International Journal Dental and Medical Sciences Research
Volume 3, Issue 4, July-Aug 2021 pp 70-74 www.ijdmsrjournal.com ISSN: 2582-6018

EstimationDose of patients during Nuclear Medicine Imaging

Osama O. Ali, Mohamed E. M. Gar-Elnabi
Sudan University of Science and Technology College of Medical Radiologic Science, P.O. Box 1908, Khartoum, Sudan
Corresponding Author : Osama O. Ali

Submitted: 01-07-2021 Revised: 13-07-2021 Accepted: 16-07-2021

ABSTRACT:
nuclear medicine involves the administration of radiopharmaceuticals that expose the patient to ionizing radiation. The aim of this study to estimate of patient's dose for patients are referred to nuclear medicine departments for thyroid and kidneys. The number of patients was 220 patients. The results showed that the group statistics for patients during renal scan, for patients age the mean ± standard deviation for female was 41.09 ± 15.09 and for male was 44.39 ± 17.36, for patient's height female was 156.33± 18.21 and for male 167.36 ± 9.12, for weight the female 63.96 ± 13.16 and for male 67.67 ± 10.76, for patient's dose female was 5.08 ± 0.78 and for male 5.23 ± 1.24.
For patients during thyroid scan, for patients age the mean ± standard deviation for female was 41.64 ± 17.36 and for male was 45.43 ± 19.24, for patient's height female was 161.28 ± 10.03 and for male 166.26 ± 11.07, for weight the female was 66.33 ± 11.10 and for male 70.37 ± 9.12, for patient's dose female was 4.48 ± 0.59 and for male 4.63 ± 0.54.
Analysis of variance for patients' dose with patients age and body mass index during renal scan, were the p.value showed significant difference between the patient's dose with age and body mass index were the p.value was 0.007 and 0.011 respectively. And for patients' dose with patients age and body mass index during thyroid scan, were the p.value showed no significant difference between the patient's dose with age and body mass index were the p.value was 0.788 and 0.423 respectively. The study concluded that the relationship between administered activity and patient size and weight needs to be better understood.

Keywords:Nuclear Medicine, Activity, Renal Scan, Thyroid Scan

I. INTRODUCTION:

Over the past 40 years, the utility of nuclear medicine procedures has been demonstrated for the clinical evaluation of patients with a wide variety of medical conditions, including urological, orthopedic, neurological, gastrointestinal and oncological conditions [1]. While medical imaging provides enormous benefit, radiation exposure also may carry risk, and the judicious use of radiologic and nuclear medicine procedures requires a balancing of these potential benefitsand risks in assessing the overall gain from exposing a patientto radiation. [2, 3]. Therefore, it is considered prudent to try to minimize even a small radiation risk, while ensuring that patientsreceive the benefits of undergoing nuclear medicineprocedures.Appropriate selection of administered RPH activity depends on patient population, choice of equipment, specific requirement of clinical protocols and the physician's judgment. It is also

possible to still lower the administered activity.[4,5]

99mTc isstill the most widely used radionuclide in nuclearmedicine, being used in about 80% of theexaminations for a variety of diagnosticprocedures performed in this field. When injectedintravenously, the radiopharmaceutical containing99mTc diffuses through the blood stream beingtaken up in specific sites of the body, dependingon its biokinetics.99mTc is obtained in the nuclear medicine ser vicesby the elution of a 99Mo-99mTc generator.Molybdenum-99 (t1/2 = 66 h) decays by betaemission to 99mTc (87%) and 99Tc (13%), emittingphotons of 740 and 778 keV [6].Ideally, 99mTc eluates contain no radionuclidicimpurity. However, as a consequence of generatoraging or possible occurrence of a mechanicaldefect, 99Mo may also be extracted from the column during this elution process, becoming acontaminant in the eluate to be administer ed to thepatient.According to the International Commission ofRadiological Protection [7], 25% ofmolybdenum which enters the blood deposits inthe liver. Bone and kidney are also depositionsites, with fractions of 10 and 5%, respectively.The other 60% is distributed through theremaining tissues of the body. Activity depositedin the skeleton is assumed to

International Journal Dental and Medical Sciences Research
Volume 3, Issue 4, July-Aug 2021 pp 70-74 www.ijdmsrjournal.com ISSN: 2582-6018

be retained with abiological half-time of 10,000 days. In all othertissues, 10% of the activity is assumed to beretained with a biological half-time of one day andthe other 90% with a half-time of 50 days [8]. However, experimental data gather ed byrecent investigations of molybdenum biokineticsand humans have shown that the current model foringestion of molybdenum isotopes recommendedby the ICRP requires some modifications [9].

II. METHODOLOGY:

The study was conducted atRadiationandIsotopeCenter in sudan in tht follwing hospital: RadiationandIsotopeCenter of Khartoum, RoyalCareInternationalHospital, AlnilainDiagnostic Center, NationalCancerInstitute, AlmakNimer Hospital, in period from Feb 2018- Aug 2021**, where** the study includes all patientsreferred tothese centers for Nuclear Medicine Exams duringthestudyperiod.(i.e.,diagnosticand therapeuticprocedures)withdifferentagebutwithcons tantrangeof weight60to80Kg.

Gamma Camera:

Hungarian Mediso SPECT system, Nucline® Spirit (DHV), S/N DH-004167-V0 with double head at Royal Care Hospital. Hungarian Mediso SPECT system, Nucline® Spirit (DHV), S/N DH-V-single V2.01 with (high, low) collimator at Al-MakNimer University Hospital. SPECT Gamma Camera, Type: Orbiter 37 with Single Head 37 PMTS/387mm] - Al-Nileen Diagnostic Center.

Dose Calibrator:

American ATOMLAB 400 Dose Calibrator, Royal Care Hospital. American ATOMLAB 400 Dose Calibrator 2.1-086-250, Al-MakNimer University Hospital and Radioisotope Dose Calibrator, CRC-25R, CAPINTEC RAMSEY, N-3-07446, T 2.0AL 250V, 100-240n, 50/60Hz, 245mA, made in U.S.A– Al-Nileen Diagnostic Center.

Renal: Renogram (Diuretic, and Captopril, Tubular Function, ffective Renal Plasma Flow, and Glomerular Filtration Rate)

Radionuclide : 99DTc: t 1\2 : 6 hours - Energies: 140 keV - Type: IT. 'Y' generator

I(123): t 1\2: 13.2 hours - Energies: 159 keV - type: EC, y, accelerator

(131): t 1\2 : 8.1 days - Energies: 364 keV - type: B ~-, y, fission product

Radiopharmaceutical: 99TC-DTPA :(diethylenetriaminepentaacetic acid), 99TC-MAG3 : (mercaptoacecyltrlglyclne)

Please note: The iodine compounds are no longer coxmnerdally available in the United States and will only be mentioned in passing as a historic note.

I123-0IH (orthoiodohippurate) sometimes still used in effective renal plasma flow (ERPF)

I131-0IH (orthoiodohippurate) sometimes still used in ERPF

Localization: Compartmental, blood flow. 9 9m'fc-MAG8o.1. highly protein bound, removed from plasma by organic anion transporter 1 in the basolateral membrane of the proximal renal tubules. It is then transported into the tubular lumen by organic anion transporters on the apical membrane with retained activity dependent on impairment. Uptake 1s by tubular secretion. Clearance Is through the urinary system and bladder with a small amount cleared through the hepatobiliary system and is 90% within 3 hours. 9 9m'J'cDTPA uptake 1s glomerular filtration and 1s purely filtered by the glomerulus and excreted through the urinary system and bladder. Clearance ls dependent on the amount of impurities In the product, which bind to the protein In the body.

Method of Administration: Bolus intravenous (IV) injection, If study includes a diuretic, use butterfly or IV catheter (furosemide 20-40 mg), Angiotensin-converting enzyme (ACE) inhibitor study: Captopril (Capoten171 50 mg) is given by mouth (PO) 1 hour before examination, Enalapril maleate (Vasotec® 0.04 mg/kg IV over 3-5 minutes).

Adult Dose Range: 99m'TC: DTPA: 5-10 mCi (185-370 MBq); pediatric :0.05 mCi/kg (1.9 MBq/kg), minimum dose 1 mCi (37 MBq).

Thyroid scan :

Radionuclide: 123I - t 1\2: 13.2 hours Energies: 159 keV type: EC, y, accelerator 131I - t1\2: 8.1 days Energies: 364 Kev (y), 606 keV (B-) \ type: B-, y, fission product 99mTC- t 1\2: 6 how-s Energies: 140 keV type :IT: .y. generator.

Radiopharmaceutical: 123I and 131I as capsules, Na 99mTCO4: Sodium perteclmetate

Localization: Active transport. 99mTC04 - trapped but not organified, 123I and 131I: Active transport; trapped in follicular cells by a high-energy sodium iodide symporter (iodine pump), organified by the thyroid, and held in cells or follicular lumen.

Quality Control: 99mTC: Chromatography >90%, moly and Al breakthrough, 123I and 131I : Assay capsule(s) in the dose calibrator to confirm amount of radioactivity.

Adult Dose Range: 131I: 1µ-ci - 10 m Ci (0.037-370 MBq) depending on patient and reason for scan Usually 5-30 µ-Ci (0.185-1.110 MBq) for uptake and scan, 2-5 mCi (74-185 MBq) for whole body imaging and/or treatment of patients, 1231: 100-600 µCi (3.7-25 MBq), pediatrtcs; 3-10 µCi/kg

International Journal Dental and Medical Sciences Research
Volume 3, Issue 4, July-Aug 2021 pp 70-74 www.ijdmsrjournal.com ISSN: 2582-6018

(0.1-0.3 MBq/ 99m'TC04-: 2-10 mCi (74-370 MBq)
Method of Administration: 123I and 131I capsule PO (per os meaning b mouth or oral)
99m'TC by intravenous injection

III. RESULTS:

Estimation of radiation dose for patient underwent nuclear medicine exam for thyroid and kidneys in Sudan,where the number of patients was 220patient's male and females and the data of this study presented as tables and figures:

Table 1. show Descriptive Statistics for all patients during Renal Scan:

	Mean	Std. Dev	Min	Max
Age	43.063	16.4926	18	80.0
Height	162.929	14.5042	50.0	190.0
Weight	66.179	11.8673	6.0	89.0
BMI	25.3525	4.34087	14.27	36.11
Dose	5.170	1.0729	2.5	10.0

Table 2. show Group Statistics for patients according to their gender during renal scan:

	Gender	Mean	Std. Deviation	Std. Error Mean
Age	Female	41.089	15.0889	2.2493
	Male	44.388	17.3563	2.1204
Height	Female	156.333	18.2109	2.7147
	Male	167.358	9.1182	1.1140
Weight	Female	63.956	13.1632	1.9623
	Male	67.672	10.7568	1.3142
Dose	Female	5.078	.7609	.1134
	Male	5.231	1.2411	.1516

Table 3. show descriptive statistic for all patients during Thyroid Scan:

variables	Mean	Std. Dev	Min	Max
Age	42.694	17.8940	18.0	88.0
Height	162.667	10.5183	132.0	189.0
Weight	67.454	10.7019	39.0	105.0
BMI	25.2991	5.48553	21.86	41.42
Dose	4.523	.5816	3.5	5.0

Table 4. show Group Statistics for patients according to their gender during thyroid scan:

	Gender	Mean	Std. Deviation	Std. Error Mean
Age	Female	41.641	17.3632	1.9660
	Male	45.433	19.2402	3.5128
Height	Female	161.282	10.0310	1.1358
	Male	166.267	11.0670	2.0205
Weight	Female	66.333	11.1024	1.2571
	Male	70.367	9.1179	1.6647
Dose	Female	4.481	.5946	.0673
	Male	4.633	.5403	.0986

Table 5. show analysis of variance for patients' dose with patients age and body mass index during renal scan:

		Sum of Squares	Df	Mean Square	F	Sig.
Age	Between Groups	5837.932	9	648.659	2.717	.007
	Within Groups	24354.631	102	238.771		

International Journal Dental and Medical Sciences Research
Volume 3, Issue 4, July-Aug 2021 pp 70-74 www.ijdmsrjournal.com ISSN: 2582-6018

	Total	30192.562	111			
BMI	Between Groups	385.485	9	42.832	2.561	.011
	Within Groups	1706.107	102	16.727		
	Total	2091.592	111			

Table 6. show analysis of variance for patients' dose with patients age and body mass index during thyroid scan:

		Sum of Squares	df	Mean Square	F	Sig.
Age	Between Groups	343.498	3	114.499	.351	.788
	Within Groups	33917.418	104	326.129		
	Total	34260.917	107			
BMI	Between Groups	85.217	3	28.406	.942	.423
	Within Groups	3134.523	104	30.140		
	Total	3219.740	107			

Table 7. show compare between the present study with other studies worldwide:

Studies	Thyroid	Renal	Bone
Present study	4.52	5.17	19.28
Malaysia 2013	349	365	832
Australia 2008	200	500	900
Ireland 2004	80	300	800
Japan 2015	370	400	950
Lithuania 2012	92	108	517

IV. DISCUSSIONS:

Table 1. show Descriptive Statistics for all patients during Renal Scan the total number of patients was 112, were the data presented as mean, standard deviation, minimum and maximum. For age the mean ± STD was 43.06 ± 16.49, for patient's height, weight and BMI was 162.93 ± 14.50, 66.18 ± 11.87 and 25.35 ± 4.34 respectively, for dose was 5.17 ± 1.07.

Table 2. show group statistics for patients during renal scan, for patients age the mean ± standard deviation for female was 41.09 ± 15.09 and for male was 44.39 ± 17.36, for patient's height female was 156.33± 18.21 and for male 167.36 ± 9.12, for weight the female 63.96 ± 13.16 and for male 67.67 ± 10.76, for patient's dose female was 5.08 ± 0.78 and for male 5.23 ± 1.24.Table 3. show descriptive statistics for all patients during thyroid Scan the total number of patients was 108, were the data presented as mean, standard deviation, minimum and maximum. For age the mean ± STD was 42.69 ± 17.89, for patient's height, weight and BMI was 162.66 ± 10.52, 67.45 ± 1070 and 25.29 ± 5.49 respectively, for dose was 4.52 ± 0.58.

Table 4. show group statistics for patients during thyroid scan, for patients age the mean ± standard deviation for female was 41.64 ± 17.36 and for male was 45.43 ± 19.24, for patient's height female was 161.28 ± 10.03 and for male 166.26 ± 11.07, for weight the female was 66.33 ± 11.10 and for male 70.37 ± 9.12, for patient's dose female was 4.48 ± 0.59 and for male 4.63 ± 0.54.Table 5. show analysis of variance for patients' dose with patients age and body mass index during renal scan, were the p.value showed significant difference between the patient's dose with age and body mass index were the p.value was 0.007 and 0.011 respectively.

Table 6. show analysis of variance for patients' dose with patients age and body mass index during thyroid scan, were the p.value showed no significant difference between the patient's dose with age and body mass index were the p.value was 0.788 and 0.423 respectively.compare between the present study with international studies worldwide, were the present study show the lowest value of dose form all others studies for both thyroid and renal scan.

V. CONCLUSIONS:

The aim of this study to estimate of patient's dose for patients are referred to nuclear medicine departments for thyroid and kidneys. The number of patients was 220 patients. The results showed that the group statistics for patients during renal scan, for patients age the mean ± standard deviation for female was 41.09 ± 15.09 and for male was 44.39 ± 17.36, for patient's height female was 156.33± 18.21 and for male 167.36 ± 9.12, for weight the female 63.96 ± 13.16 and for male 67.67

± 10.76, for patient's dose female was 5.08 ± 0.78 and for male 5.23 ± 1.24. For patients during thyroid scan, for patients age the mean ± standard deviation for female was 41.64 ± 17.36 and for male was 45.43 ± 19.24, for patient's height female was 161.28 ± 10.03 and for male 166.26 ± 11.07, for weight the female was 66.33 ± 11.10 and for male 70.37 ± 9.12, for patient's dose female was 4.48 ± 0.59 and for male 4.63 ± 0.54.

Analysis of variance for patients' dose with patients age and body mass index during renal scan, were the p.value showed significant difference between the patient's dose with age and body mass index were the p.value was 0.007 and 0.011 respectively. And for patients' dose with patients age and body mass index during thyroid scan, were the p.value showed no significant difference between the patient's dose with age and body mass index were the p.value was 0.788 and 0.423 respectively. comparing between the present study with international studies worldwide, were the present study show the lowest value of dose form all others studies for both thyroid and renal scan.

REFERENCES:

[1]. Treves ST, Baker A, Fahey FH et al (2001) Nuclear medicine in the first year of life. J Nucl Med 52:905–925
[2]. Committee to assess health risks from exposure to low levels of ionizing radiation (2006) Health risks from exposure to low levels of ionizing radiation: BEIR VII Phase 2. National research council of
[3]. the national academies. The National Academies Press, Washington
[4]. United Nations scientific committee on the effects of atomic radiation (2013) Sources, effects and risks of ionizing radiation. Vol. II, scientific annex B: effects of radiation exposure of children. United
[5]. Nations Publication E.14.IX.2, New York.
[6]. Sheehy N, Tetrault TA, Zurakowski D, Vija AH, Fahey FH, Treves ST. Pediatric 99mTc-DMSA SPECT performed by using iterative reconstruction with isotropic resolution recovery: Improved image quality and reduced radiopharmaceutical activity. Radiol 2009;251:511-6.
[7]. Stansfield EC, Sheehy N, Zurakowski D, Vija AH, Fahey FH, Treves ST. Pediatric 99mTc-MDP bone SPECT with ordered subset expectation maximization iterative reconstruction with isotropic 3D resolution recovery. Radiol 2010;25:793-801.
[8]. Lawrence Berqueley National Laboratory (2005),LBNL Isotopes Project - LUNDS Universitet. WWW
[9]. Table of Radioactive Isotopes. Disponívelem:http://ie.lbl.gov/toi/index.asp.
[10]. International Commission on Radiological Protection(1979), Limits for intakes of radionuclides by
[11]. workers. Oxford : Pergamon Press; ICRP.
[12]. International Commission on Radiological Protection(1993), Age-dependent doses to members of the publicfrom intake of radionuclides: Part 2 - Ingestion dosecoefficients. Oxford : Pergamon Press. (ICRPPublication; 67).
[13]. Giussani, A.; Cantone, M. C.; Bartolo, D.; Roth, P. andWerner, E. (1998), A revised model of molybdenumbiokinetics in humans for application in radiationprotection. Health Physics, 75 : (5), 479-486.