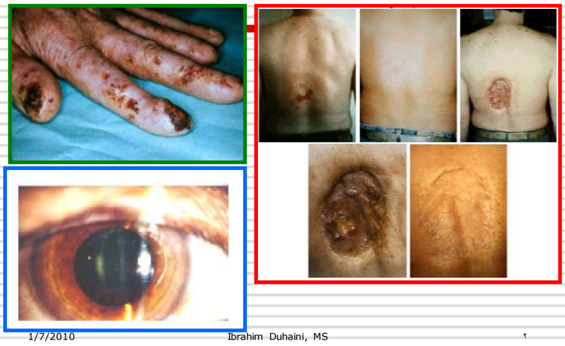
Pilot Study of Patient Doses from Conventional Diagnostic Radiology in Lebanon

Prepared by: Leila El- Nachef
Section Head, Diagnostic Radiology
Authorization, Inspection and Regulation Department
Lebanese Atomic Energy Commission (LAEC)

Presented by: Ibrahim Duhaini
Chief Physicist & RSO
Radiation Therapy Department
Rafik Hariri University Hospital

Radiation Effects



ABSTRACT

- The widespread use of x-ray examination and the increased utilization of recent development of remarkable x-ray equipment have improved the lives of patients in Lebanon;
- This evolution of imaging has also resulted in a significant increase in the population's cumulative exposure to ionizing radiation

- The objective of this study is to assess the patient doses for most frequent x-ray examinations in Lebanon by measuring the entrance skin dose for patients within the weight range of 65 to 70 kg taken in some of the Lebanese hospitals.
- The results will be compared to the international Guidance levels of patient dose.
- This study will help to provide a more unified diagnostic radiology practice and help to reduce patient exposure levels to those comparable to IAEA standards.

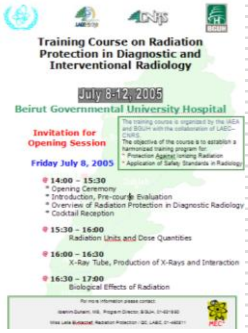
INTRODUCTION

The use of ionizing radiation is not entirely without risk.
Exposures to diagnostic x-rays need to be justified and optimized in terms of benefit and risk.
One of the basic relevant requirements is the knowledge of patient doses.

Recently, the patient exposure to ionizing radiation is not yet a part to the legislative system in Lebanon, also there are not established a national diagnostic reference levels.

- LAEC in cooperation with the IAEA started a pilot project in order to examine the situation and compare it to the IAEA Guidance levels at the aim to establish a national guidance levels for medical exposures for diagnostic radiological procedures
- The present work was undertaken in collaboration with radiology departments of six selected hospitals and as follow up to the national radiation protection course organized jointly by the LAEC and the IAEA at RHUH

Training for Radiation Safety



This study determines the patient entrance air kerma obtained from common diagnostic radiology procedures

Number	Type of x-ray examination
1	Chest (AP)
2	Lumbar Spine (AP)
3	Lumbar Spine (LAT)
4	Pelvis (AP)
5	Abdomen (LS-AP)

8

PATIENT ENTRANCE SKIN DOSE

Data sheets for collecting statistical data concerning each examination were prepared:

Hospital name, department x-ray room number, film screen speed, model and manufactured date of the machine.

For each type of examination the following data were collected: patient weight, exposure parameters (kVp and mAs) set or displayed, FFD, film size and focal spot size.

9

X-ray data were collected for patients weighting between 60 and 75 kg, 10 patients were observed for each x-ray examination type.

All measurements were performed prior to any quality control tests on the equipments involved.

three-step protocol for estimation patient dose:
1- X-ray tube output measurements
2- Incident kerma measurements
3-Entrance surface air kerma calculations

10

X-ray tube output measurements

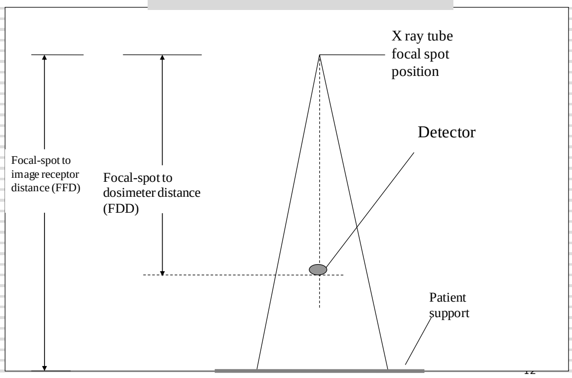
UNFORS Xi R/F detector is used for the air kerma measurements.
The dosimeter was positioned in the central beam axis at 100 cm distance from the x-ray tube focal spot.

The radiation field size was set to just cover the dosimeter to avoid the scatter radiation.

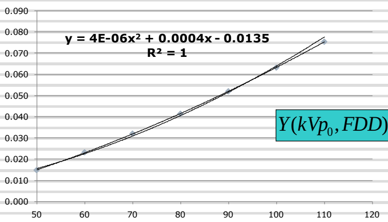
The tube potential was set at 50 kVp and any mAs value (depending on convenient tube load conditions).

This step was repeated once more at the same kVp and mAs settings and the average dosimeter reading determined.

X-ray Tube Out-put Measurement



The x-ray tube output was determined as the ratio of average dosimeter reading (in air kerma) to the tube current-time product used for tube voltages 50-110 kVp in steps of 10 kVp . The values of the x-ray tube output per mAs were plotted against the tube potential and the resulting curve was fitted using a power function.



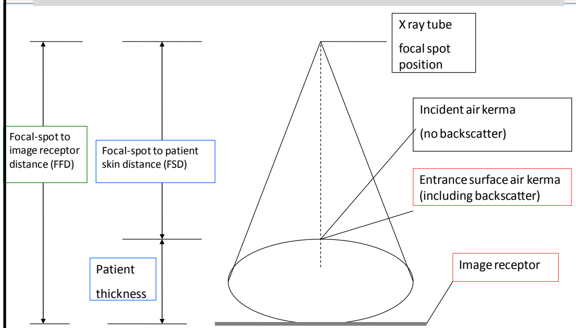
$$Y(kVp_0, FDD) = K_a(FDD)/mAs_0$$

Incident Air Kerma

The incident air kerma was determined by the product of x-ray tube output value (derived from the output per mAs-kVp curve corrected for the inverse distance effects between the patient's distance from the x-ray tube focus and the distance at output measurements) and the actual mAs used in the radiographic examination:

$$K_a(FDD) = M \cdot N_K \cdot k_Q$$

Diagram Showing Dosimetric and Geometric Quantities



Entrance Surface Air Kerma

The entrance surface air kerma value was calculated by multiplying incident air kerma to the patient's surface by the appropriate backscatter factor (BSF) (vary between 01-04) which depends on the tube voltage, total filtration, and radiation field size.

$$ESAK = Y(kVp, FDD) \cdot mAs \cdot \left(\frac{FDD}{FFD - t_p} \right)^2 \cdot BSF$$

RESULTS AND DISCUSSIONS

0

The results of mean entrance surface air kerma to adult patients are measured and presented in table (1) and were compared to the **Guidance Levels of patient dose in BSS 115 (IAEA)**

Dose levels exceeding Guidance Levels are indicated in table (1) by the shaded cells.

Hospital	Chest (AP)	Lumbar Spine (AP)	Lumbar Spine (LAT)	Pelvis (AP)	Abdomen (AP)
A*	0.03	0.43	0.06	0.23	0.24
B	0.18	2.06	6.68	1.10	2.53
C	0.21	2.3	-	2.8	4.1
D*	0.48	6.78	21.62	3.56	3.69
E	0.024	0.95	0.89	-	0.91
F	0.16	2.26	0.75	3.06	3.45
ESD (mGy) Guidance Levels[6] (BSS 115) 400 film - screen	0.2	5	15	5	2.5

The entrance surface air kerma varied by a factor of 20 (chest anteroposterior projection), 15.7 (LS anteroposterior projection), 15.5 (Pelvis anteroposterior projection), 17.1 (Abdomen anteroposterior projection).

Many entrance surface air kerma values were of the order of the diagnostic guidance levels, exceptions were observed for Abdomen anteroposterior projection.

It is seen that the highest values of entrance surface air kerma values were observed at hospital **D**

Some hospitals use a low kVp technique (60 kVp) for Abdomen, which results in higher Entrance air kerma

A large variation of patient dose expressed in terms of entrance surface air kerma have been observed, which could be attributed to different levels of training in radiology, the choice of radiographic technique , the status of quality assurance program implementation, and the status of implementation of radiation protection standards.

This work is the **first phase** of optimizing patient doses in x-ray imaging, the experimental work, conducted on a small sample of hospitals without any modifications or any quality control, has given us a preliminary description of the current practice of radiology in the selected Lebanese hospitals.

Second phase:

Similar measurements will be carried out after performing the proposed modifications and quality control following the four proposed

recommendations:

1- Quality control, such that the technical parameters of the x-ray machines should be controlled periodically.

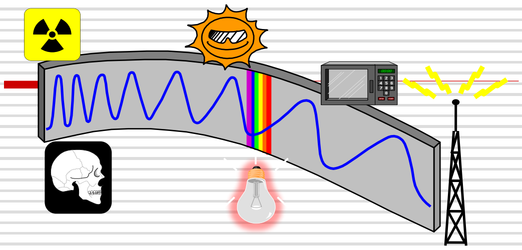
2- X-ray examinations must be optimized in order to achieve good image quality while maintaining the patient doses at the lowest possible level.

3- X-ray examinations should be performed in accordance to written procedures in line with internationally recognized standards.

4- The x-ray staff should be given additional training to help them implement a patient dose reduction programs.

Further measurements in this field should be extended to a larger number of hospitals in Lebanon and must not only include conventional radiography but all existing x-ray imaging procedures (fluoroscopy, CT, mammography), after which:

National Guidance Levels could be obtained.



THANK YOU