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Nuclear Medicine Practice in Africa

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ABSTRACT
Nuclear medicine has progressed and assumed full recognition as a separate specialty in medical practice. This is because of the simplicity and low morbidity of its methods, the wealth of the physiological and anatomical information attainable in its applications, the introduction of new and better radiopharmaceuticals and development of improved radioisotopic imaging devices. However, this success has not been matched by the level of awareness of clinicians and other medical personnel as to the worth and scope of the various investigations especially in developing countries in Africa.

The data base and on-line fact sheets of sixteen African countries on nuclear medicine, were evaluated and analyzed. Essential nuclear medicine requirements like number of nuclear medicine centres, the number of essential personnel and the imaging and therapeutic devices, were compared in relation to the United Nations' 2003 population estimates of the countries and against the background of worldwide surveys of standard nuclear medicine requirements in developed countries.

There was regional stratification into countries with well developed, and those with less developed nuclear medicine services. Services attainable in the former are comparable with those available in developed countries. Similar variations were observed in the type and quality of diagnostic and therapeutic services available in the countries studied. However, all the countries showed similar projections on their national strategic plans for future development of nuclear medicine services.

This paper discusses the levels of nuclear medicine procedures available in Africa, their problems, projected areas of further improvement and finally suggests ways of promoting nuclear medicine services, especially in those countries with less developed facilities.

KEY WORDS: Africa, Nuclear Medicine, Practice, Radiopharmaceuticals, Gamma Camera.

INTRODUCTION
Nuclear Medicine (NM) is a clinical specialty which for several decades has progressed from a minor sub-specialty to a full fledged specialty[1]. This rapid progress is attributed to the simplicity of its procedures, the wealth of information obtained from it, which is usually not attainable by other diagnostic methods as well as the growing awareness of clinicians of the worth and scope of the various investigations and treatment methods, which nuclear medicine provides and the introduction and availability of many new and better radiopharmaceuticals and radioisotopic imaging devices[2,3,4,]
Some efforts have been made to assess the status of nuclear medicine services in developing countries[5,6]. An evaluation was done in Nigeria in the mid-eighties with rectilinear scanner[7], which today has gone through several generations of development to the level of SPECT/CT and PET/CT[3]. Other surveys have centered on general awareness and standards of nuclear medicine equipment[8]. Other studies have compared the importance and use of quality control methods in nuclear medicine services to other healthcare systems in Africa[6]. This study is designed to evaluate the status of the essential requirements in nuclear medicine departments in some African countries.

MATERIALS AND METHODS
The data base of sixteen African countries obtained from the first African Conference on Nuclear Medicine, in Sudan, 2008 and on-line fact-sheets on nuclear medicine practice of these countries were analyzed in relation to their United Nations' 2003 population estimates and against the background of standard nuclear medicine methods and facilities that exist in developed countries. The comparisons were based on the number of nuclear medicine

centers, the number of essential personnel, available equipment, investigations being carried out (in-vitro and in-vivo methods) and the countries' projected strategic plans for the future. The criteria used were the number of inhabitants in the population that are covered by a centre, a nuclear medicine physician and a nuclear medicine equipment a gamma camera. The average of each of the three factors (table 3), was used as the basis to determine future projections in those countries with less developed facilities, to bring them at least at par with the practice in the rest of the continent.

RESULTS

Table 1 shows the data base and on-line fact sheets on status of nuclear medicine practice in sixteen African countries. Both government owned and private establishments were taken into account, since they serve the countries' population.

As shown in table 2, the average number of inhabitants covered by a nuclear medicine centre is 11.8 million, a nuclear medicine physician 1.9 million, and a nuclear medicine equipment 3.1 million. Countries like South Africa, Egypt, Tunisia, Mauritius and Algeria have values well below these averages, which range from 2 to 7.6 million for a nuclear medicine center, 0.3 to 0.8 for a nuclear medicine physician and 0.4 to 1.2 millions for nuclear medicine equipment. These countries are classified as having developed nuclear medicine services. Countries like Sudan, the Democratic Republic of Congo (DRC), Niger, Nigeria, Senegal, Mali, Cameroon, Tanzania, Kenya, Uganda, Ethiopia and Zimbabwe, have values well above the 'continental' averages and thus classified as less developed in terms of nuclear medicine services. More efforts are needed in cases of Ethiopia with values of 35,35,35 million, Nigeria with 62,41,62, DRC with 60,15,30 and Tanzania 20,20,40 millions respectively. This observation is attributed to the countries' relatively large populations. Table 3 shows the projected improvement needed to harmonize nuclear medicine practice in countries with less developed services.

Table 1: shows the data base and fact sheets of nuclear medicine facilities in the Countries studied.

Country	*Population in millions*	*Number of NM Centers*	*Number of NM Personnel*	*Equipment: Gamma Camera/SPECT/PET*
Algeria	33	7	41	27
Cameroon	16	1	2	2
DRC	60	1	4	2
Egypt	76	10	98	47
Ethiopia	71	2	2	2
Kenya	33	2	3	1
Mali	12	1	1	1
Mauritius	1.2	1	2	3
Niger	13	1	2	1
Nigeria	124	2	3	2
South Africa	47	8	108	90
Sudan	40	5	12	6
Tanzania	40	2	2	1
Tunisia	10	5	40	12
Uganda	26	1	3	2
Zimbabwe	13	2	1	1
Total	615.2	52	324	200

Table 2 illustrates the coverage of nuclear medicine services in the populations

Country	Population (millions) covered per center	Population (millions) covered per physician	Population (millions) covered per camera
Algeria	**4.7**	**0.8**	**1.2**
Cameroon	16	8.0	8.0
DRC	60	15	30
Egypt	**7.6**	**.08**	**1.6**
Ethiopia	35.5	35.5	35.5
Kenya	16.5	11.0	33.0
Mali	12.0	12.0	12.0
Mauritius	**1.2**	**0.6**	**0.4**
Niger	13.0	6.5	13.0
Nigeria	62	41	62.0
South Africa	**5.9**	**0.4**	**0.5**
Sudan	8.0	3.3	6.7
Tanzania	20.0	20.0	40.0
Tunisia	**2.0**	**0.3**	**0.8**
Uganda	26.0	8.7	13.0
Zimbabwe	6.5	13.0	13.0
Total average	**11.8**	**1.9**	**3.1**

Table 3 shows normalized coverage of population in countries with less developed nuclear medicine services based on total 'continental' average values in table 2.

Country	*Projected population coverage (millions) per center*	*Projected population coverage (millions) per physician*	*Projected population coverage (millions) per camera*
Cameroon	2	4	3
DRC	**5**	**7**	**10**
Ethiopia	**3**	**13**	**12**
Kenya	2	5	11
Mali	2	6	4
Niger	2	3	4
Nigeria	**4**	**22**	**21**
Sudan	1	2	2
Tanzania	**2**	**10**	**13**
Uganda	2	4	4
Zimbabwe	1	7	4

DISCUSSION

The study revealed significant developments in the number of in-vitro and in-vivo procedures, such as use of Tumour Markers and DNA probes, SPECT/PET imaging in Cardiology and Oncology mainly in Paediatrics, efforts to boost local production of diagnostic and therapeutic radiopharmaceuticals (bulk reagents), therapeutic applications of nuclear medicine, improved recognition of the roles of medical physicists and use of quality control and quality assurance methods in nuclear medicine practice in Africa. The countries also show progressive efforts being made in their future strategic plans to harmonize these services in Africa. More efforts are needed to increase the facilities in the cases of Ethiopia, DRC, Nigeria and Tanzania, because of their relatively large populations, and bring them up at par with the rest of African countries as shown in table 3.

Nuclear Medicine Centres.

There are approximately fifty-two nuclear medicine centres in Africa with the exception of

those who did not participate in the study. With a total African population of about 615.2 million, for those used in the present study, this number is considered low and does not compare with the number of nuclear medicine centres in other countries[10] This observation is illustrated in table 2 which shows a range of between 6.5 million and 62 million inhabitants being covered by one nuclear medicine centre in countries with less developed nuclear medicine facilities, and 1.2 to 5.9 million inhabitants to one centre in those with developed nuclear medicine services.

Nuclear Medicine Personnel

The effectiveness and standards of medical operations are usually measured by the number of staff against the country's population. This situation is relatively adequate in those countries with developed nuclear medicine facilities, for example, in this group, there is one nuclear medicine physician to between 0.08 to 0.8 million inhabitants, while in countries with less developed nuclear medicine facilities, it is one nuclear medicine physician to between 3.3 to 41 million inhabitants. This is very inadequate and consequently affects the performance of the personnel and nuclear medicine services in general.

Nuclear Medicine Equipment

Another factor that determines the standards of medical practice is the type of equipment used in rendering services. An assessment of nuclear medicine equipment in Sub-Saharan Africa[8] showed that standard equipment required in a nuclear medicine department include each of the following: Single or Double head gamma camera, dose calibrator, refridgerated centrifuge, laminar flow cabinet, radiation monitor, including personnel monitor, computerized data processing system and well counter. The study further observed that some of the indicators assessed in this region are consistently worse than what is usually observed in developed countries[10]. A similar situation is observed in the present study. Countries with better developed nuclear medicine facilities have between 0.4 to 1.6 million inhabitants to one gamma camera, while in countries with less developed facilities, one gamma camera serves between a range of 6.7 to 62 million inhabitants.

Nuclear Medicine procedures available in Africa

There are two major nuclear medicine techniques observed in this study. In-vitro methods include Radioimmunoassays (RIA) and Immuno radiometric assays (IRMA), collectively referred to as Radiolabeled immunoassays[5]

Common diagnostic in-vitro RIA methods in this study are measurements of Thyroid function (TSH, T3 and T4), Thyroglobulin FSH-LH-Testosterone, Growth hormones, Prolactin, Cortisol and Parathormone. In Egypt, for example, there are a total of over 10,000 in vitro assays done each year. Algeria performs more than 27,000 RIA assays per year and these include, studies on hormonology, total and free PSA, thyroglobulin, use of tumor markers, breath tests for Helicobacter Pylori (which accounts for between 600-800 tests/year) and oncology In Niger, there are about 3000 in-vitro activities per year. Other diagnostic RIA services provided are use of tumor markers in Niger, Tanzania, Kenya, Cameroon and DNA studies (DNA probes) in Tanzania. Cameroon has a high record of over 4,500 thyroid hormonal assays and use of tumor marker of about 7,500 assays per year. The occurrence of high incidences of thyroid related diseases in neighbouring Nigeria[11,12] has been repotted, this study and calls for urgent investigation and research in this field.

In vivo scintigraphy is also common in Africa. It is interesting to note that the Rectilinear scanner which was invented in 1950 by Cassen and later replaced by the invention of Gamma Camera in 1956[1] and used in Nigeria in the mid-eighties[7] , is still in use in Kenya. Common diagnostic investigations among the nations studied, include thyroid, bone, renal, cardiac, brain, whole-body, red bloods cells, lymph, lung, parathyroid, lachrymal, adrenal and liver scans. Tunisia has a record high of over 8,000 in-vivo scans per year. Other special studies being undertaken in more advanced countries include use of nuclear medicine (in-vitro and in-vivo) techniques for the investigation of diseases like infection, cancers, cardiovascular diseases, paediatric, metabolic and degenerative diseases and application of therapeutic

radionuclides in the management of these diseases.

Problems associated with Nuclear Medicine services.
Problems faced by nuclear medicine establishments in Africa are generally very similar, ranging from lack of modern equipment to frequent breakdowns and inadequately trained personnel for maintenance[8,9].

These problems are attributable to the following factors:
1. Decrease in governmental support and budget for the health sectors.
2. Low staff retention due to "brain drain
3. Lack of communication between member states
4. Low patient flow due to lack of awareness and patients inability to pay for services. Lack of accreditation and recognition of nuclear medicine staff and facilities by governments.
5. Lack of centralization of facilities that limits access of patients to services. Insufficient production and availability of radiopharmaceuticals.

Suggestions on improving Nuclear Medicine practice
Decentralization and expansion of nuclear medicine facilities will facilitate access of the services by the majority of the population. There should be improvement in governmental support and budget to the health sector with more emphasis on nuclear medicine. This will be followed by recognition and accreditation of nuclear medicine qualifications and building of career structures for nuclear medicine personnel. There is a generally dearth of radio pharmacists and medical physicists in the whole region and more so, in countries with less developed facilities. This calls for concerted efforts in promoting the development of human resources through the exploration of training programmes. Such programmes are available at regional designated centrer in countries with developed services and they offer fellowship training, scientific visits and expert missions. These opportunities should be pursued. Above all, distance assisted training (DAT)[13], are currently being organized at these regional centres as a way of reaching out to countries with less developed facilities, Other requirements to improve services are promotion of quality control and assurance programmes, development of external and internal audits and establishment of tele-links in nuclear medicine services between countries with developed and less developed nuclear medicine facilities.

Finally, efforts should be made to educate and create awareness on the importance of nuclear medicine through incorporation of nuclear medicine curriculum in medical training institutions[14].

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REFERENCES

1. Edwin LP, James AS, Strauss NW. Practical Nuclear Medicine. Publ. WB Sanders Company, Philadelphia, London, Toronto, Montreal, Sydney and Tokyo. 1990

2. Croft BY. SPECT, Chicago Year Book, Medical Publishers. 1986

3. Heller SI, Goodwin PN. SPECT: Instrumentation, performance, lesion detection and recent innovations, 1987; 17184-189.

4. Hoffman EJ, Phelps. PET Principles and quantification. In: Phelps NE: Mitzziota JC, Schelbert HR eds. PET and Autoradiography, NY Raven Rees 1986; 237-286.

5. Edwards R. Edward R, Hope HJ, Suprarop P. Development in RIA and Related Procedures in Developing countries. Proc. Intl. Symp. on RIA and related procedures: perspectives in developing countries., IAEA, Vienna, 1992.

6. Edwards R et al. "A regional and

national RIA scheme, using matched reagents. Nuclear Medicine and related Applications In Developing Countries. Proc. Symp. IAEA, Vienna,17-30.

7. Fregene AO. Nuclear Medicine in Nigeria: achievements, and limitations IAEA-SM-283/25-P. 1985.

8. Kachienga MO, Boonzaier D, Fataar AB, Boniaszezuk and Boltman G. Assessing the use of Nuclear Medicine technology in Sub-Saharan Africa: the essential equipment list. J. of Nucl. Med. Technology, 1999;27,62-68.

9. IAEA QC of Nuclear Medicine Instruments 1991, IAEA- TEC-602, Vienna Austria, IAEA.

10. Freeman LM, Nuclear Medicine in Vietnam. Eur. J. Nucl. Med. 1996; 23: 1630 1640.

11. Ekpechi OLV (late). Personal Communication, Department of Medicine, College of Medicine, University of Nigeria, Enugu Campus, Nigeria, 1982.

12. Okoye IJ. Personal Communication. Department of Radiation Medicine, College of Medicine, University of Nigeria, Enugu Campus, Nigeria. 2002

13. Pjilotheou GM,. Distance Assisted Training in Sub-Saharan Africa: A Program Evaluation. J. Nucl. Med. Technol. 2004; 32 (3) 166-170.

14. PMID 11236745 (Pub Med- indexed for MEDLINE). New Medical Schools and Nuclear Medicine in Africa: prestige or necessity? Eur. .J. of Nucl. Med. 2000; 27 (2) 1877-8.