LOCAL DRL IN NUCLEAR MEDICINE DEPARTMENT OF CANCEROLOGY INSTITUTE OF LIBREVILLE

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ABSTRACT

The present study aimed to evaluate the Diagnostic Reference Level (DRL) of the only nuclear medicine department of Libreville in Gabon. The studies were carried out with a SPECT/CT equipment and adult patients, the focus was on Tc-99m Bone scan examinations. Actual administered activities were calculated by the difference between the measured activity and residual activity after injection, the decay time was also considered for actual activities. Then, the median, mean and third quartile of actual administered activities distribution have been calculated. Results: The values found are comparable with those reported in other countries. Conclusion: This study presents the establishment process and the results of the first national DRLs for nuclear medicine procedures in Gabon to optimize radiation exposure.

Keywords: Radiation Protection, Nuclear medicine, Diagnostic reference levels, bone scintigraphy

I. INTRODUCTION

Over the past century, medical imaging has evolved to an indispensable part of diagnostic procedures. However, some of the most common imaging methods make use of ionizing radiation and thus, inherently imply radiation exposure to patients [1 below]. Diagnostic Reference Levels (DRLs) have been introduced by the International Commission on Radiological Protection ICRP publications [2,3] for assisting the optimization of radiological investigation.

In 2012, a nuclear medicine global initiative was established that aims to promote human health by advancing the fields of nuclear medicine and molecular imaging, to encourage global collaboration in education, and to harmonize procedure guidelines and other policies that ultimately lead to improvements in quality and safety in the fields throughout the world [on page 63]. One of the recommendations of this initiative was that countries with no current guidelines on administered nuclear medicine activities in children should either develop their own or officially adopt currently existing ones.

Nuclear medicine and hybrid imaging procedures may also increase radiation exposure to the general public because of the characteristics of the administered radiopharmaceuticals compared with diagnostic radiology procedures. This potential increased exposure has raised many concerns about potential radiation risks [5]. There is substantial need to establish DRLs in nuclear medicine imaging studies to reduce unjustified medical radiation exposure and social concerns, as well as to optimize radiation protection. DRL are standard levels of easily measurable quantities, such as the dose length product in computer tomography (CT) or administrated activity in nuclear medicine (NUC), for common procedures. DRL for NUC can be set at the third quartile as for radiography or CT but also at the median or mean of each examination type.

II. MATERIALS AND METHODS

This study was conducted at the Institute of Cancerology of Akanda, formerly known as the Institute of Cancerology of Libreville. The data were collected from the nuclear medicine department of the institute over several months, the NUC department is the only one in Gabon, so this study has covered all the national nuclear medicine activities of the country.

Data recording and collection has been done with those different parameters:

- Patient and examination information: patient identification, procedure type, equipment, date, time, age, gender and weight.

- Nuclear medicine: radionuclide, radiopharmaceutical, administered activity, pre-administration measured activity, post-administration measured activity and activity per weigh.

The studies were carried out with a SPECT/CT equipment (Philips) and the data for 30 adult patients (more than 30 years old) is presented in this paper. The focus was on Tc-99m-methyl diphosphonate Bone scan examinations. All datasets of patient weight lower than 45 kg were excluded and less than 20% of the group weighed over 90kg.

The collected data of patients was analysed, and the required details were extracted. The departmental protocol for bone scintigraphy included preparing the radiopharmaceutical (^{99m}Tc), measuring it with a dose calibrator in the radiopharmacy hot lab, administering it

intravenously to referred patients. The administered activity administered, and other anthropometric parameters were recorded for each patient.

Actual administered activities were calculated by the difference between the measured activity and residual activity after injection, the decay time was also considered for actual activities.

The data collected in this study were saved and analyzed using Microsoft Office Excel. It was mainly used to compute administered activity of each patient, the mean values, median values and plot graphs.

The actual administered activities (Aadm) for each patient have been calculated using the following formula:

$$\mathrm{Aadm} = \mathrm{Ameas} * e^{\ln(2)*\frac{\mathrm{admT}-\mathrm{meas}}{\lambda}} - \mathrm{Ares} * e^{\ln(2)*\frac{\mathrm{resT}-\mathrm{admT}}{\lambda}} \quad (1)$$

With:
Measured activity: Ameas (MBq)
Measured time: measT
Administered time: admT
Residual activity: Ares (MBq)
Residual activity time: resT
Actual administered activity: Aadm (MBq)
λ: half-life of the ^{99m}Tc. (Day)

Then, the 75th percentile, median and mean of actual administered activities were calculated to get local reference levels.

III. RESULTS

Patients data, measured activities and residual activities for the 30 patients have been collected and registered in an Excel spreadsheet. With the compiled data, the actual administered activity has been calculated for each patient using the formula (1). **Table 2** shows a sample of patients and their collected parameters.

Thereafter, the median and mean of administered activities have also been calculated and are respectively 700.76 MBq and 686.74 MBq and the DRL value that has been calculated with the 3rd quartile is 721.03 MBq.

The DRL in Gabon was compared with DRLs recently internationally reported [6,7,8,9] (**Table 3)**. The Gabon DRL value is lower than the DRL values from Sudan [6], Kuwait [7], Nigeria [8] and Australia but higher than the U.K. [9] value; It is also in the range of European union values [10].

The mean administered activity has also been compared to other countries **(Table 4**). The Gabonese mean value was lower than the Sudanese, Nigerian and Brazilian mean value but higher than the French mean value [11].

It was also important to see if there is a correlation between administered activities to the patient and his weight (**Figure 1)**. The graph has showed that for these datasets, the administered activity did not take into account the weight of the patient. Infact, a patient with a weight of 52Kg has received an activity of 815Mbq while another one weighing 78Kg has received an activity of 721MBq.

IV. DISCUSSION

DRLs are considered an effective optimization tool for improving radiation protection in medical imaging [12] and are not in any way dose limits or constraints, nor do they serve regulatory purposes. However, they aim to identify whether some common procedures present unusually high values, alerting the department to act accordingly by, for instance, reviewing procedures, protocols, or equipment.

This study has established preliminary DRLs for bone scintigraphy for the only hospital that offers nuclear medicine services currently. The values have been found within the international range of 500 – 1110 MBq whether for the DRL value or mean administered activity value. The DRL value is 721.03MBq and the mean administered activity is 686.74MBq

Nevertheless, the present study has some limitations. The patient weight has not been considered for the administered activity, while the ICRP recommend a consideration should be given to adjusting administered activities based on agreed factors linked to weight [13]. So, procedures should be optimized to include the patient weight factor to determine the administered activity, thus the next DRL should be better improved with this new added component.

Also, the administered activity alone is analyzed without evaluation of the image quality. Although, it may be difficult to assess the image quality objectively as it involves not only administered activity but also the use of different hardware and readers' preferences.

More, the equipment used in the institution is a SPECT/CT so for the next study, the DRL of the CT component of SPECT/CT should be considered for hybrid imaging examinations.

Also, the administered activity in children is not analyzed in this study while children are more sensitive to ionizing radiation.

Table 2: Actual administrated activities

Patients	Age	Weight (kg)	A_{meas} (MBq)	Meas time	Admin time	Ares (MBq)	Res time	A_{adm} (MBq)
1	78	73.6	775	08:20	08:28	22.51	08:33	**740.43**
2	54	51.5	876	08:44	08:53	29.62	08:55	**831.22**
3	31	46.1	832	08:12	09:17	14	09:20	**720.05**
4	77	50.1	727.5	08:17	09:00	17.4	09:15	**651.78**
5	59	78	856	08:14	09:00	61.13	09:08	**721.37**
6	34	87.7	926.1	08:18	09:08	48.83	09:11	**791.99**
7	55	52.3	868.7	08:16	08:35	21.44	09:00	**815.00**
8	36	45	724	08:06	08:30	39.66	08:42	**650.72**
9	40	98.1	759.3	08:08	08:35	18.1	08:42	**702.49**
10	39	64.3	852.3	08:10	08:45	48.95	08:53	**747.05**

Table 3 : DRL (MBq) in Gabon compared with other countries.

Radioisotope study	Gabon	European Union	Kuwait	Sudan	Nigeria	Australia	U.K.
^{99m}Tc-MDP Bone scan	721.03	500–1,110	944	777	895.4	920	600

Table 4: Mean administered activity (MBq) in Gabon Compared with Other Countries

Radioisotope study	Gabon	France	Sudan	Nigeria	Brazil
99mTc-MDP Bone scan	686.74	670	709.7	833.98	1,036

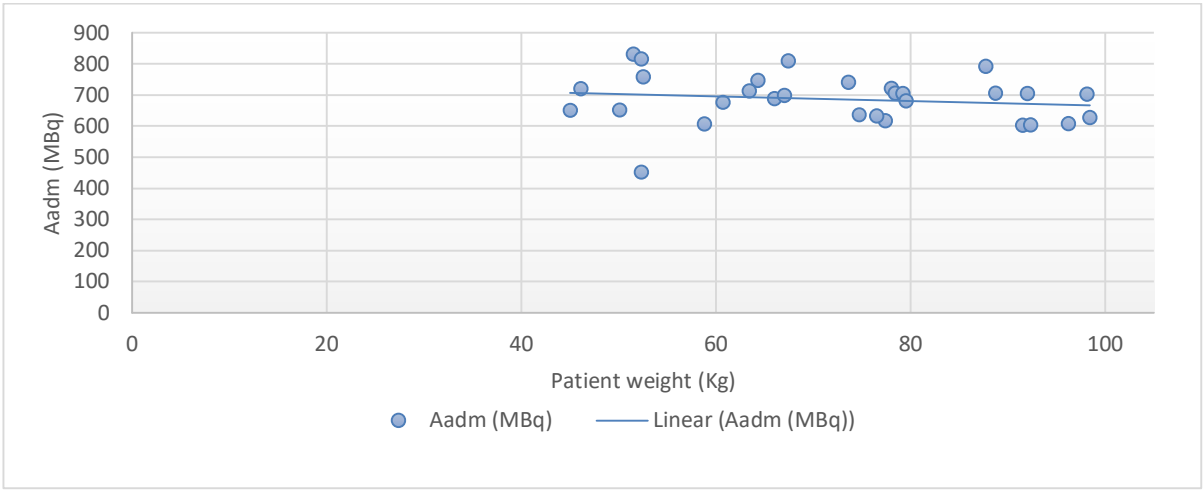

Figure 1: Correlation administered activity and patient weight.

V. CONCLUSION

This work presents data on administered activities used in clinical practice for diagnostic nuclear medicine procedures in Gabon to provide the DRL at a national level. The administered activities found are comparable with those reported in other countries. However, meeting DRLs does not automatically mean that good practice is being performed. The patient weight factor is not included in this review and must be added for the update of the DRL as well as DRLs of other procedures. Additionally, local reference levels should continuously be reassessed to optimize protocols, to ensure best practices and to reduce radiation exposure to patients and workers.

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