If 100 mA produces 200 photons in one second, 100 mA will produce 400 photons in 2 seconds.

As a general rule, the mA should be as highas possible with a short time, to reduce the risk of movement unsharpness[2].

2. Kilovoltage (Kvp)

This indicates how the X-ray beam will penetrate the body. The range of kilovoltages used in diagnostic radiography is normally between 50 and 120 kVp, although a kilovoltage as low as 25 kVp may be used for certain soft-tissue examinations, such as mammography. High-kVp techniques, such as those used in chest radiography, employ a kilovoltage in excess of 120 kVp.

The kilovoltage will have a profound effect on the image density. As the kilovoltage increases, the X-rays produced have a higherenergy and more will be able to penetrate the body. This willbedetected by the image-acquisition device. Kilovoltage is also the most important factor in the controlof contrast of the radiographic image and should therefore be chosen carefully.Thekilovoltage should be such that the radiation has enough energy to penetrate the body part and reach the image-acquisition device. Maximum contrast will be achieved if the lowest possible kVp is used which will allow a reasonable proportion of the radiation to penetrate the body part. Dense structures within the body (e.g. bone) will absorb these low-energy X-rays, but structures of lower density (e.g. soft tissue) will absorb relatively fewerX-rays. This leads to a large difference in image density between these structures, i.e. high contrast. As the kilovoltage increases, proportionately more radiation will be able to penetrate the denser body part compared with the less dense part. The resulting difference in density between the two images will be reduced, giving a lower-contrast image[2]. If there is a very wide range of patient densities within the region being examined (e.g. the chest), then the image may show excessive contrast and it might be necessary to reduce the contrast within the image to allow a diagnostic image density to be attainedthroughout the region of interest. This can be achieved by increasing the kVp and, as mentioned previously, is commonly undertaken in chest radiography. Another reason for increasing the kVp is to allow the mAs, and therefore the exposure time, to be reduced. As kilovoltage is increased, not only does the radiation have more energy but also more radiation is produced, thus allowing the reduction in mAs. This reduction in exposure time will, however, be at the expense of image contrast.

3. Focus-To-Film Distance

The film to focus distance is simply defined as the distance between the x-ray tube and the film. For a given kVp and mAs, the greater the FFD, the lower the intensity of radiation reaching the film[2]. Therefore, to obtain the same film blackening, if the FFD is increased the mAs must also be increased. When choosing the FFD, the following factors are taken into consideration:

i. The X-ray tube must not be too close to the patient's skin,otherwise radiation damage could be caused.
ii. Short FFDs could give unacceptable geometric unsharpness.
iii. The FFD must not be excessive, otherwise the large increase in mAs required would mean high tube loading.

Most radiographic examinations are carried out with an FFD of 90 cm, which gives acceptable focus-to-skin distance and geometrical unsharpness but does not put unnecessary thermal stress on the X-ray tube. If this is the customary FFD used, then the department will require grids focused at 90 cm.

4. Filteration

The diagnostic X-ray beam is composed of X-rays that have a whole range of energies. Theproduction of a radiograph depends on the different rates of absorption of X-rays by different tissues. Bone absorbs more radiation than soft tissue, which absorbs more radiation than gas. As the X-rays pass through a patient, most of the lower energy X-rays are absorbed in the first few centimetres of tissue, and only the higher energy X-rays penetrate the patient to form the radiographic image. Since the patient's radiation dose depends on the number of X-raysabsorbed, it can be seen that the low energy radiation adds to the radiation dose to the patient without contributing anything to the radiograph. The low energy X-rays can be removed fromthe beam by the use of an aluminium filter interposed between the X-ray tube and the patient, this helps in hardening the beam and reducing radiation dose to the patient[3].

5. Secondary Radiation Grids

The **grid** is a device invented by German radiologist Gustav Bucky and improved by American radiologist Hollis E. Potter that enhances the quality of diagnostic medical x-ray images by reducing the effect of scattered radiation on the image acquisition device[4].A grid is composed of a seriesof small slits, aligned with the focal spot that are separated by highly attenuating septa[5].By blocking scattered x-rays, the grid improves contrast but also increases the amount of radiation absorbed by the patient[8]. It does not, however, reduce the radiation exposure to x-ray lab personnel[4].The different types of grids are, parallel grid, focussed grid and criss-cross grids[6].

Table 1.0Function of Exposure Factors in Conventional X-ray

EXPOSURE FACTOR	RELATIONSHIP TO X-RAY
Kilovoltage (KV)	Controls penetrating power of x-rays
Milliampere(mA)	Controls quantity of x-rays
Exposure Time (S)	Controls duration of Exposure
Mas	Product of mA multiplied by s
Film Focus Distance(FFD)	Controls intensity of x-rays at target
Secondary Radiation Grid	Reduce effect of Scattered radiation

III. Materials And Methods

The objective of this study was to develop a standard exposure chart for a MINXRAY HF120/60HPPWV/PowerPlus^{TM} (Mobile Xray Machine with high degree portability)which could be comfortably utilized for most mobile x-ray machines used with film-screen system. A prospective cross-sectional study of 504 patients at a tertiary healthcare institution in Nigeria was carried out. The study was conducted from November 2015 – February, 2016. Patients presenting for various radiographic examinations were examined in compliance with international radiation protection guidelines[12]. The exposure factors recommended by ICRP and other relevant literatures which provided exposure factors on diverse projections were also reviewed in order to attain research objectives. Based on these recommendations, the Kvp and exposure time were manipulated by the radiographer depending on the patient size, weight, age, sex, and pathology in question. Finally, exposure factors which produced images of adequate diagnostic quality were documented. The quality of radiographs was determined by two radiologists and two radiographers using radiographic viewing boxes based on image contrast, resolution and lesion visibility. A minxray mobile machine with:

Model number: HF120/60HPPWV/PowerPlus^{TM}
Serial Number: 34514
X-ray Tube: Superior X-rayTube Co.
SXR-140-15-1.2
Source: 100V-260V 50/60Hz
Filtration: 2.2mmAl

Output: 120KV 20mA 5.00 Sec
40KV 60mA 5.00 Sec

Exposure room with an x-ray couch, x-ray chest stand, weighing scales, grids, x-ray cassettes, Agfa exposure films and a darkroom with manual x-ray film processing units were utilized to achieve research objectives.

After developing the chart, the researchers tested the accuracy of the chart on 214 patients using the MINXRAY HF120/60HPPWV/PowerPlus^{TM}and 138 patientsusinganother POWERPLUS 1260 mobile xray machine with similar xray output/tube rating and results obtained were also documented.

Statistical Analysis

Data was analysed using Statistical Package forSocial Sciences (SPSS) version 19.0. Descriptive statistics such as percentages and frequency distribution tables were utilized to analyse quantitative data.

IV. Results

A total of 504 patients were considered for this study. This included both adults and paediatric patients. The frequency of patients who presented for chest xray was 303(60.11%), 43 patients (8.53%) were for lateral oblique mandible x-ray and 24 patients (4.76%) were for ankle x-ray. These three projections accounted for the most prevalent of all the radiographic projections.

The least requested x-rays were humerus, with 1 (0.19%) followedby sinuses and clavicle each with 2 (0.40%) and foot with 3(0.59%).

A constant tube current of 50mA was used for all projections. This was used inorder to select lowest possible exposure time there by reducing motional unsharpness and radiation dose.In the adult category, Skull x-rays accounted for highest exposure factors with 86-90kvp and 0.55-0.60 seconds while hand and wrist x-ray accounted for the lowest exposure with 50-52kvp and 0.05-0.06s. In the paediatric category, skull x-rays also accounted for the highest exposure factors with 76-78kvp and 0.30-0.32s while hand, wrist, foot and ankle were least with 48-50kvp and 0.05-0.06s. The chart accuracy was 95.33% on the MINXRAY machine and 78.99% on the Powerplus 1260 xray machine as there were 204 good quality radiographs and 10 poor quality radiographs from the minxray machine while the powerplus 1260 machine produced 109 good quality radiographs and 29 poor quality radiographs.

1.1 Radiographic ProjectionsConsideredin Developing Chart

Radiographic Projection	Frequency (%)	Cummulative Exposure(Kv/mAs)
Hand	**4 (0.79)**	**200/10**
Wrist	**5 (0.99)**	**250/12.5**
Forearm	**5 (0.99)**	**280/15**
Elbow	**5 (0.99)**	**280/15**
Shoulder	**5 (0.99)**	**350/55**
Clavicle	**2 (0.40)**	**148/12**
Chest	**303 (60.11)**	**20604/1818**
Cervical	**13 (2.58)**	**1092/104**
Soft tissue Neck	**5 (0.99)**	**380/45**
Jaw	**15 (2.98)**	**1200/225**
Mandible	**43 (8.53)**	**3010/301**
Sinuses	**2 (0.40)**	**172/50**
Femur	**4 (0.79)**	**304/44**
Tibia/Fibula	**17 (3.37)**	**986/76.5**
Skull	**6 (1.19)**	**516/165**
Knee	**9 (1.79)**	**522/40.5**
Ankle	**24 (4.76)**	**1200/60**
Abdomen	**9 (1.79)**	**450/36**
Post Nasal Space	**4 (0.79)**	**256/20**
Foot	**3 (0.59)**	**150/7.5**
Humerus	**1 (0.19)**	**60/5**
Hip	**9 (1.79)**	**720/202.5**
Pelvis	**11 (2.18)**	**880/247.5**
Total	**504 (100)**	**32350/3567**

1.2Range of Exposure factors which produced excellent radiographs (70kg normal sized adults 18years+)

RADIOGRAPHIC EXAM	PROJECTION	KVp	TIME(S)	FFD(cm)	CURRENT(mA)
Hand	Posteroanterior	50-52	0.05-0.06	90	50
	Dorsipalmar-oblique	50-52	0.05-0.06		50
Wrist	Posteroanterior	50-52	0.05-0.06	90	50
	Lateral	50-52	0.05-0.06		50

Forearm	Anteroposterior	56-58	0.06-0.08	90	50
	Lateral	56-58	0.06-0.08		50
Elbow	Anteroposterior	56-58	0.06-0.08	90	50
	Lateral	56-58	0.06-0.08		50
Shoulder	Anteroposterior (Grid)	70-74	0.22-0.24	90	50
	Superior inferior	66-70	0.16-0.20		50
Clavicle	Anteroposterior	74-76	0.12-0.16	90	50
Chest	Posteroanterior	68-74	0.12-0.18	150	50
Cervical	Anteroposterior (Grid)	84-86	0.22-0.24	90	50
	Lateral	76-78	0.16-0.20	120	50
Soft Tissue Neck	Anteroposterior (grid)	76-78	0.18-0.20	90	50
	Lateral	66-68	0.12-0.15	120	50
Jaw	Posteroanterior	80-84	0.30-0.32	90	50
Mandible	Oblique Lateral	70-74	0.14-0.16	90	50
Sinuses	Occipitofrontal	88-90	0.60-0.65	90	50
	Lateral	86-88	0.50-0.55		50
	Occipitomental	88-90	0.60-0.65		50
Femur	Anteroposterior	76-80	0.22-0.26	90	50
	Lateral	76-80	0.22-0.26		50
Knee	Anteroposterior	58-60	0.09-0.12	90	50
	Lateral	58-60	0.09-0.12		50
Tibia/Fibula	Anteroposterior	58-60	0.09-0.12	90	50
	Lateral	58-60	0.09-0.12		50
Ankle	Anteroposterior	50-52	0.05-0.07	90	50
	Lateral	50-52	0.05-0.07		50
Foot	Anteroposterior	50-52	0.05-0.07	90	50
	Lateral	50-52	0.05-0.07		50
Abdomen	Erect	80-84	0.45-0.50	90	50
	Supine	80-84	0.45-0.50		50
	Lateral	118-120	0.65-0.80		
Skull	Occipitofrontal (Grid)	88-90	0.65-0.70	90	50
	Lateral(Grid)	86-88	0.55-0.60		
Pelvis	Anteroposterior	80-84	0.40-0.45	90	50
Hip	Lateral	80-84	0.45-0.50	90	50
Humerus	AP and Lat	62-68	0.10-0.14	90	50

1.3Range of Exposure factors which produced excellent radiographs (Paediatrics, 6-13years)

RADIOGRAPHIC EXAM	PROJECTION	KVp	TIME(S)	FFD(cm)	CURRENT(mA)
Hand	Posteroanterior	48-50	0.05-0.06	90	50
	Dorsipalmar-oblique	48-50	0.05-0.06		50
Wrist	Posteroanterior	48-50	0.05-0.06	90	50
	Lateral	48-50	0.05-0.06		50
Forearm	Anteroposterior	54-56	0.06-0.08	90	50
	Lateral	54-56	0.06-0.08		50
Elbow	Anteroposterior	56-58	0.06-0.08	90	50
	Lateral	56-58	0.06-0.08		50
Shoulder	Anteroposterior	66-70	0.16-0.20	90	50
	Superior inferior	66-70	0.16-0.20		50
Clavicle	Anteroposterior	60-62	0.07-0.08	90	50
Chest	Poster anterior	52-54neonate 60-62	0.07-0.08 0.10-0.12	150	50
Cervical	Anteroposterior	66-68	0.14-0.16	90	50
	Lateral	68-70	0.16-0.18	120	50
Soft Tissue Neck	Anteroposterior	60-64	0.18-0.20	90	50
	Lateral	60-64	0.18-0.20		50
Jaw	Posteroanterior (grid)	76-78	0.26-0.28	90	50
Mandible	Oblique Lateral	64-68	0.10-0.13	90	50
Post Nasal	Lateral Supine	64-68	0.10-0.13	90	50

Space					
Femur	Anteroposterior	66-68	0.18-0.20	90	50
	Lateral	66-68	0.18-0.20		50
Knee	Anteroposterior	54-56	0.07-0.09	90	50
	Lateral	54-56	0.07-0.09		50
Tibia/Fibula	Anteroposterior	58-62	0.09-0.12	90	50
	Lateral	58-62	0.09-0.12		50
Ankle	Anteroposterior	48-50	0.05-0.07	90	50
	Lateral	48-50	0.05-0.07		50
Foot	Anteroposterior	48-50	0.05-0.07	90	50
	Lateral	48-50	0.05-0.07		50
Abdomen	Erect	50-52neonate	0.08-0.10	90	50
	Supine	60-64 (grid)	0.24-0.28		50
Pelvis	Anteroposterior	68-72	0.22-0.24	90	50
Skull	AP and Lateral	76-78	0.30-0.32	90	50

1.4 Results from radiographic examinations of 214 Patients using the exposure charts developed.(MINXRAY HF120/60HPPWV/PowerPlus^{TM})

Radiographic Projection	**Frequency**	**Image Quality**	
		Good Quality	Poor Quality
Hand	**2**	**2**	**0**
Wrist	**3**	**3**	**0**
Forearm	**2**	**2**	**0**
Elbow	**3**	**3**	**0**
Shoulder	**3**	**2**	**1**
Clavicle	**3**	**3**	**0**
Chest	**120**	**115**	**5**
Cervical	**6**	**6**	**0**
Soft tissue Neck	**3**	**3**	**0**
Jaw	**2**	**2**	**0**
Mandible	**20**	**18**	**2**
Sinuses	**2**	**2**	**0**
Femur	**2**	**2**	**0**
Tibia/fibula	**8**	**8**	**0**
Skull	**4**	**3**	**1**
Knee	**4**	**4**	**0**
Ankle	**8**	**8**	**0**
Abdomen	**4**	**4**	**0**
Post Nasal Space	**2**	**2**	**0**
Foot	**2**	**2**	**0**
Humerus	**1**	**1**	**0**
Hip	**6**	**5**	**1**
Pelvis	**4**	**4**	**0**
Total	**214**	**204**	**10**

Accuracy of Chart: No. of Good Images/Total Images * 100 = 95.33%

1.5 Results from radiographic examinations of 138 Patients using the exposure charts developed for MINXRAY HF120/60HPPWV/PowerPlus^{TM}ona POWERPLUS 1260 mobile xray machine in a different center.

Radiographic Projection	**Frequency**	**Image Quality**	
		Good Quality	Poor Quality
Hand	**2**	**2**	**0**
Wrist	**2**	**2**	**0**
Forearm	**2**	**2**	**0**
Elbow	**3**	**2**	**1**
Shoulder	**3**	**2**	**1**
Clavicle	**2**	**1**	**1**
Chest	**66**	**54**	**12**

Cervical	**4**	**3**	**1**
Soft tissue Neck	**3**	**2**	**1**
Jaw	**2**	**2**	**0**
Mandible	**10**	**6**	**4**
Sinuses	**2**	**2**	**0**
Femur	**2**	**2**	**0**
Tibia/fibula	**6**	**4**	**2**
Skull	**3**	**2**	**1**
Knee	**4**	**3**	**1**
Ankle	**4**	**3**	**1**
Abdomen	**3**	**2**	**1**
Post Nasal Space	**2**	**2**	**0**
Foot	**3**	**3**	**0**
Humerus	**2**	**2**	**0**
Hip	**4**	**3**	**1**
Pelvis	**4**	**3**	**1**
Total	**138**	**109**	**29**

Accuracy of Chart: No. of Good Images/Total Images * 100 = 78.99%

V. Discussion

This particular study considered 504 patients who presented for various radiographic examinations at a tertiary healthcare institution in preparing a standard x-ray exposure chart.This was carried out after a critical review of literatures on patient factors and exposure factors for different radiographic projections. The radiographers were guided towards selection of correct exposure factors based on data available within the literatures reviewed. A comprehensive list of exposure factors(Kvp, mA, s, grid, filtration) which provided acceptable diagnostic images were documented afterwards. The quality of radiographs was evaluated by two certified radiographers and radiologists. This assessment was based on image contrast, image resolutionandlesion visibility.In order to test accuracy of the chart, it was utilized for another 214 patients who presented for radiographic examinations.Radiographsof adequate diagnostic quality due to optimal exposure were classified as good quality radiographs while radiographs which did not provide sufficient detail due to inappropriate exposure factor selectionwere classified as poor quality radiographs. This was done while other conditions remained essentially normal and acceptable. Results indicated that the chart has 95.33% accuracy on the mobile xray machine.

Generally, exposure factors selected for any radiographic examination depends on the density, pathology, thickness of body part, film processing, age, and image acquisition device[9]. In patients with huge body mass, the exposure factors are usually increased in order to ensure optimal penetration of the beam. Conversely, patients who present with thin body parts would require a reduction in the exposure factors in order to prevent over-penetration or loss of soft tissue detail.Pathology and density of body parts also have strong influence on the exposure factor selected. It is also important to note that the condition of processing chemicals also determine the exposure factors utilized. When the processing chemicals are highly functional the Kvp and mAs is normally reduced. However, when the chemicals are weak the kvp and mAs are increased to provide film of optimal diagnostic significance.

The age of a patient is also another critical factor which is considered in the selection of exposure factors. Results obtained from this study clearly shows that there is a significant decrease in the exposure factors which are used for the paediatrics when compared with that of adults. This agrees with Knight[9], Hart et al.,[13]and Billinger[11]. The reason being that paediatric patientshave less dense body parts, rapidly dividing cells and consequently require low x-ray exposures inorder to preclude stochastic effects.

In the radiology department, exposure chart failure might be due to controllable factors which have not been standardized and may influence radiographic quality, these include; dark room technique,x-ray unit malfunction , incorrect measurement of an anatomic part , not compensating mAs when changing film-screen combinations, inserting or removing a grid, altering the focal-film distance.Once these have been standardized, any poor quality radiograph is due to an exposure error with excess or inadequate kV and/or mAs[17]. In this research, accuracy of chart was tested while ensuring that all these conditions remain essentially standardized and an accuracy of 95.33% was observed. This proves that the exposure chart generated can be utilized effectively on a mobile xray machine.

Although, existing literatures[9, 10, 14]suggest that it is quite difficult to use exposure factors generated on one x-ray machine on a different x-ray machine; results obtained on machine A can certainly serve as a guide in determining exposure factors for Machine B especially when they have the same xray output and tube rating as results obtained from another mobilexray machine using the same chart under same working conditions in a different centre produced an accuracy of 78.99%.

From this research, it is evident that radiographic examinations of extremities do not require the use of anti-scatter grids except in rare cases where the patients have huge body mass which may cause an increase in scattered radiation thereby leading to gross radiographic image unsharpness. All patients for extremities were examined without grids and no poor quality radiograph was documented. On the other hand, femur and other parts of the body require the use of grids especially because the amount of radiation needed to traverse the body and reach the image receptor is much higher.

The adult x-ray exposure chart in this particular study is developed for an adult of average size and weight of 70kg. When patients present with lesser weight thekvp and mAs may be reduced by 3% while bulky patients may require a 3% increase in Kvp and mAs. However this is still subject to the discretion of the radiographer.In the paediatric category, Kvp and mAs documented were adjusted specifically to suit paediatric patients between 6 and 13 years. Thus, if patients of ages less than 6 present for an xray the kvp and mAs on the paediatric chart will be reduced by 5-10% while paediatrics above 13 years require a 5-10% increase.

This research reveals chest xray as the most commonly performed radiography examination in the radiology department while humerus was least common. This was also highlighted in earlier studies by Osman[14] and Stollfuss[15].This emphasizes the increasing relevance of chest xray as a diagnostic tool for chest pathologies.

VI. Conclusion

Radiographic Exposure chart is a critical aspect of quality assurance which must not be neglected by any radiology department. Now, due to the paucity of literature worldwide in this particular subject area, the researchers thought it necessary to produce this chart which would serve as a template in developing charts for otherxray machines. It is imperative to note that, the chart developed from this study may not be conveniently utilized for all x-ray machines worldwide as so many other factors are responsible for producing radiographs of optimal diagnostic quality. Nevertheless, information provided here can be translated to similar mobile xray machines with same xray output and tube rating under same working conditions.

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