International Journal of Cancer Therapy and Oncology
www.ijcto.org

Estimated radiation exposure from medical imaging for patients of radiology service of Al Faraby Hospital, Oujda Morocco

Slimane Semghouli[1], Bouchra Amaoui[2], Abdellatif Maamri[3]

[1]*Department of Health Techniques, Higher Institute of Nursing Professions and Health Techniques Agadir, Morocco*
[2]*Department of Radiotherapy, Regional Center of Oncology Agadir, Morocco*
[3]*Higher Institute of Nursing Professions and Health Techniques Oujda, Morocco*

Received February 13, 2015; Revised August 23, 2015; Accepted August 23, 2015; Published Online Sepetember 13, 2015

Technical Report

Abstract

Purpose: To evaluate the effective dose received per radiological examination per patient and the additional cancer risk factor in the Radiological Service of Al Faraby Hospital in 2012. **Methods:** From the number of radiological procedures (N_X) made in 2012 in the radiology service of Al Faraby Hospital and the average effective dose D_E^X associated with each type of act exam X, it is possible to calculate the effective dose collective [$S = \sum D_E^X * N_X$]. The additional cancer risk factor is calculated by the X-ray risk software promoting responsible imaging through patient and provider education. It is function of the effective dose received, the age at the time of exam, and gender of patient. **Results**: The radiological average effective dose received per act exam is 1 millisievert (mSv), whereas it is 4.45 mSv and 0.21 mSv for the computed tomography (CT) scan and conventional radiological examinations, respectively. As for the average number of acts per patient 2.66, the effective dose is 1.16 mSv and 3.8 mSv for CT scan and conventional radiological examinations, respectively. As for the average effective dose per patient 2.69 mSv, it is 5.16 mSv and 0.81 mSv for CT scan and conventional radiological examinations, respectively. As for the additional cancer risk in 40 years at the time of exam, the average additional cancer risk is equal to 2.17×10^{-4}, wheras the risk is 4.17×10^{-4} and 6.54×10^{-5} for CT scan and conventional radiological examinations, respectively. **Conclusion**: Medical exposure related to the diagnosis of patients in the radiology service in 2012 can be characterized by: (a) 2.66 Act exams on average per patient diagnosis corresponding to a mean effective dose equal to 2.69 mSv per patient, (b)frequency of conventional radiology and CT scan was 81% and 19%, respectively. These act exams contribute to the collective effective dose by 17% and 83%, respectively, and (c) radiological acts can be divided into three levels of exposures: 0 to 5 mSv, 5 to 10 mSv, and > 5 mSv, and the proportion of each level is 90.12%, 9.84%, and 0.05%, respectively.

Keywords: Radiological Exam; Dosimetry; Effective Dose; Additional Cancer Risk Factor

Introduction

Ionizing Radiations are largely used in different socio-economic fields, especially in medicine. These radiations are produced by various technologies such as computed tomography (CT), positron-emission tomography (PET), mammograms etc. Physicians' daily use these technologies to screen diagnose, stage, and treat cancers with the aim of saving thousands of lives.

The individual effective dose average received in a natural radiation exposition is about 2.4 millisievert (mSv) per year.[1] Moreover; the medical exposition increases the annual total effective dose received per capita, for example the U.S population's average annual exposition is about 6,2 mSv.[1]

The primary risk associated with exposure to ionizing radiation is cancer. Based on the BEIR VII report, it is estimated that approximately 1 among 1,000 individuals will develop cancer from an exposure of 10 mSv. This risk level is relatively small in comparison to approximately 420 out of 1,000 individuals expected to develop cancer from all other causes combined.[2] Keep in mind that cancer, regardless of the etiologic process, has a latent period of 10-20 years. The aim of this study is to estimate the average effective doses received by radiological act exam, by patient and the additional cancer risk factor associated with this exposition at the service of radiology diagnostic in Al Faraby Hospital during 2012.

Methods and Materials

The effective dose (E_D) represents the impact of the absorbed dose in terms of the risk to the whole body. It is expressed in

Corresponding author: Slimane Semghouli; Department of Health Techniques, Higher Institute of Nursing Professions and Health Techniques Agadir, Morocco.

***Cite this article as**: Semghouli S, Amaoui B, Maamri A. Estimated radiation exposure from medical imaging for patients of radiology service of Al Faraby Hospital, Oujda Morocco. Int J Cancer Ther Oncol 2015; 3(3):3325. **DOI**: 10.14319/ijcto.33.25*

ISSN 2330-4049

sievert (Sv) or millisievert (mSv). It also allows comparisons between countries as well as the study of the evolution of exposure those results from a particular type of act exam in time.

From the number of radiological procedures N_X made in 2012 in the radiology service, and the average effective dose D_E^X associated with each type of act exam X, it is possible to calculate the effective dose collective S:

$$S = \sum D_E^X * N_X$$

The absence of dosimetric data on the Moroccan estimated average effective dose associated with each type of radiological procedure, prompted us to use data from the literature.[3-7] The average effective doses associated with different acts were calculated for an adult patient standard morphology (70 kg).[8] According to the report No. 154 of the EC [2], the effective dose for a given type of act exam can be considered constant regardless of the age and sex of the patient.

The average annual effective dose per capita is obtained by dividing the collective effective dose S by the total population of the province of Oujda for a particular year, either exposed or not to ionizing radiation.

The additional cancer risk factor is calculated by the x-ray risk software Promoting responsible imaging through patient and provider education. It is function of the effective dose received, the age at the time of exam and for the gender of patient.[9]

Results

In total, we estimate 52692 radio-diagnostic examinations which were performed in the radiology service of the Al Faraby hospital Oujda in 2012. Such actions lead to collective effective dose *S* equal to 53214 mSv. Detailed results by types of diagnostic scanning and anatomical region acts exam are shown in **Table 1**.

Acts exam of conventional radiology represent 81% of diagnostic imaging tests compared to 19% for CT scan acts. They only contribute by 17% to the collective effective dose compared to 83% for CT scan acts.

TABLE 1: Distribution by anatomical area of diagnostic exams performed in the radiology service of the Al Faraby Hospital.

Radio-diagnostic Types	Patients	Actes		Effective Dose E	Effective Dose collective	
		Effectif	%	per exam in mSv[7]	mSv	%
Conventional Radiology	11256	42774	100		9092,09	100
Skull and / or facial bones by 1 or 2 impact		2784	7	0,0500	139,20	2
Cervical segment of the spine by one or two impacts		528	1	0,1000	52,80	1
Thorax		13056	31	0,0500	652,80	7
Shoulder girdle and/or the shoulder as 1 or 2 impact		2352	5	1,0000	2352,00	26
Abdomen without preparation		1296	3	1,9000	2462,40	27
Pelvic girdle [basin] by 1 incidence		1680	4	1,2000	2016,00	22
Hip joint by 1 or 2 impact		240	1	0,3500	84,00	1
Unilateral knee by 1 or 2 impact		2976	7	0,0030	8,93	0
Leg		1680	4	0,0020	3,36	0
Elbow by 1 or 2 impact		2496	6	0,0015	3,74	0
Hand or Finger		2880	7	0,0003	0,86	0
Unilateral of the foot by one to three impacts		3504	8	0,0003	1,05	0
Ankle by one to three impacts		3072	7	0,0003	0,92	0
Wrist according to 1 or 2 impact		1728	4	0,0003	0,52	0
Forearm		1344	3	0,0010	1,34	0
Handel		580	1	0,0010	0,58	0
Thigh		578	1	0,0010	0,58	0
Spine in full (CD-CL)		570	1	2,3000	1311,00	14
CT- Scan	8555	9918	100		44121,6	100
Skull and its contents		4608	46	2,1	9676,8	22
Soft tissues of the Neck		24	0	5,2	124,8	0
Thorax		1200	12	5,7	6840	16
Unilateral or bilateral lower limb Segment.		72	1	0,1	7,2	0
unilateral or bilateral upper limb segment		30	0	1,6	48	0
Pelvis		912	9	5,3	4833,6	11
Abdomen		1320	13	5,3	6996	16
Segment of the spine (RL-RD-RC)		1728	17	8,4	14515,2	33
Angio CT		24	0	45	1080	2

ISSN 2330-4049

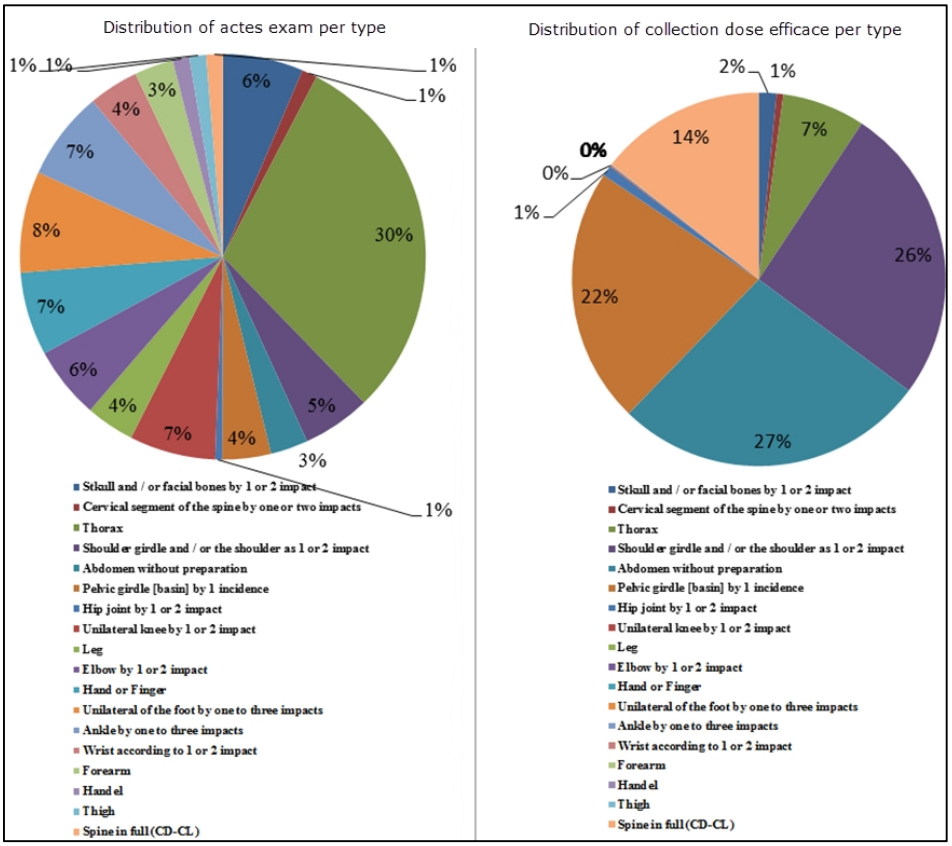

FIG. 1: Conventional Radiology exploration exams performed in radiology service in 2012.

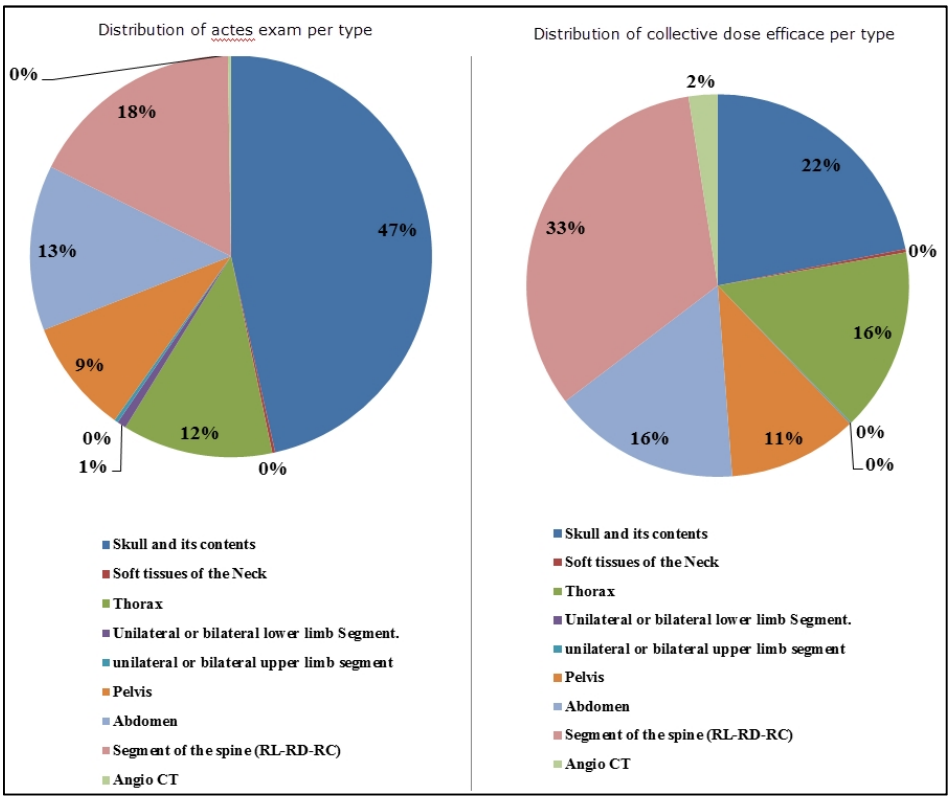

FIG. 2: CT Scan exploration exams performed in radiology service in 2012

In conventional radiology (**Figure 1**), the most common acts exam concerns the members and the thorax (48% and 31% of acts, respectively). The Acts exam exposing Spine (CD-L), Abdomen without preparation and shoulder mainly The most common CT scan acts concern the skull and its contents, the Segment of the spine (RL-RD-RC) and the abdomen (46%, 17%, and 14% of acts exam, respectively) (**Figure 2**). For this type of exploration, the collective dose is mainly due to exams segment of the spine (RC-RD-RL), the skull and its contents and abdomen (33%, 22% and 16% of collective effective dose, respectively). The radiological acts realised can be divided into three levels of exposures: 0 to 5 mSv, 5 to 10 mSv and > 5 mSv. The proportion of each level is 90.12 %, 9.84%, and 0.05%, respectively.

The average effective dose received per act exam is 1 mSv. It is 4.45 mSv and 0.21 mSv for CT scan and conventional radiological examinations, respectively. The average number of acts per patient is 2.66 and effective dose is 1.16 mSV and 3.8 mSV for CT scan and conventional radiological examinations, respectively. As for the average effective dose per patient is 2.69 mSv, and it is 5.16 mSv and 0.81 mSv for CT scan and conventional radiological examinations, respectively. As for the additional cancer risk in 40 years at the time of exam, the average additional cancer risk is equal to 2.17×10^{-4}, wheras the risk is 4.17×10^{-4} and 6.54×10^{-5} for CT scan and conventional radiological examinations, respectively. According to the 2004 census, the population of the province of Oujda Angad is 477,100 people. By combining the frequency of realization of different types of acts exam and the collective effective dose, the average number of acts per capita is 0.11 and the average effective dose received per capita is 0.11 mSv.

Discussion

The average effective dose per inhabitant in the province of Oujda Angad (0.11 mSv) is a lot higher than 0.04 mSv put forward by Semghouli *et al.* for capita in Agadir Ida Outtanane province.[10] This result is negligible compared to that received in France in 2007 (1.3 mSv) [7], the difference between these two results is due to the fact that the current study was conducted on a data limited to the radiology service Al Faraby Hospital in Morocco while it was more general in France in the sense that it was conducted on the whole French territory. The average radiological examinations by residents of the province of Oujda Angad (0.11 radiological exams) is very higher than 0.04 radiological exams put forward by Semghouli *et al.* for capita of Agadir Ida Outtanane.[10] This result is lower compared to that carried out in France in 2007[7]. Conventional radiology (excluding dental radiology) represents 81% of radiological examinations and 17% of the collective effective dose. contribute to the collective dose for this type of exploration (14%, 27%, and 26% of the collective effective dose, respectively).

The results obtained in this study will be completed and updated in order to generalize this experience to other cities in Morocco. Moreover, it is compulsory to develop a computer tool that will be installed in all radiology departments. This tool will evaluate, map and monitor the evolution of medical exposure indicators. Therefore, these indicators will improve patients' radioprotection of different practitioners during the acquisition of radiological images.

Conclusion

The medical exposure of patients to this service as well as the population of the Oujda Angad province can be characterized by:

- 2.66 Act exams on average per patient diagnosis, corresponding to a mean effective dose equal to 2.69 mSv per patient.
- The frequency of conventional radiology and CT Scan is 81% and 19%, respectively.
- The radiological acts realised can be divided into three levels of exposures: 0 to 5 mSv, 5 to 10 mSv, and > 5 mSv. The proportion of each level is 90.12 %, 9.84% and 0.05%, respectively.
- The average additional cancer risk is equal to 2.17×10^{-4}, wheras the risk is 4.17×10^{-4} and 6.54×10^{-5} for CT scan and conventional radiological examinations, respectively.

Conflict of interest

The authors declare that they have no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

1. Gale RP, Lax E, Hoffman FO. On Radiation and Cancer Risk. The ASCO POST. 2013; 4.
2. De Roquefeuil L, Studer A, Neumann A, Merlière Y. The general sample of benificiaries representativeness. Scope and limits Practice and Organisation of Care. 2009; 40: 213-23.
3. Hart D, Wall BF. Radiation exposure of the UK populations from medical and dental X-rays examinations. Report NRPB – W4; 2002; 33. Available from https://inis.iaea.org/search/searchsinglerecord.aspx?recordsFor=SingleRecord&RN=33029624#
4. Mettler FA Jr, Huda W, Yoshizumi TT, Mahesh M. Effective doses in radiology and diagnostic nuclear medicine: a catalog. Radiology. 2008; 248:254-63.

 ISSN 2330-4049

5. Bedetti G, Botto N, Andreassi MG, *et al*. Cumulative patient effective dose in cardiology. Br J Radiol. 2008; 81: 699-705.
6. McParland BJ. A study of patient radiation doses in interventional radiological procedures. Br J Radiol. 1998;71:175-85.
7. Etard C, Sinno-Tellier S, Aubert B. Medical ionising radiation exposure of the French population in 2007 – IRSN Report Institute of Health Surveillance June 2010 ISSN : 1958-9719.
8. European guidance on estimating population doses from medical X-ray procedures, Radiation protection. Avialble from http://www.itn.pt/projs/ddm2-portugal/rp154.pdf
9. Mike Hanley, Jay Koonce, Marques Bradshaw. X ray risk: Promoting responsible imaging through patient and provider education. Available from http://xrayrisk.com/
10. Semghouli S, Amaoui B, EL Fahssi M. Estimate of the average effective dose received by radiological exam and by patient at the diagnostic radiology service of Hassan II Hospital Agadir during 2012. 4th African Regional IRPA congress (AFRIRPA04), Rabat, Morocco.

 ISSN 2330-4049