

Current Status of Radiation Oncology Facilities in Nigeria

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ABSTRACT

Background: An analysis of the current radiation oncology facilities status in Nigeria was conducted to establish a comprehensive baseline. Nigeria is the most populated African country with a population of at least 160 million people based on 2006 population census and average annual growth rate of 3.1%. It is also one of the least developed countries as regards radiation oncology resources with inadequate radiotherapy facilities. Many of the patients have little or no access to safe and modern radiation therapy. **Purpose:** To obtain a better understanding of the status of radiation oncological practices in Nigeria and to help sensitize the Nigerian government and its developmental partners on the way forward. **Materials and Methods:** The data were obtained mainly through surveys on the availability of major items of equipment and personnel which were conducted in September 2011. The study included only commissioned and functioning public radiotherapy facilities which are 5 in the country. Data were related to number and types of megavoltage machines, trained manpower (Radiation Oncologists, Medical Physicists, Oncology Nurses, Radiotherapy technologists, maintenance engineers and mould room Technicians), treatment planning systems TPS, Brachytherapy equipment, CT Simulator and Conventional simulators. **Results:** Of over 50 Tertiary Health Institutions (Teaching Hospitals and Federal Medical Centers) in the country, only 5 has Radiation Therapy facilities with 1 megavoltage machine each, 2 located in the north, 2 in the south and 1 in the Federal Capital Territory. The population served by each megavoltage machine ranges from 20 to 40 million per machine based on 2006 census. Most patients have little or no access to radiation oncology services. Some differences in equipment and personnel amongst centers were demonstrated and the shortage of radiation therapy resources was grossly evident. There are 18 Radiation Oncologists, 8 Medical physicists, 18 Radiotherapy technologists, 26 Oncology Nurses, 3 linear accelerators, 2 Co-60 machines, 2 orthovoltage therapy machines, 2 conventional simulators, 2 CT simulators, 2 centers with 3D TPS, 3 LDR and 1 HDR brachytherapy machines and 2 mould rooms. Some centers were found to treat patients without simulators or treatment planning system. **Conclusion:** A large deficiency exists for radiation oncological services in Nigeria. There are significant deficiencies in the availability of all components of radiation therapy in the analysed centers. Cognisance should be taken of the specific short falls in each centre to ensure that there is expansion of existing centers and creation of new centers especially in every geopolitical zone and major teaching hospitals in the country.

Key words: Medical physicists; megavoltage machines; radiation oncologist; radiation therapy; radiotherapy technologist

Introduction

An analysis of the current radiotherapy status in Nigeria was conducted to establish a comprehensive baseline and

assist in Nigeria's future demand analysis using international benchmarks. Nigeria is a large country with 36 states and Federal Capital Territory having a very porous border with influx of patients from neighboring countries especially in the North. Lack of political will, prevailing poverty, and apathy for orthodox treatments and beliefs that cancer is caused by evil spirits and as such requires spiritual treatment has contributed to the poor development of healthcare especially cancer-related in the country.^[1,2]

All components of healthcare in the country from primary to tertiary care levels need attention, but this communication is to address oncological services in Nigeria. Presently,

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provision of capital intensive medical equipment is an unaffordable luxury in the developing countries due to wrong priorities.^[1] The national health insurance scheme is yet to enroll cancer care and expensive diagnostic tests on its list of care. Another unwanted scenario among the political class is medical tourism to India, Egypt, United Kingdom, USA and South Africa to cater to relatives having cancer sometimes using national funds at the expense of developing the health centers in the country. Being diagnosed of cancer in Nigeria is like a death sentence due to costs of drugs, surgeries and investigations; deficient facilities for radiotherapy and specialized care; and inadequate manpower in every aspect of radiation therapy.^[3,4]

There is a deficient cancer registry in the country and coupled with rapid population growth, falling infant mortality, malnutrition and increased attention to infectious diseases, including HIV, all contribute to a misconception of low incidence of cancer but there is an obvious increase in cancer cases in the country.^[4] This increase maybe an actual increase or as a result of improvement in diagnostic facilities, failure of herbal or traditional treatments, improvement in orthodox care and increase in awareness. The referral system in the country needs to be improved so that tertiary health institutions will be able to capture most of the cancer cases.

It is pertinent to recognize the role of radiation therapy in cancer management both for curative and palliative intent, and the need to immediately address the paucity of manpower, equipment and faulty geographical distribution. The situation is similar in Sub-Saharan Africa countries, but better in South and North African countries. The better radiation therapy facilities in North and South African countries is because of concerted political will, government commitment and non-governmental organizations' involvement in funding cancer care.^[5,6] There is significant contribution from the private sector to development of radiation therapy facilities in South Africa, Egypt and other developed countries. This is absent in Nigeria. Strategies for developing radiation oncological services need planning at the national level, and substantial investments for staff training and equipment.^[3] While radiation oncologists are being trained in Nigeria by both national and West African postgraduate colleges, there are no established colleges to train and certify radiotherapy technologists (RTTs) (therapy radiographers), medical physicists, oncology nurses, maintenance engineers and technicians within the country. Safe and effective development of radiation oncological services would benefit from links with established facilities in other countries, particularly those within the same region, access to information such as free online journals, and better education of all medical staff about the roles and benefits of radiation therapy.^[2,4]

In this country, no priority is given to cancer care services by healthcare planners at all levels. Similarly, the rural population

in the country lacks a sense of cancer awareness or recognition that treatment is available. Consequently, they fail to seek help, resulting in relatively low numbers of cancer cases on both hospital and treatment registers. Although the rural population has knowledge of treatment, the long distance from such centers and poverty become major obstacles. Travel expenses, accommodation and other factors prevent or delay many of those who are aware of their diseases from seeking medical attention. This contributes to relatively advanced stages at presentation.^[7] Adequate access to radiotherapy is a crucial component of modern multidisciplinary cancer care. Provision of safe and effective radiation oncology services is complex. It needs not only substantial capital investment in radiotherapy equipment and specially designed buildings, but also continuous investment in maintenance and replacement of equipment and manpower development.^[3,8] In order to make a proper plan to meet this increase and the challenges, it is desirable to know the present status of radiation therapy resources in Nigeria as a baseline for future references. These data resources give a valuable basis for the requirements for development and technical cooperation. It would also give some directions to both administrators and practitioners who are considering establishment or expansion in radiation oncology in the geopolitical zones.

The provision of megavoltage equipment has been used as a yardstick for cancer services worldwide.^[2-6] The validity of this approach lies in the fact that to run such a unit requires governmental commitment in the form of substantial buildings, capital equipment, maintenance and staffing. The major limitation is the exclusion of the only established private center in Lagos with megavoltage teletherapy equipment and trainees in all specialties. The purpose of writing this article is to analyze the resources for radiation therapy in Nigeria and obtain a better understanding of the status of radiation oncological practice in the country.

Materials and Methods

Nigerian population was estimated based on the 2006 population census and an estimated annual growth rate of 3.1%. Commissioned and functional federal government-owned radiation therapy centers were surveyed in September 2011. For the purpose of this study, radiation therapy personnel (radiation oncologist, medical physicists, RTTs, oncology nurses, mould room technicians and maintenance engineers) were considered as those staff who had received formal training within and or outside the country in their specialty. Trainees were excluded in the personnel analysis. Similarly, newly established but yet to be commissioned centers were also excluded because they were yet to start treating patients. Data from all radiotherapy centers in Nigeria were collected through visitation and cross-checked with staff on ground. The survey covered the status of radiotherapy centers in terms of major equipment and personnel. The major equipment evaluated included linear accelerators, Cobalt-60 machines, high-dose rate and low-dose

rate brachytherapy equipment, conventional and computerized tomography simulators, orthovoltage equipment, treatment planning systems and mould room. The only private hospital with megavoltage equipment for its radiation therapy facility in Nigeria is located in Lagos and was excluded from this study for the purpose of transparency. The results of the findings are presented in simple tables.

Results

Of the 36 states and Federal Capital Territory and about 56 tertiary health institutions in the countries, five centers have radiation oncology facilities. These five centers surveyed operate the five megavoltage machines in the country for a population of over 160 million people. A total of 5 megavoltage (3 linear accelerators and 2 Cobalt-60) equipment, 2 orthovoltage, 2 conventional simulators, 2 computerized tomography simulators, 2 three-dimensional treatment planning systems and 4 brachytherapy machines (3 low-dose rate and 1 high-dose rate) were seen. Some differences in equipment and personnel among the centers were demonstrated and shortage of radiation therapy resources was grossly evident. There are 18 radiation oncologists, 8 medical physicists, 18 RTTs, 26 oncology nurses, 2 trained mould room technicians and 3 trained maintenance engineers [Tables 1 and 2].

This number has been based on actual operability and continuing function of the equipment and presence of staff in employment as at the time of survey. Each center has only one megavoltage machine and located in South-West, North-West and Federal Capital Territory. While the corresponding centers

cover their state and neighboring states, each megavoltage equipment is serving about 20–40 million populations based on the 2006 population census and an annual growth rate of 3.1%. The South-South, South-East, North-East and North-Central are the poorest served, with no radiotherapy facilities. The only center in private establishment with megavoltage equipment throughout the country is located in Lagos, South-West, and was excluded from study. None were seen in state government-owned health institutions, military hospitals and in non-governmental organizations.

Discussion

Radiotherapy is an essential part of treatment of cancer. In high-income countries, 50–60% of new cases of cancer would receive radiotherapy at least once and up to 25% might receive a second course.^[9–14] Because of different distribution of tumor types worldwide and of advanced stage at presentation in the developing countries, patients with cancer in low-income and middle-income regions, Nigeria inclusive, could have greater need of radiotherapy than those in high-income countries.^[5,9,13,14] More than half of the cases of cancer in the world arise among people in the low-income and middle-income countries. This proportion is expected to rise to 70% by 2020.^[3,5] Despite this bad news, most low-income countries are doing nothing to avert this looming crisis in healthcare. Despite evidence that radiotherapy for cure or palliation is cost-effective,^[15] cancer patients in Nigeria have no or limited access to radiotherapy.

Establishment of radiotherapy facilities is very costly due to the peculiarity of the buildings and the required equipment.

Table 1: Manpower distribution in functioning radiotherapy centers in Nigeria

Centers	Radiation oncologist	Medical physicist	Therapy radiographer	Oncology nurse	Mould room technician
ABUTH	4	1	3	5	1
UCH	6	2	2	6	–
LUTH	5	2	3	6	1
NHA	3	2	8	3	–
UDUTH	Visiting	1	2	6	1
Total	18	8	18	26	3

ABUTH – Ahmadu Bello University Teaching Hospital, Zaria; UCH – University College Hospital, Ibadan; LUTH – Lagos University Teaching Hospital, Lagos; NHA – National Hospital, Abuja; UDUTH – Usman Danfodio University Teaching Hospital, Sokoto

Table 2: Equipment distribution in functioning radiotherapy centers in Nigeria

Center	Linear accelerator	Cobalt-60	Superficial X-rays	Conventional simulator	CT simulator	3D TPS	Brachytherapy	Mould room
ABUTH	–	1	1 (non-functioning)	–	–	–	LDR=1	Yes
UCH	–	1 (shut down)	–	1	–	–	LDR=1 HDR=1	–
LUTH	1	–	–	–	1	Yes	–	–
NHA	1	–	1	1	–	–	LDR=1	–
UDUTH	1	–	–	–	1	Yes	–	Yes
Total	3	2	2	2	2	2	LDR=3 HDR=1	2

CT – Computerized tomography; TPS – Treatment planning system; ABUTH – Ahmadu Bello University Teaching Hospital, Zaria; UCH – University College Hospital, Ibadan; LUTH – Lagos University Teaching Hospital, Idi Araba; NHA – National Hospital, Abuja; UDUTH – Usman Danfodio University Teaching Hospital, Sokoto; LDR – Low dose rate; HDR – High dose rate

Radiotherapy facilities use radiation in the treatment of cancers and some benign disease conditions, and this implies stringent measures in the building of bunkers, simulator rooms, darkroom, mould room and the clinical space for examination, consultation, changing and waiting rooms.^[8,16] The bunker walls are concrete-made and lined with lead (Pb), and the composite thickness of the bunker wall is determined by the energy of the megavoltage equipment.^[16-18] These structures and buildings must satisfy the radiation protection principles of as low as reasonably achievable (ALARA) dose to the staff, patients and care givers.^[16]

The megavoltage equipment for external beam radiotherapy is either a linear accelerator, which generates X-rays and electrons, or Cobalt-60, which in the course of radioactivity emits gamma-rays with an average energy of 1.25 MV. This equipment though expensive still requires other sophisticated equipment for radiation safety and optimal patient care. These include a conventional simulator, a computerized tomography simulator, a three-dimensional computerized treatment planning system, a well-equipped mould room, immobilization devices, a C-arm X-ray machine and necessary relevant quality assurance physics equipment for dosimetry.^[16]

The relevant equipment and strength of manpower (radiation oncologists, medical physicists, radiation therapy technologists, technicians, nurses, etc) required in a particular radiotherapy center is determined by the pattern of cancers seen as shown by the cancer registry and the population of the coverage areas.^[15,18] A confounding problem in Nigeria is the deficient cancer registry in the country and the only available source of data on cancer cases is hospital-based, which is usually inadequate because many of the patients never present to hospitals.

Table 2 shows that there is a total of five megavoltage equipment (3 linear accelerators and 2 Cobalt-60 machines) in Nigeria public hospitals for a population of 160 million people. The International Atomic Energy Agency (IAEA) recommendation is that there should be one megavoltage

equipment per 250,000 population or if there is excellent cancer registry, one megavoltage equipment per 350-400 new cancer patients.^[15] Considering Nigeria with a population of 160 million people, the expected number of megavoltage equipment is 640 units. Nigeria has only five megavoltage equipment, which is less than 1% of the requirement. While these figures may be contested according to the concept of “service” and “standard of care”, it is indisputable that one machine for 10 or more million population in Nigeria is grossly inadequate. Table 3 shows the population in million people per megavoltage machine in selected countries across the globe. Similarly, where there is an excellent cancer registry, the IAEA advisory group in 1993 suggested that the typical incidence of new cancer patients is 75-150 per 100,000 population.^[18] This implies, using an average of 100 new cancer patients per 100,000 populations, that Nigeria is expected to have an average cancer incidence of 160,000 patients per annum. Assuming, with reference to the literature, that 50% of these patients will require radiation therapy at one time or the other, about 80,000 cancer patients will require radiation therapy per annum. Using the IAEA recommendation of one megavoltage equipment for 400 cancer patients, Nigeria requires 200 megavoltage units. Whichever recommendation used, there is gross shortage of megavoltage equipment in Nigeria.

From Table 2, the absence of a superficial X-ray machine in some centers makes some cancers to be managed ineffectively.^[1,2] Similarly, absence of a conventional simulator forced radiation oncologists to manage cancer patients using anatomical landmarks and at most two-dimensional planning. This is prone to high chances of geographical miss, high recurrence, suboptimal care and possible complications.^[3,5] Absence of high-dose rate brachytherapy in most centers especially in the north minimizes the number of cervical uteri cancers being treated in these centers. During a visit to Department of Radiation Oncology, Charlotte Maxeke Academic Hospital, Johannesburg, South Africa, the center was found to have 4 linear accelerators, 2 Cobalt-60 megavoltage equipment, 2 high-dose rate brachytherapy, 2 conventional

Table 3: Number of megavoltage machines and population per megavoltage in selected countries

Country	Department	Cobalt-60	Linear accelerator	Total megavoltage machine	Megavoltage per million	Megavoltage per department	Population million per megavoltage
Australia	42	4	86	90	4.80	2.14	0.21
China	453	381	286	667	0.53	1.47	1.89
India	188	256	35	291	0.30	1.55	3.33
Japan	611	213	603	816	6.46	1.34	0.15
Pakistan	19	21	13	34	0.26	1.79	3.85
Sri Lanka	4	7	0	7	0.37	1.75	2.70
Indonesia	16	15	9	24	0.12	1.50	8.33
Bangladesh	11	10	1	11	0.09	1.0	11.1
Nigeria	5	2	3	5	0.03	1	33.3
Egypt	35	25	28	53	0.80	1.51	1.26
South Africa	18	16	24	40	0.78	2.22	1.13

simulators and 1 computerized tomography simulator with a three-dimensional treatment planning system, all the above in one center. Nigerian centers need to be well equipped like their counterpart in South Africa. In Africa, Nigeria like other sub-Saharan African countries is lagging behind their counterparts in North and South Africa. Although developing countries represent about 85% of the world population, the industrialized countries (Australasia, Western Europe, Japan and North America) have 60% of the world's radiotherapy facilities: about 80% of all linear accelerators and 25% of all Cobalt-60 units.^[9-14] For comparison, published data show that the number of megavoltage machines per million population in industrialized countries ranges from 8.2 in the USA to 5.5 in Western Europe, with 70-95% of the machines being linear accelerators [Table 3].^[9-14] There are 10 privately owned radiation therapy centers fully equipped with modern equipment in South Africa.^[6] Each machine in the South African Development Countries (SADC) is serving a 3.4 million population.^[6] In Nigeria, each megavoltage machine is serving a population of 33.3 million people. Only South Africa and Egypt have well-established oncological facilities with involvement of private institutions and a relatively large population, good functioning cancer registry and accessible data for comparison.

Cancer treatment is a multidisciplinary effort even while using radiation therapy alone. This multidiscipline involves radiation oncologists, medical physicists, oncology nurses, radiation therapy technologists (therapy radiographer), maintenance engineers, mould room technicians, dosimetrists, dieticians, physiotherapist and social workers.^[15] Deficiency in any of the core units of the multidisciplinary can stop treatment, render equipment underutilized or cause suboptimal care of patients. Manpower development is as important as procurement of radiotherapy equipment for radiotherapy clinics. Availability of radiotherapy equipment without necessary manpower at work renders the center useless and such centers will never be accredited by the Nigerian Nuclear Regulatory Authority to function and vice versa. It is important for administrators and managers of radiotherapy facilities to pay very close attention to the development of relevant manpower. It may take the government 1-2 years to build the physical structures and equip the centers, but will take longer time to train the relevant specialists.

Table 1 shows that there are only 18 radiation oncologists in the whole country to cover the population of 160 million people. The recommendation by the IAEA is that there is a need of a minimum of two radiation oncologists per center and an additional radiation oncologist for each 200-250 new cancer patients treated annually. Similarly, IAEA recommends that no more than 25-30 patients should be under treatment by a single radiation oncologist at any one time.^[15,16] This recommendation is to minimize radiation accidents and for optimal cancer treatment.^[19] The implication is that a center with an average of 1000 new

cancer patients per annum requires at least five radiation oncologists. Similarly, there will be need of more radiation oncologists for chemotherapy administration, brachytherapy and three-dimensional computerized treatment planning. Despite the presence of two postgraduate colleges (National and West African postgraduates Medical Colleges), the number of consultant radiation oncologists available is still not enough to adequately run existing radiation therapy centers; further gross shortages will be noted when new centers are commissioned. To ameliorate these shortages and improve the quality of care, more radiation oncologists should be trained. There should be exchange programmes with centers in developed countries, availability of access to online journals, training and retraining programmes and pairing with established institutions. Also more young doctors should be encouraged to specialize in radiation oncology. If one radiation oncologist is required to treat 250 new cancer patients per annum, there is need of 320 radiation oncologists to adequately cover Nigeria. Presently, there is gross shortage of radiation oncologists in the country.

The situation for medical physicists is more complicated than that of radiation oncologists in that there is no established training and certifying body for medical physicists in the country. The Federal Minister of Health only recently inaugurated an interim registration council. There is only one center for postgraduate training in M.Sc. Medical Physics, which is located at University of Lagos. All functioning radiotherapy centers have trainee medical physicists undergoing on-the-job training. There is need of concerted efforts to establish more training centers and have a recognized certifying body for medical physicists in the country so as to reduce the high reliance on IAEA. There is an urgent need of more medical physicists to man existing centers and upcoming ones. The IAEA recommendation is to have one medical physicist for 400 patients annually, and an additional medical physicist each for the dosimetry and brachytherapy equipment.^[15,20,21] The situation in the country is that there are only eight medical physicists for five centers, which is grossly inadequate.

There are only 18 RTTs (therapy radiographers) in the country. The requirement for RTTs is two per megavoltage machine treating 25 patients daily. For treating above 25 patients and up to 50 patients daily, there is need of four RTTs per megavoltage machine. There is need of additional RTTs per simulator, brachytherapy machine, treatment planning system and one supervisor.^[15,22,23] That is to say there is need of at least eight RTTs per center for optimal functioning. For the five existing centers, there is need of at least 40 RTTs to function optimally. Presently there are only 18 trained RTTs, with only one center meeting the requirement. Efforts were made locally to convert diagnostic radiographers to therapy radiographers at the National Hospital, Abuja, but lack of proper syllabus and competent trained certified trainers marred these efforts. This shortage of RTTs is a major problem

in achieving prompt and optimal cancer care as it also limits the total number of patients that can be treated daily, with a resultant long waiting time.

These shortages cut across every other aspect of the required manpower. Of note is the gross shortage of maintenance engineers and mould room technicians. The shortage of maintenance engineers coupled with inadequate experience with megavoltage equipment and absence of relevant tools makes the turnaround time for repairs very long, at times months of waiting for an engineer from the manufacturer to come and rectify simple repairs. The scarcity of trained staff can restrict the number of patients who can be treated to the point of under-utilization of equipment and also cause suboptimal treatment, prolonged waiting time, disease progression, and ultimately increase in morbidity and mortality.^[1-3]

Surgery, radiation therapy and systemic chemotherapy remain the basis of management of patients with cancer and as such a radiotherapy facility should not be in isolation. A radiotherapy department should be integrated into a comprehensive cancer treatment program with qualified personnel. Investment in equipment without concomitant investment in training is dangerous.

For the 21st century optimal cancer care, Nigeria is grossly lacking both in equipment and manpower. The government must continue to improve existing centers and build new centers in all geopolitical zones. There is need of collaboration with established centers in developed countries. There is need of increased governmental awareness of the importance of radiation therapy, and the benefits to patients from a wider national distribution of radiation oncology facilities at other teaching and specialists' hospitals with adequate diagnostic and surgical infrastructure should be carefully evaluated. For institutions to have a functioning radiotherapy center, it requires enormous funds, which is beyond current yearly budgetary allocation to Ministry of Health and also cannot be sustained by patients' treatment fees. There is need of concerted efforts by the government to vote dedicated funds for these centers so as to give optimal care to all cancer patients. The Nigerian government should implement the World Health Organization (WHO) recommendation of a 15% of the annual budget for healthcare.^[2] The shortfall from ideal standards is considerable and there is need for collaboration with non-government organizations, IAEA, WHO, private hospitals and health insurance companies to overcome the current challenges facing cancer patients in Nigeria.

Conclusion

Nigeria faces a gross shortage of radiation oncologists and other personnel, with under supply of megavoltage machines. Careful planning is required to allocate adequate resources for

manpower development and purchase of equipment. There is need of additional radiotherapy centers in all geopolitical zones and further strengthening of existing ones.

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