Evaluation of Radiation Dose Patients Received during X-ray Examinations Dire Dawa City, Hospitals

Abstract

The aim of this study was to assess and examine the patient doses in the most common radiographic X-ray examinations in selected hospitals in Dire Dawa city, Ethiopia. The examination parameters of 133 radiographs were used to evaluate the entrance surface air kerma (ESAK) of patients undergoing chest posterioanterior (PA), abdomen anterioposterior (AP) and lumbar spine anterioposterior (AP) in seven major hospitals. In this study kV, mAs and FFD used ranged from 54-119 kVp, 0.5-120 mAs and 100-150 cm, respectively. Hospital mean ESAKs estimated range from 0.13 – 1.540 mGy for chest PA, 0.470–4.538 mGy for Lumbar Spine AP, and 0.405- 4.905 mGy for Abdomen AP. Analyses were performed on measurements throughout the seven radiological departments. In all hospitals ESAK for chest exam is higher than the recommended value from International Atomic Energy Agency (IAEA), National Radiological Protection Board (NRPB) and Commission for European Community (CEC) Diagnostic Reference Levels(DRL) except in two hospitals Yemariam Work Higher Clinic (YHC) and Bilal Hospital (BH). For the other examinations the values are within the recommended values from IAEA, NRPB and CEC. This data will be useful for the formulation of national reference levels as recommended by the International Atomic Energy Agency (IAEA). Due to relatively high tube output in all except two hospitals YHC and BH in chest PA x-ray examinations, the study were concluded for increasing the filtration in these hospitals. It is also concluded the radiographer adhere to guidelines for quality radiograph for standardizing their practice. Quality control of the dark room is highly concluded. It is anticipated that the results presented will serve as a baseline data needed for deriving DRLs for X-ray examinations in Ethiopia.

1. Introduction

In both developed and developing countries, the number and range of X-ray facilities and X-ray equipment is increasing rapidly (UNSCEAR, S, 2000). The alternative modalities for diagnosis of diseases and injury, such as ultrasound and MRI, are becoming increasingly available; however, steady improvement in the quality of X-ray images and patient protection have ensured that diagnostic X-rays remain the most used tool in diagnosis (Muhogora et al, 2001). Hence make a major contribution to man's exposure to ionizing radiation from man-made sources.

In recent years, health physicists have devoted much effort to the minimization of patients' doses in diagnostic radiology. Through these efforts, substantial reductions in radiation doses to patients resulting from radiographic procedures have been achieved in many countries (Martin et al, 1999). Since medical physicist is a certified medical professional with education and clinical training in the safe and effective application of radiation in the fields of medical imaging and radiation therapy, and certified by the American Board of Radiology. A qualified medical physicist can play in managing radiation doses in medical imaging (McCollough, C. H , 2016).

The International Atomic Energy Agency has recommended guidance levels of dose for diagnostic radiography for a typical adult patient. These levels were intended to act as thresholds to trigger investigations or corrective actions in ensuring optimized protection of patients and maintaining appropriate levels of good practice. Since guidance levels should be derived from wide scale surveys of exposure factors performed in individual hospitals (Mohammedzein, 2009).

The radioprotection of patients in imaging appears as an emergency and a particular attention related to the practices to minimize radiation risk. Without compromising the effectiveness of the diagnosis or their therapeutic value, the overall goal is to reduce exposure to what is absolutely necessary. That is why any examination must be justified by its diagnostic contribution in relation with the irradiation, its realization must be optimal, that is to say, in conformity with the as low as reasonably achievable (ALARA) principle, and the doses delivered must be regularly evaluated for comparison with diagnostic reference levels, which should not be exceeded without justification (Gnowe et al, 2019).

Some dose surveys were conducted recently in Ethiopia. However previous studies cover only for calculating the Entrance Surface Doses (ESDs) received by adult

patients undergoing Posteroanterior (PA) chest X-ray examinations in major public hospitals in Addis Ababa, thereby to establish the first Ethiopian local diagnostic reference levels (LDRLs) as part of ongoing dose reduction program. Hospitals mean ESDs for adult PA chest X-ray examination is found with the range of 0.76 to 1.48 mGy (Teferi et al, 2010). However, Most of the ESD measured doses were slightly greater than the National Radiological Protection Board (NRPB), Commission of European Community (CEC) and International Atomic Energy Agency (IAEA) reference doses.
Therefore, the aim of this study was to evaluate patients' dose arising from X-ray examinations of the abdomen anteroposterior (AP), chest posteroanterior (PA), and lumbar spine anteroposterior (AP) at selected hospitals in Dire Dawa city, Ethiopia. Data from these measurements was serving as a useful baseline to establish national reference levels. It was anticipated that the study will help in the optimization of radiation protection of the patient. The patient dose were estimated in the present study in terms of Entrance Surface Air Kerma (ESAK).

2. Material and Method

In this study, Optically Stimulated Luminescence Dosimetry (OSLD) was used for measuring the tube output and it is calibrated at Secondary Standard Dosimetry Laboratory (SSDL) Ethiopian Radiation Protection Authority (ERPA).
This study used a cross-sectional study design with quantitative and qualitative data to evaluate radiation dose patients received during radiographic x-ray examination.
This study was conducted in seven selected hospitals in the Dire Dawa city, Ethiopia. Seven X- ray units were included in this study. The hospitals which participate in this study is: Dilchora Referrel Hospital (DRH), Sabiyan General Hospital (SGH), Art General Hospital (AGH), Bilal General Hospital (BGH), YeMariamWork General Hospital (YGH), YeMariam Work Higher Clinic (YHC), and Iftu Specialized Clinic (ISC). These hospitals were chosen for the study because they are the higher hospitals and there is a radiographic x-ray examination in Dire Dawa city, Ethiopia in terms of workload.
The target population of the study was included all radiographs of adult patients who are ≥ 20 years during data collection period. In this study, Non probability purposive sampling method was used to evaluate radiation dose patients received during

radiographic x-ray examinations. The sample size of the study was 133 radiographs of adult patients who are ≥ 20years.

The study was used the primary data collection method. The study was collected primary data using observation and measuring on evaluation of radiation dose patients received during radiographic x-ray examinations.

Initially, the researcher used for data collection an observation and measurement method.

For each patient, Sex, Age, type of examination (chest, abdomen, and lumbar spine) with their projections was documented in the format. In addition, exposure parameters like tube potential (kVp), milli Ampere (mA) milli Second (mS) exposure current–time product (mAs), focus to film distance FFD (cm) and tube output was recorded by the radiographers at the time of examination for each patient during exposure.

Finally, the proposed LDRLs were compared with the national and international reference dose values reported by the Commission for European Community (CEC), the International Atomic Energy Agency (IAEA) and the National Radiological Protection Board (NRPB).

The researcher used Microsoft Excel for data manipulation and ESAK calculations.

3. Results and Discussions

This study was carried out in seven major hospitals in Dire Dawa city, Ethiopia. Seven X-ray units were included in this study.

Table: 4.1-4.7 shows the Patient exposure parameters and ESAK for all selected X-ray examinations

In these tables; kV, mAs and FFD used ranged from 54-119 kVp, 0.5-120 mAs and 100-150 cm, respectively .Analyses were performed on measurements throughout the seven radiological departments. The distribution and mean values of ESAKs for individual adult patient exposures are presented. For Abdomen AP and Lumbar Spine AP x-ray examinations, all doses were below the corresponding IAEA levels. But for Chest AP x-ray examinations, except two hospitals the others are above the recommended values. It can be seen from the Tables that the doses presented in hospital (YHC) were lower compared to the doses in other hospitals included in the study. This can be described to the relatively lower X-ray tube output parameters used. In all examinations by average (Chest PA, Abdomen AP, Lumbar Spine AP) the highest values of ESAK was found in DGH hospital. This because of the relatively high tube output parameters used in this hospital. The variations in these parameters, as reflected in the range values, are partially due to variations in patient size and technique used.

Table: 3.1 Patient exposure parameters and ESAK for selected X-ray examinations in Sabiyan General Hospital (SGH)

No	Projection	Sample Size	kV	mA	mS	mAs	FFD	ESAK
1	Chest PA	7	54	152	156	24	150	0.610
2	Abdomen AP	7	62	151	145	22	100	1.528
3	Lumbar Spine AP	7	70	230	176	42	100	3.139

Table: 3.2 Patient exposure parameters and ESAK for selected X-ray examinations in Dilchora Referral Hospital (DRH)

No	Projection	Sample Size	kV	mA	mS	mAs	FFD	ESAK
1	Chest PA	7	71	19	-	-	150	0.711
2	Abdomen AP	-	-	-	-	-	-	-
3	Lumbar Spine AP	-	-	-	-	-	-	-

Table: 3.3 Patient exposure parameters and ESAK for selected X-ray examinations in Bilal Hospital (BH)

No	Projection	Sample Size	kV	mA	mS	mAs	FFD	ESAK
1	Chest PA	7	119	331	13	4	150	0.186
2	Abdomen AP	7	74	253	204	51	100	2.254
3	Lumbar Spine AP	7	79	310	118	37	100	0.879

Table: 3.4 Patient exposure parameters and ESAK for selected X-ray examinations in Yemariam work Higher Clinic (YHC)

No	Projection	Sample Size	kV	mA	mS	mAs	FFD	ESAK
1	Chest PA	7	78	80	0.3125	25	150	0.13
2	Abdomen AP	7	74	100	0.157	15.7	100	0.866
3	Lumbar Spine AP	7	79	100	0.12	12	100	0.583

Table: 3.5 Patient exposure parameters and ESAK for selected X-ray examinations in Art General Hospital (AGH)

No	Projection	Sample Size	kV	mA	mS	mAs	FFD	ESAK
1	Chest PA	7	90	100	1.2	120	150	0.407
2	Abdomen AP	7	87	100	1.2	120	100	0.405
3	Lumbar Spine AP	7	87	100	1.2	120	100	0.470

Table: 3.6 Patient exposure parameters and ESAK for selected X-ray examinations in Iftu Specialized Clinic (ISH)

No	Projection	Sample Size	kV	mA	mS	mAs	FFD	ESAK
1	Chest PA	7	81	160	0.003125	0.5	150	0.568
2	Abdomen AP	7	74	189	0.006514	1.25	100	4.905
3	Lumbar Spine AP	7	81	200	0.006250	1.25	100	4.538

Table: 3.7 Patient exposure parameters and ESAK for selected X-ray examinations in
DeltYemariam work General Hospital (DGH)

No	Projection	Sample Size	kV	mA	mS	mAs	FFD	ESAK
1	Chest PA	7	87	100	0.25	25	150	1.540
2	Abdomen AP	7	74	100	0.2	20	100	1.230

3	Lumbar Spine AP	7	78	125	0.1248	15.6	100	1.030

3.2 Discussions

Results in table 4.8 show ESAK for all examinations which included in this study for the seven machines at seven hospitals and the guidance levels that recommended by International Atomic Energy Agency (IAEA), the National Radiological Protection Board (NRPB), Commission of European Community (CEC).

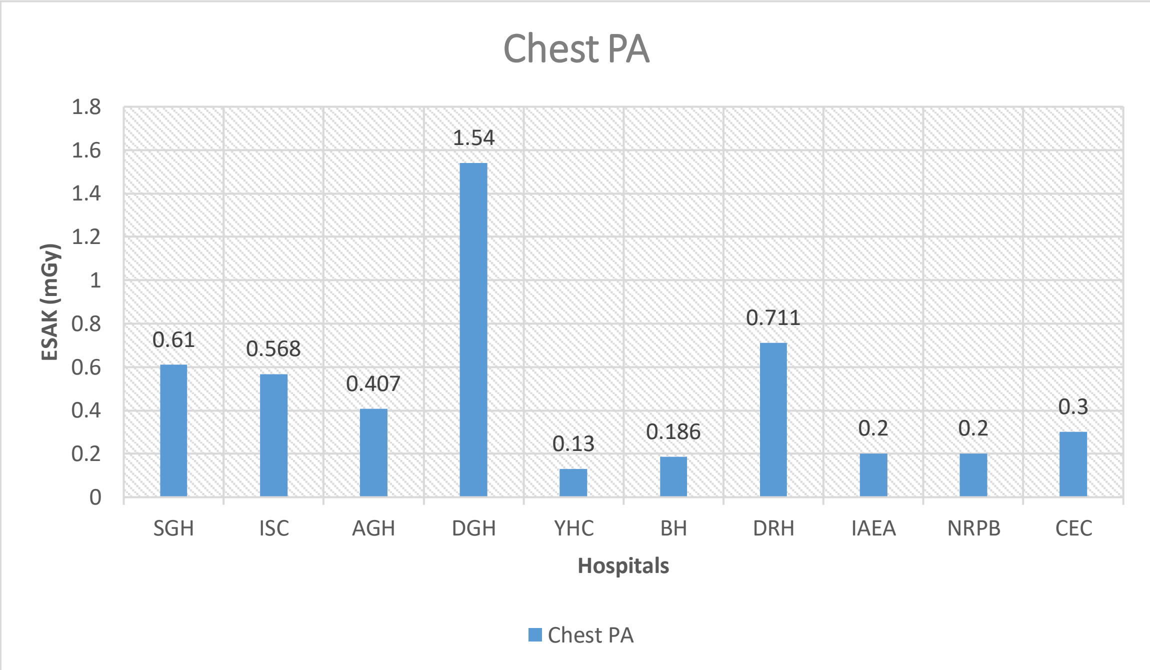
Table: 3.8 Mean ESAK (mGy) for all hospitals included in this study with IAEA &NRPB &CEC recommended guidance level

Organization with This Study reference dose levels										
Projections	SGH	ISC	AGH	DGH	YHC	BH	DRH	IAEA	NRPB	CEC
Chest PA	0.610	0.568	0.407	1.540	0.13	0.186	0.711	0.2	0.2	0.3
Abdomen AP	1.528	4.905	0.405	1.230	0.866	2.254	-	5.0	-	
Lumbar Spine AP	3.139	4.538	0.470	1.030	0.583	0.879	-	5.0	6.0	10.0

From all observations (YHC) is the smallest value in Chest PA and (AGH) is the smallest value in both Abdomen AP and Lumbar Spine AP examinations because of the low output of the machine combined with high tube filtration.

In chest examinations all hospitals showed ESAK values are higher than IAEA reference dose except two hospitals YHC and BH. This could be attributed to the relatively high exposure parameters used in these hospitals. It is also possible that radiographers experience has some impact. Similar characteristic in this study was that there were quality control (QC) performed for chemicals and film processing materials a factor that resulted in high technique factors used throughout this study. Based on the results obtained recommendations will made on how to bring the doses below the international recommended dose levels. In general all values of ESAK in this study within IAEA recommendation and exceed with fraction in some cases.

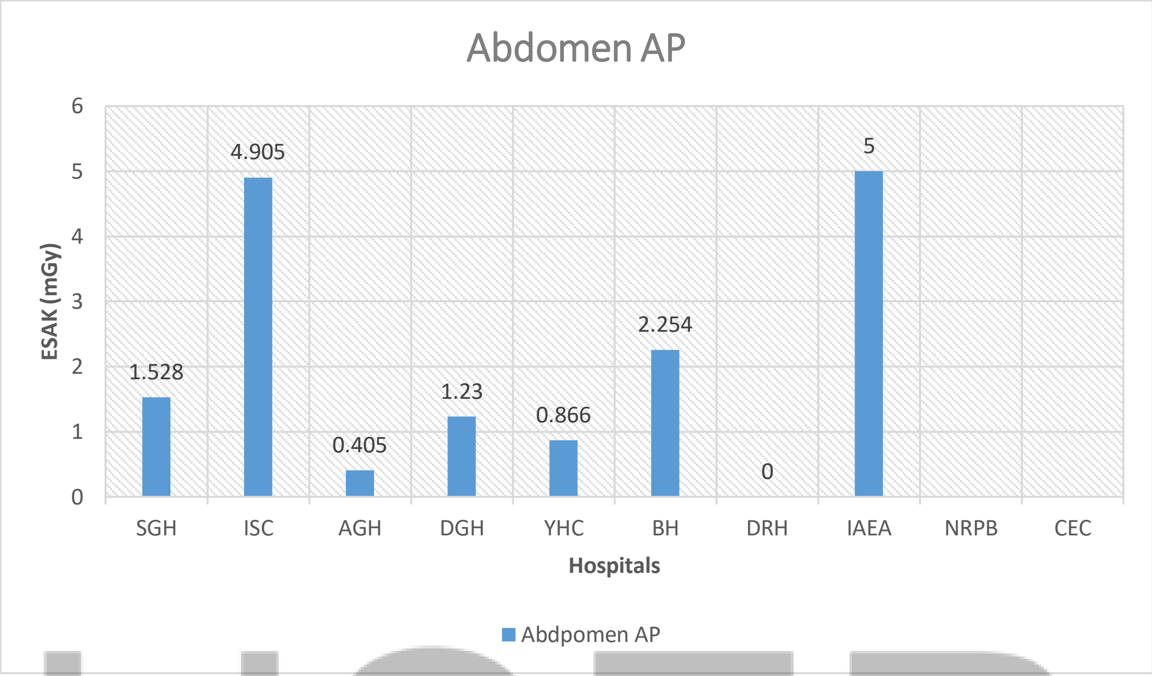
Figure: 3.2a The histograms of ESAK distribution for Chest PA x-ray examinations



Results in figure 4.2a show ESAK for all examinations which included in this study for the seven machines at seven hospitals and the guidance levels that recommended by International Atomic Energy Agency (IAEA).

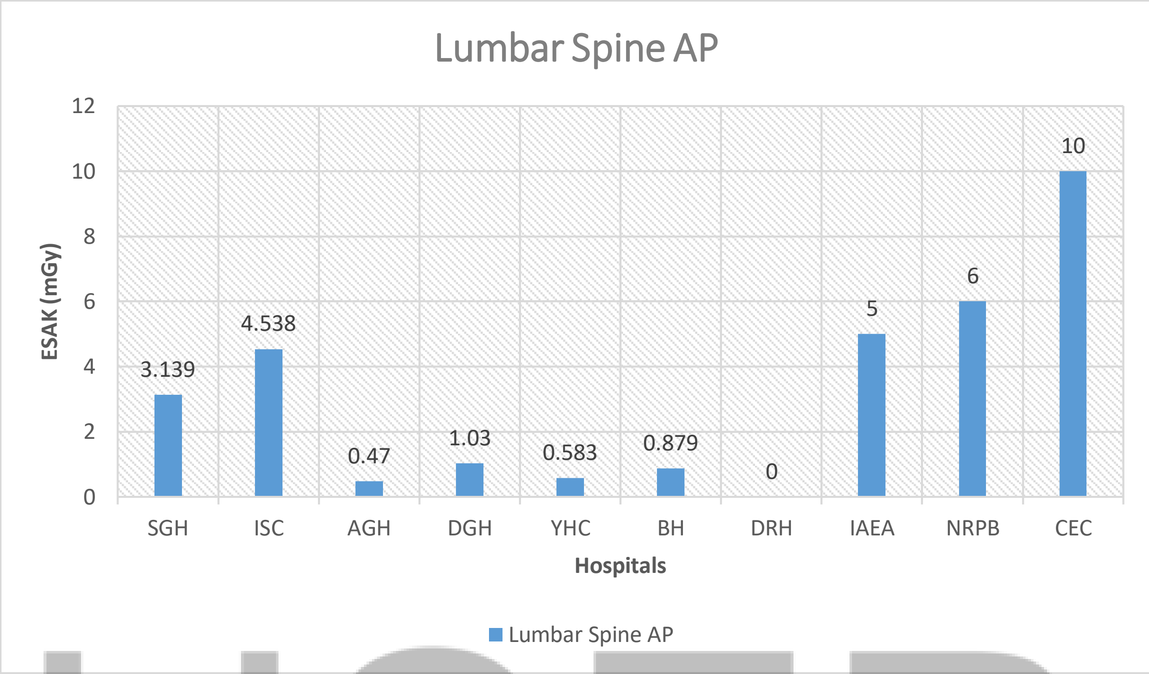
From the observations (YHC) is the smallest value and (DGH) is the highest value in Chest AP x-ray examinations in all selected hospitals because of the low output of the machine combined with high tube filtration. All hospitals showed ESAK values that are lower than IAEA reference dose. This could be attributed to the relatively low exposure parameters used in these hospitals. Based on the results obtained recommendations will made on how to keep the doses to the international recommended dose levels.

Figure: 3.2b The histograms of ESAK distribution for Abdomen AP x-ray examinations



Results in figure 4.2b show ESAK for all examinations which included in this study for the seven machines at seven hospitals and the guidance levels that recommended by International Atomic Energy Agency (IAEA). From the observations (AGH) is the smallest value and also (ISC) is the highest value in Abdomen AP x-ray examinations because of the low output of the machine combined with high tube filtration.Since DRH x-ray machine didn't giving examinations on Abdomen AP, the study couldn't record its value.

Figure: 3.2c The histograms of ESAK distribution for Lumbar Spine AP x-ray examinations



Results in figure 4.2c show ESAK for all examinations which included in this study for the seven machines at seven hospitals and the guidance levels that recommended by International Atomic Energy Agency (IAEA). From the observations (AGH) is the smallest value in and (ISC) is the highest value in Lumbar Spine AP examinations because of the low output of the machine combined with high tube filtration. Since DRH x-ray machine didn't giving examinations on Lumbar Spine AP, the study couldn't record its value.

All hospitals showed ESAK values are lower than IAEA reference dose. This could be attributed to the relatively low exposure parameters used in these hospitals.

4. Conclusions

ESAKs were estimated in the present study for patients undergoing selected diagnostic X-ray examinations in major hospitals in Dire Dawa.

The examination parameters of 133 radiographs were used to evaluate the entrance surface air kerma (ESAK) of patients undergoing chest posterioanterior (PA), abdomen anterioposterior (AP) and lumbar spine anterioposterior (AP) in seven major hospitals. In this study kV, mAs and FFD used ranged from 54-119 kVp, 0.5-120 mAs and 100-150 cm, respectively. Hospital mean ESAKs estimated range from 0.13 – 1.540 mGy for chest PA, 0.470–4.538 mGy for Lumbar Spine AP, and 0.405-4.905 mGy for Abdomen AP. Analyses were performed on measurements throughout the seven radiological departments. This data will be useful for the formulation of national reference levels as recommended by the International Atomic Energy Agency (IAEA).

Due to relatively high tube output in all except two hospitals YHC and BH in chest PA x-ray examinations ESAK for chest exam is higher than the recommended value from IAEA, NRPB and CEC DRLs except in two hospitals YHC and BH. For the other examinations the values are within the recommended values from IAEA, NRPB and CEC.

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