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Establishment of Dose Reference Levels for Nuclear Medicine in Sudan

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Abstract

In this study, a national survey for establishment of Nuclear Medicine (NM) Dose Reference Levels (DRLs) for adult patients was carried out. The Administrated Activity (AAs) (MBq) was collected from six nuclear medicine departments. Factors influencing the image quality were also observed. The established Sudan National DRLs represent the AA value corresponding to 75th percentile of the AA frequency distribution. Generally, Sudan National DRLs and average AAs are comparable with the papers published in the international literature. All Sudanese DRLs values were found within the international range. While it is noted that the Sudanese DRLs is higher than the values of ARSA except for the MIBI pharmaceuticals that used in both parathyroid and myocardial perfusion scan and for ^{99m}TcDTPA that used for Dynamic Renal scan study the DRLs values were decreased. In compared with UNSCEAR 2008 data, the average dose (MBq) for Sudanese we note that the bone scan falls within the average values while it's lower in all other scans except for parathyroid scan in which the AAAs increase more than twice. When compared to BSS 1996, it showed variation in increased and decreased AAAs. There may be potential for reducing the higher values of AAs, in co-operation with Nuclear Medicine staff.

Keywords

Nuclear Medicine, Diagnostic Reference Level DRLs

1. Introduction

Diagnostic reference Levels (DRLs) have been introduced by the International Com-

mission on Radiological Protection ICRP publication 60 [1] and 37 [2] and by European Directive 97/43/Euratom [3] for assisting the optimization of radiological investigation. The objective of DRLs is to help avoid radiation dose to the patient that does not contribute to the clinical purpose of a medical imaging task. This accomplished by comparison between the numerical values of the DRLs (delivered from relevant regional, national of local data) and the mean or other appropriate value observed in practice for a suitable reference group of patient or a suitable reference phantom. All DRLs have been given in term of Administrated Activity (AA) in Mega Becquerel (MBq). There is a large variation between DRLs given by countries. DRLs in NM are based on AAs used for normal size patients (typically 70 ± 15 Kg). The concept of DRLs is not based on the 75th percentile but on the AA necessary for good image quality during a standard procedure. Committee 3 of ICRP encourages authorized bodies to set DRLs that best meet their specific needs and that are consistent for the regional, national or local area to which they apply [4]. In nuclear medicine, the effective dose is directly proportional to AA. Therefore, it is highly important to give guidance for a dosage and the following effective dose, especially concerning pediatric patients [5].

2. Method

The data of this study were collected by complying the checklist that concerning the administrated activities (AAs) (MBq) to the standard sized adult patients (*i.e.* 70 ± 10 Kg) for standard procedure necessary to obtain the optimum diagnostic information as recommended by previous study [6]. The data were collected from six nuclear medicine departments (100% of total Number of nuclear medicine Departments in Sudan). *i.e.* this study covers all the nuclear medicine activities in Sudan without Exclusion to any units or department. administrated activities frequency distribution were obtained for the nuclear medicine diagnostic scan presented in **Table 1** and **Table 2** and in **Figure 1** with comparing the values to the ARSAC [7], UNSCEAR 2009 A [8], and BSS 1996 B [9]. For each patient the dose was calculated according to the patients weight using the formula of patient dose for exam = (slandered dose of exam × patient weight)/standard weight (70 Kg), and this is a fastest methods for obtaining the patient dose on routine work rather than the use of body Mass index (BMI). Sudan National DRLs were accomplished according to which the DRLs represent the administrated activities value corresponding to the 75th percentile of the distribution. Also, the average AAs (AAAs) and the relevant ranges were calculated.

A = Typical AAs.

B = Guidance levels (maximum usual activities).

3. Result

Established Sudan DRLs (*i.e.* national) are presented in **Table 1** and **Figure 2**. The Sudanese AAAs (*i.e.* national) are presented in **Table 2** and **Figure 3**. Factors, such as instrumentation's poor performance and procedures followed by the staff, which influence the image quality and may result in higher AAs, were also investigated during the

Table 1. Sudan DRLs (values are A in MBq, for adults).

Radioisotopes study	Sudan DRLs (calculated)	Most common values ARSA [7]	International range [5]
^{99m}Tc-MDP Bone scan	777	600 (800 SPECT)	500 - 1110
^{99m}TcO4 Thyroid scan	185	80	75- 222
^{99m}Tc-DMSA Static renal scan	173.9	80	70 - 183
^{99m}Tc-DTPA Dynamic renal scan	206.5	300	150 - 540
^{99m}Tc-MIBI Parathyroid scan	555	600	400- 900
^{99m}Tc-MIBI myocardial perfusion imaging*	740	1200	300 - 1480*

*=one day protocol, MDP = methylene-diphosphonate, DMSA = Dimercaptosuccinate, DTPA = Diethylene Triamine Penta Acidic Acid, MIBI = methoxyisobutylisonitrile.

Table 2. Sudan AAA (values are A in MBq, for adults).

Radioisotopes study	Sudan AAA	UNSCEAR 2008 A [8]	BSS 1996 B [9]
^{99m}Tc-MDP Bone scan	709.7	740 - 1110	600
^{99m}TcO4 Thyroid scan	184.3	370	200
^{99m}Tc-DMSA Static renal scan	165.2	185	160
^{99m}Tc-DTPA Dynamic renal scan	301.3	370	350
^{99m}Tc-MIBI Parathyroid scan	555	200	75 - 150
^{99m}Tc-MIBI myocardial perfusion imaging*	708.3	1100	Not identified

A = Typical AAs, B = Guidance levels (maximum usual activities).

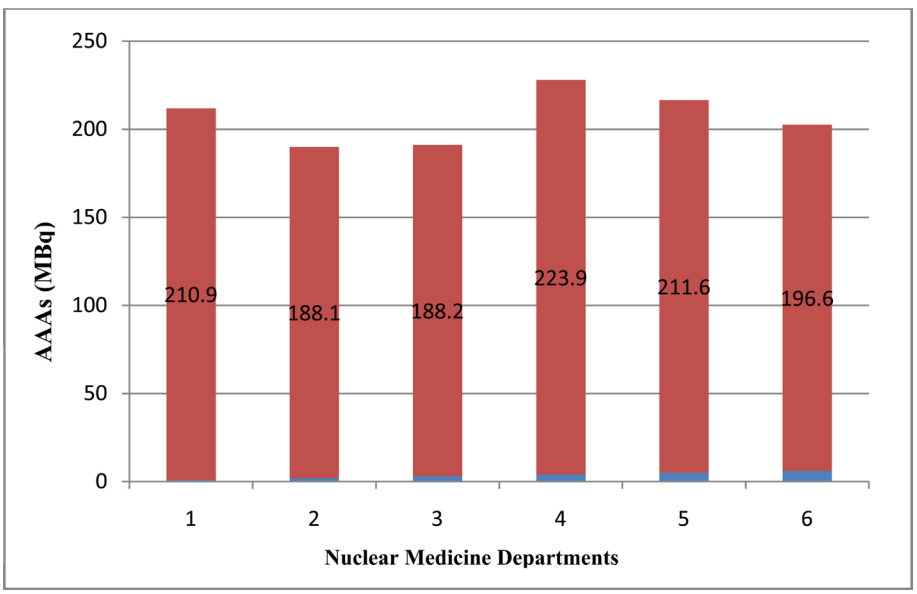

Figure 1. AAAs frequency distribution for Dynamic Renal scan with ^{99m}Tc-DTPA AAAs = Average Administrated Activities.

survey and found satisfactory. Figure 1 represents the AAAs of one example of nuclear medicine scan that was commonly performed in Sudan which is ^{99m}Tc-DTPAuse for

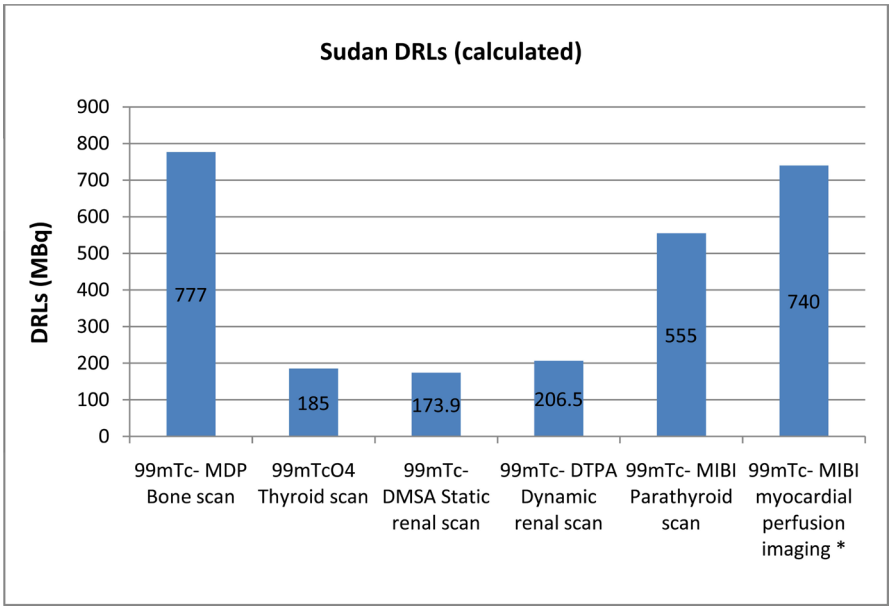

Figure 2. The calculated Sudan DRLs for nuclear medicine examination.

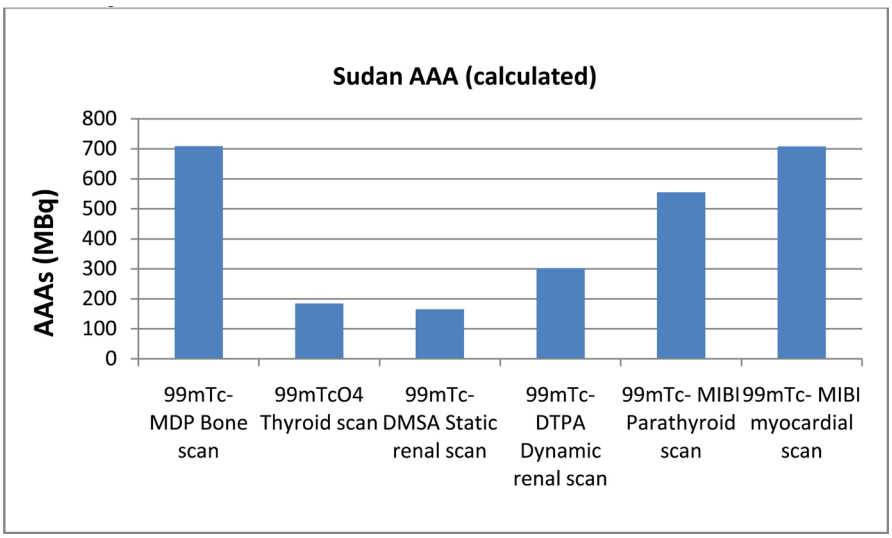

Figure 3. The calculated Sudan AAAs for nuclear medicine examination.

renal system function evaluation. We noted clearly that the range of AAAs of DTPA range from 188.1 to 223.9 MBq with no matching values between the departments because the AAAs depend on the department protocol and the averaged of patients scanned per unit time.

4. Discussion

4.1. Sudan DRLs

All Sudanese DRLs values were found within the international range [5] as they showed in Table 1, the Sudan DRLs for Bone scan, Thyroid Scan, Static renal scan, Dynamic Renal scan, Parathyroid scan, and Myocardial scan are 777, 185, 173.9, 206.5, 555 and

740 MBq respectively compare to international range of (500 - 1110), (75 - 222), (70 - 183), (150 - 540), (400 - 900), and (300 - 1480) MBq respectively. While it is noted that the Sudanese DRLs is higher than the values of ARSA [7] except for the MIBI pharmaceuticals that used in both parathyroid and myocardial perfusion scan and for ^{99m}TcDTPA that used for Dynamic Renal scan Study the DRLs values were decreased. Opposite to ARSA, the nuclear medicine centers and activities in Sudan was newly introduced, and for the reasons of Socio-economic factors somehow the dose in sometimes was not optimized even with a final diagnosable image.

4.2. Sudan AAAs

In compared with UNSCEAR 2008 data [8] the average dose (MBq) for Sudanese we note that the bone scan falls within the average values while its lower in all other scans except for parathyroid scan AAAs which increase more than twice (555 MBq compared to 200 MBq) as the technologist used high dose for optimum detection of the pathology of the small sixed parathyroid gland because of the lack of high resolution camera in some center that must be used for imaging small organs and gland like parathyroid, but as DRLs the parathyroid gland value is still within the acceptable range of international range [5] [400 - 900 MBq] and also the values was still lower than that of ARSA [8] [600 MBq]. In Routine work in nuclear medicine departments in which the parathyroid scan carried out the technologist use the dose increase by a factors of 1.5 to 2 from a measurable dose using patient weight is provide an optimum image quality, the experiments of this values was carried out earlier with the feedback of nuclear medicine specialist about the influence if increasing the radiation dose on the image quality. While when compared to BSS 1996 [9] it showed variation in increased and decreased AAAs.

For establishments of DRLs the 75th percentile methods will use, while in case of future re-evaluation an "optimum values" is recommended to be use in NM DRLs instead of 75th percentile [10].

5. Conclusions

In some studies, Sudan DRLs and AAAs appear lower than the values found in literature while in other cases observed higher.

Meeting the DRLs does not automatically mean that good practice is performed [8]. There is a minimum activity for each radiopharmaceuticals and a baseline activity that is multiplied with factor given in tables according to the patient weight [5]. Sudan DRLs for nuclear Medicine Diagnostic studies are to be as national guideline and should not be exceeded only for individual patients who are over standard weight.

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