DIAGNOSTIC REFERENCE LEVEL FOR COMMON NUCLEAR MEDICINE STUDIES IN NATIONAL HOSPITAL ABUJA

Musa Y Dambele[1], Abdulkarim Muhammad Sulaiman[1], and Agwu K.K[2]

[1]Department of Medical Radiography, Bayero University Kano, Abdulkarim Muhammad470@gmail.com

[2]Department of Medical Radiography, Bayero University Kano, Mydambele.rdg@buk.edu,ng

[3]Department of Medical Radiography, University of Nigeria Nsukka, Kenneth.agwu@unn.edu.ng

ABSTRACT

Introduction: Diagnostic reference level (DRL) is a tool used to aid in optimization in medical exposure for diagnostic and interventional procedures that involve the use of ionizing radiation. It has been observed that there is no establish DRL for nuclear medicine studies in National Hospital Abuja, so this research will establish DRL for proper dose optimization.

Objective: This study aimed at establishing a concise DRL for common nuclear medicine studies in National Hospital Abuja.

Methodology: All the available data of the administered activity (AA) for adult most common requested examination of patients with normal size of 70 ± 15 kg from the archive of the Nuclear Medicine department for two consecutive years from January 2016 to December 2017 were collected.

Result: It was found that the proposed DRL from this study in MBq are 762, 192 and 370 for 99mTcMDP Bone Scan, ^{99m}Tc-DMSA Renal Scan and ^{99m}Tc-DTPA Renal Scan respectively. The proposed DRL is set based on the 3rd quartile (75th percentile) of the survey result and indicate no correlation between administered activity with patient weight and height ($p>0.05, r=0$).

Conclusion

Based on the proposed DRL from the study it was found that the proposed DRL is higher than that of IAEA. But with ^{99m}Tc-MDP and ^{99m}Tc-DTPA within the range values of the European countries, while the ^{99m}Tc-DMSA is slightly higher than the EC range.

Keywords: DRL, Bone scintigraphy, Administered Activity.

INTRODUCTION

Diagnostic reference level (DRL) is a tool used to aid in optimization in the medical exposure of patients for diagnostic and interventional procedures. It is use in medical imaging that involve the use of ionizing radiation [1]. Diagnostic reference level (DRL) was first introduced in the International Commission on Radiation Protection (ICRP) Publication 73 [2]. For nuclear medicine it is given in terms of Administrated Activity (AA) in Mega Becquerel (MBq) and the effective dose is directly proportional to AA [3]. Diagnostic reference level is not always available or established locally for nuclear medicine(NM) and this could lead to the non standardization of radioisotope activities administered to patients and increase radiation exposure, without any improvement in the diagnostic ability [4]. And DRLs in NM are based on administered activities used for normal size patients (typically 70 ± 15 kg) [5]. Therefore, DRL is use to help avoid delivery of excess radiation to the patient that does not contribute to the clinical purpose of a medical imaging task and this can be accomplish by comparing the numerical value of the DRL (derived from relevant regional, national, or local data) and the mean or other appropriate value observed in practice [1]. Diagnostic reference level are potentially set by each individual clinic to meet its unique needs to ensure appropriate, consistent practice for radiation safety and optimal image quality within individual clinics [6]. Because each clinic has a unique set of factors (scanner technology, time for examinations, patient population, physician preference) that can dictate radiation doses (and local reference levels) that deviate from published levels which need to be reviewed regularly [6]. Therefore, Local DRL established for an institution should be subject to annual review as well as independent scrutiny and audit [7].

However when it comes to image quality in nuclear

medicine, the image photon density is directly proportional to administered activity (AA) and acquisition duration. Thus DRL is mainly for the purpose of radiation protection guidance [6] and they are basically determined based on 75th percentile of the survey results [4]. A research conducted by Willegaignon in 2016 in brazil indicated that renal dynamic (99mTc-DTPA), bone (99mTc-MDP), renal static (99mTc-DMSA), and parathyroid (99mTc-MIBI) scans are the four procedures used in more than 85% of the 107 clinics analyzed, with respective administered activities averages of 406 (±164), 1036 (±190), 189 (±64), and 708 (±161) MBq [8]. Therefore there is always a need to establish a system for patient dosimetry, audit and setting of local DRL for nuclear medicine [9]which will serve as a tool for radiation protection, protocol improvement, and to ensure best practices [6]. However, DRL does not provide a dividing line between good and bad practice [10] .

This study aimed to establish a concise method for determining the local DRL based on the two common requested examinations as a means of optimizing medical exposure.

MATERIAL AND METHOD

All the available data of the adult AA for the most common requested examination (Bone and Renal scintigraphy) with normal size of 70 ± 15 kg for four consecutive years from January 2014 to December 2017 were collected from the archive of nuclear medicine department National hospital Abuja.

A total number of 226 patients AA for all the studies were recorded on an electronic data capture sheet. The data was then analyzed using statistical package for social sciences (SPSS) version 21.

RESULT

NHA Administered activity (AA) are presented in Table 1 and Figure 1 represent the average administered activity (AAA), Table 2 represents the relationship between the AA with patient weight and height while Table 3 shows the comparison between the proposed DRL and the recommenced standard.

TABLE I: NHA ADMINISTERED ACTIVITY (VALUES ARE IN MBQ)

Radioisotopes study	Administered Activity			
	Minimum	Maximum	Average AA (±1 SD)	P_{75} (Proposed DRL)
^{99m}Tc-MDP Bone Scan	548	850	738±44	760
^{99m}Tc-DMSA Renal Scan	75	370	187±96	192
^{99m}Tc-DTPA Renal Scan	130	462	322±78	370

P=Percentile, TC=Technetium, MDP=Methylene diphosphonate, DTPA=Diethylene triamine penta-acetic acid and DMSA=Dimercaptosuccinic acid

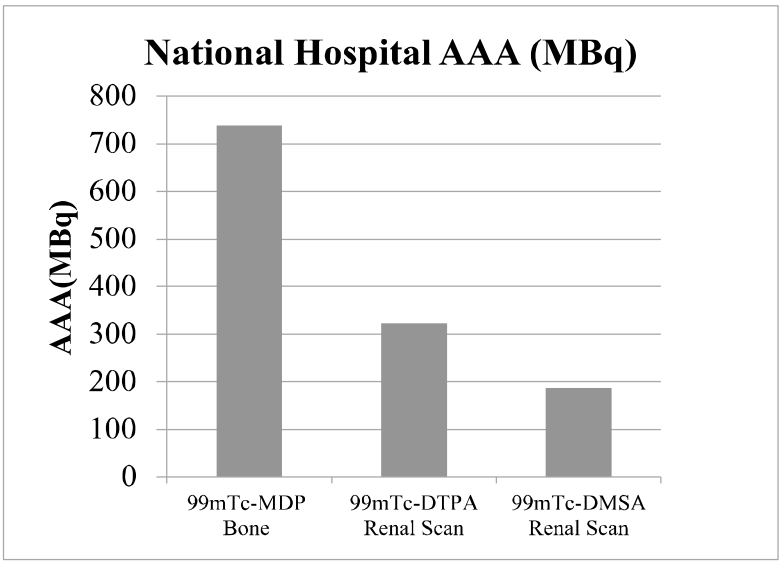

Figure I. The calculated AAA for common nuclear medicine studies.

TABLE II. RELATIONSHIP BETWEEN AA AND PATIENT WEIGHT AND HEIGHT.

Radioisotopes study	Weight(kg)		Height(cm)	
	r	p	r	p
^{99m}Tc-MDP Bone Scan	0.069	0.357	0.05	0.949
^{99m}Tc-DMSA Renal Scan	-0.132	0.717	0.221	0.540
^{99m}Tc-DTPA Renal Scan	-0.100	0.607	-0.130	0.500

r=coefficient of correlation and p=level of significance.

TABLE III. PROP0SED DRL AND INTERNATIONAL STANDARD (values are in MBq).

Radioisotopes study	P_{75}(Proposed DRL)	BSS(11)	EU(5)
^{99m}Tc-MDP Bone Scan	760	600	500 – 1110
^{99m}Tc-DMSA Renal Scan	192	160	70 – 183
^{99m}Tc-DTPA Renal Scan	370	350	150– 540

BSS=Basic safety standard, EU=European Union.

DISCUSSION

Reference levels are primarily intended to offer benchmark values as a rough guideline for appropriate practice and they do not need to be exact [6]. Therefore it is difficult to establish the best activity to be use for each exam as various factors can exert an influence, namely, the desired quality of the image, the time-lapse between administration of the radiopharmaceutical to image acquisition, the count rate of photons necessary for forming the image, the physical characteristics of the equipment (collimators, detectors), as well as the characteristics of the patients themselves (weight, height, clinical conditions) [8].

The proposed DRL is set based on the 3rd quartile (75th percentile) of the total calculated dose distribution. However it was observed that the standard deviation for all the studies were high. The high value has been reported in some studies and this study agree with their findings[3,4,5].

Detail result from the table shows that, during ^{99m}Tc-MDP Bone scintigraphy the result indicated that there was a positive no significant relationship ($p>0.05$) between the weight and height of the patients with the AA, however ^{99m}Tc-DMSA renal scintigraphy showed a negative no significant correlation between AA and the weight while the height indicate no significant correlation positively. Similarly, for ^{99m}Tc-DTPA Renal Scan the result showed that there was a negative no significant relationship ($p>0.05$) between the height and weight of the patients with the AA.

The comparison of the proposed DRL with the recommended value of the International atomic energy agency (IAEA) Basic Safety Standard (BSS) and the value range by European union; European Association of Nuclear Medicine (EANM) further confirmed that the DRL for ^{99m}Tc-MDP Bone is 760MBq while that of BSS and EU are 600 and 500-1110 respectively. ^{99m}Tc-DMSA Renal Scan proposed DRL was 192 while that of BSS and EU are 160 and 70–183 respectively. However the proposed DRL for ^{99m}Tc-DTPA Renal Scan is 370 while that of BSS and EU value are 350 and 150– 540 respectively. The proposed DRL for all the study were higher when compared with that of the BSS while that of ^{99m}Tc-MDP Bone Scan and ^{99m}Tc-DTPA Renal Scan were within the recommended value range of EU with ^{99m}Tc-DMSA Renal Scan higher than the maximum value range of EU [5,6]

In comparison with a study in Sudan pointed out that the Sudanese DRLs for Bone scan, , Static and Dynamic Renal scan, are 777, 173.9 and 206.5 MBq respectively. It was noted that the Sudanese DRLs for bone is slightly higher while lower for static and dynamic renal scan than the proposed NHA values[12].

Another study by (Cho, Kim and Song, 2017) [11] in Korea established a preliminary DRLs which are found to be 925, 195 and 555 for bone, static and dynamic renal scan respectively. The preliminary DRLs from this study are noted to be higher than the proposed DRLS from our study.

Also in comparison with another Report of a nationwide survey on actual administered radioactivities of radiopharmaceuticals for DRLs in Japan on 516 nuclear medicine facilities

revealed that the 75th percentile in MBq from those facilities were calculated to be 950,210 and 400for bone, static and dynamic renal scan respectively which are higher when compared to the proposed DRLs from our study[12].
Furthermore another study by (Willegaignon *et al.,* 2016) [8]from brazil established a proposed DRL in MBq as follows 1110, 185 and 449 for bone, static renal scan and dynamic renal scan respectively. It was noted that the established DRLs for bone and dynamic renal scan are higher while static renal scan is lower when compared to the proposed DRL from our study.

CONCLUSION

The nonstandardization of activities administered for the same type of exam in nuclear medicine can reflect the lack of control of radiation exposure, and it was observed that there is wide range between the AA to the patient for the same type of examination. The proposed DRL for all the study were higher when compared with that of the BSS while that of ^{99m}Tc-MDP Bone Scan and ^{99m}Tc-DTPA Renal Scan were within the recommended value range of EU with ^{99m}Tc-DMSA Renal Scan higher than the maximum value range of EU. However establishing the proposed Local DRL will serve as a guide for radiation protection and protocol improvement.

Conflict of Interest: Nil

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