ASSESSMENT OF THE STATUS OF RADIOTHERAPY SERVICES IN NIGERIA: AN INTERVENTION TO IMPROVE THE SITUATION

AFOLAYAN Andrew Olumide
Physics with Electronics Unit, Department of Science Laboratory Technology,
Federal Polytechnic Ilaro, Ogun State
E-mails: flyn_olumide@hotmail.com

Abstract
As an important component of cancer control programs, the scarcity of radiation therapy resources in Nigeria is becoming more severe as cancer incidence increases. This study analyses and suggests possible solutions to the causes of this rather disastrous state of radiation therapy in Nigeria. In the study the available radiotherapy centers in Nigeria were analyzed, while relevant information about the types and number of radiotherapy equipments was obtained using retrospective method of data collection. Results showed that between 2001and 2014 the number of megavoltage therapy machines has reached nine from five, with at least one therapy machine situated in nine of the radiotherapy center. 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 3.10%, giving only a marginal improvement in the radiotherapy service. The results also showed that these facilities are concentrated in the southern and northern states of the country. Although progress has been made in the establishment of radiation therapy services in Nigeria, a large need still exists for training of manpower in all fields of specialization related to radiotherapy service in order to adequately care for the multitude of cancer patients. Radiotherapy centers need to be established in Nigeria, due to the increasing number of patients requiring the facility. Awareness of such centers should be raised among medical practitioners and the populace.

Keywords: *Radiotherapy, Cancer, Megavoltage Therapy Machine, Linear Accelerator.*

Introduction/Background Study
Cancer currently causes more deaths around the world than HlV, tuberculosis, and malaria combined (Strong et al, 2005). Radiation therapy is an important component of cancer control programmes. The management of cancer involves screening, diagnosis, therapy, follow-up and palliation. Surgery, Radiotherapy, Chemotherapy and Nuclear Medicine Techniques are the mainstay procedures for the management of cancer. Incidence of cancer is on the increase and the greater proportion of that increase is from developing countries (Nwankwoet et al., 2013). The scarcity of radiation therapy resources in Nigeria is becoming more severe with the increase in cancer incidence in the country. The first therapeutic use of ionizing radiation was in January 1896 when two patients, one with breast cancer commenced treatment with radiotherapy in Chicago. Thereafter, other malignancies were treated. Following the introduction of megavoltage (high energy) radiotherapy in the 1950s, the practice of radiotherapy achieved a great and accelerated improvement (Levin et al, 200l; Nwankwo et al. 2013). The National Bureau of Statistics reported that the total population of Nigeria was last recorded at 173.6 million people in 2013 from 45.2 million in 1960, changing 284 percent during the last 50 years. Population in Nigeria averaged 94.88 Million from 1960 until 2013, reaching an all-time high of 173.60 Million in 2013 and a record low of 45.15 Million in 1960 (NBS, 2015). According to the National Population Commission, 97% of the population in the country is less than 65 years (NPC, 2008). The increasing burden of cancer seemed to have spurred low resource nations, including Nigeria to recognize the threat of malignant diseases and hence the need to improve the standard of care for the patients, especially with the use of ionizing radiation (Levin et al, 2001; Durosinmi-Etti et al. 1991; Nwankwo et al, 2013). Effort to improve cancer care in Nigeria began in 1968, when Lagos University Teaching Hospital (LUTH), Lagos, Nigeria acquired a superficial radiotherapy machine. The LUTH became the first center in West Africa in 1973 to acquire a cobalt-60 teletherapy machine. It is one of the three old radiotherapy centers; the other two being University College Hospital (UCH), Ibadan and Ahmadu Bello University Teaching Hospital (ABUTH), Zaria (Nwankwo et al, 2013). Radiotherapy treatment is a multi-stage, complex process that involves treatment of a wide range of cancer conditions through utilization of various technologies and related professional expertise. A high level of accuracy is needed at every step so that the maximum tumor control is produced with minimal risk to normal tissue. Risks should be managed prospectively and dose errors should be maintained within acceptable tolerances (WHO, 2008). The facilities for cancer care in this country are like a drop in the ocean. 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.

Materials and Method

The main purpose of the study was to find out the number and distributions of radiotherapy centers in Nigeria, types of treatment machines in the various centers, assessment of the level of utilization of radiotherapy centers in relation to the population of Nigeria to form an essential tool in planning an intervention to improve the situation and minimize the effect of cancer on the populace. The data were obtained mainly through surveys on the availability of major items of equipment and personnel which were conducted on the radiotherapy centers in the country. Equipments and personnel were analyzed and related to known benchmarks such as megavoltage machine/million population. The status of the radiotherapy equipments at present were compared to the reported situation status (Frora 2001). Data from all radiotherapy centers in Nigeria were collected through visitation and cross-check. 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 and treatment planning systems. The results of the findings are presented in simple tables.

Results and Discussion

Availability of Radiotherapy Machines

The first therapeutic use of ionizing radiation was in January 1896 when patients, one with breast cancer commenced treatment with radiotherapy in Chicago. The LUTH became the first center in West Africa in 1973 to acquire, a cobalt-60 teletherapy machine. Which happens to be one of the old radiotherapy centers and others are University College Hospital (UCH), Ibadan and Ahmadu Bello University Teaching Hospital (ABUTH), Zaria. (Nwankwo et al, 2013). Other radiotherapy center available in the country include National Hospital Abuja with one Linear Accelerator and a low dose rate Brachytherapy, University of Nigeria Teaching Hospital Enugu with one linear accelerator, UINIBEN Teaching Hospital with one linear accelerator, Usman Dan Fodio University Teaching Hospital Sokoto also with one linear accelerator, Federal University Hospital Gombe with a high dose rate brachytherapy. The only private Hospital with a radiotherapy machine is the Eko Hospital in Lagos with one cobalt 60 machine.

Estimated Need for Megavoltage Machine

By recommendation of International Atomic Energy Commission (IAEA) country's recommendation for every one million population one radiotherapy unit is needed for you to have an efficient radiotherapy service. Because of the poor infrastructure in low and medium income countries, Nigeria currently has nearly 9 centers for radiotherapy and of those 9 centers, there are barely six of them working. The population of Nigeria as estimated is 173 million and that is supposed to be an under estimation. So, if we are taking the population of 173 million that means we need 173 radiotherapy units in Nigeria. Rising cases of cancer and the cost implications of treatment are putting Nigerians on edge since the current minimum wage of N30, 000, may not be able to afford diagnosis no to talk of procure the right medical service to control and manage the ailment. Cancer is increasingly becoming a scourge in the country lately, as both the low and high income have fallen victim to the ailment. Investigations show that an individual is likely to spend about N67, 000 for bosom scan, Mammogram, Biopsy and other tests. An average surgery costs between N80, 000 and N 150, 000, while chemotherapy cost ranges between N 100, 000 and N500, 000. Targeted therapy in the country cost as much as over N4 million, this is putting more financial pains on cancer patients and their caregivers. Experts have predicted that by 2022, the number of cancer patients in Nigeria will rise from 24 million to 42 million, in line with speculations 21 years ago. It is also feared that by same 2022, death rates from cancer in Nigeria males and females may reach 72.7/100,000 and 76/100000 respectively. Even cancer though in Nigerian about 52% of cancer and patients in the developed countries would need radiotherapy at least once (Barton et al 2006; Nwankwo et al, 2013) because most cancer patients are presented to hospital lately. By the International Atomic Energy Agency's IAEA's recommendation, one LINAC megavoltage therapy machine is required for 400 patients (Levin et al, 2001; Nwankwo et al, 2013), and then Nigeria requires at least 137 LINACs, a shortfall of more than 129 LINACs, that is, presently Nigeria has less than 6% of the required need for megavoltage radiotherapy machines.

Human Resources in Radiotherapy Services in Nigeria

There are three main specialties/specialists involved with the practice of radiotherapy are basically radiation oncology, medical physics, and therapy radiography. The radiation oncologists are the medical doctors who develop and prescribe each patients treatment plan. They ensure that the treatment is accurately given. The role of medical radiation physicists includes taking precise measurement of' radiation beam characteristics and also to ensure that the treatment planning is properly tailored for each patient. Among other roles, they are responsible for developing and directing quality control programs for equipment and procedures. The therapy radiographers take the images for treatment planning, administer the daily radiation dose under the doctor's prescription and supervision. Any of the above mentioned medical specialists can equally advance in study to become a dosimetrist who carefully calculates and estimate the dose of radiation and appropriate plans the treatment to ensure the tumor gets enough radiation (Nwankwo et al, 2013). The numbers also of the radiotherapy personnel in the country are shown in Table 1. The radiation oncologists also functions as the medical oncologists in most centers in Nigeria as many centers do not have qualified medical oncologists.

Table 1: Present Staff Strength in Nigeria

Centers	Radiation oncologist	Medical physicist	I'lxcrapy radiographer	Engineers
LUTH	4		4	1
UCH Ibadan	6		6	1
ABUTII	4	2	3	1
Eko Hospital	2		4	1
NHA	3	6	4	1 (LINAC)
UNTH		7	1	
UDUTH		5	2	
UBTH	1	6	3	
FUH Gombe	1	1		
Total	22	28	20	5

LUTH — Lagos University teaching hospital, UC - University College Hospital, ABUTH-Ahmadu Bello University teaching hospital, NHA-National Hospital Abuja, UNTH-University of Nigeria Teaching Hospital, UDUTH-Usman DanFodio University Teaching Hospital, UBTII-University of Benin Teaching Hospital, FUH -Federal University of Gombe.

Cancer Registry

Some of the cancer registries in Nigeria include University College Hospital, Ibadan, Lagos University Teaching Hospital., Jos University Teaching Hospital., Ahmadu Bello University Teaching Hospital, Zaria., Obafemi Awolowo Teaching Hospital Complex, Ile-lfe, etc. Majority of the teaching hospitals operate mainly a hospital-based cancer registry and are poorly funded, also lack appropriately trained staff, and therefore unable to provide accurate and reliable information and data.

Role of International Organization in Cancer Management

Through (International Atomic Energy Agency) IAEA-supported projects, some national medical authorities are becoming better equipped to help patients treat cancer. The IAEA is currently helping to upgrade radiotherapy facilities in some 80 countries through national and regional projects. It is also establishing or improving quality assurance programmes another 20 national projects and five regional projects. Regional projects in east and southeastern Europe are assisting countries emerging from years of conflict and economic hardships. In most cases these countries retained medical expertise but need to re build or upgrade radiotherapy facilities. Nigeria has benefitted from the assistance of various international organizations such as IAEA, World Health Organization (WHO), Japan International Cooperation Agency (JICA) in the development of radiotherapy facilities. The IAEA has been helping through: technical cooperation projects, coordinated research programs, fellowships, training programs and short courses, seminars and publications (Nwankwo et al, 2013). These include LUTH, UCH, Ibadan; and ABUTH, Zaria. The project provided radiotherapy equipments and training of radiotherapy staff.

By the end of 2001 there are a total of five cancer treatment centers in Nigeria, with three in the South-West, one in the North-West and one in North-Central. For radiotherapy/Oncology, there are a total of twelve equipment; comprising of six external beam radiotherapy (teletherapy), five brachytherapy units and one treatment planning 'units. By the end of 2014 only marginal improvement have been made in the field of radiotherapy with a total of nine cancer treatment centers, with three in the South West, two in the North-West and one in each of the North-Central, South-East, South-South and North-East (Table 5). However, of the nine teletherapy units, only 7 are operational, 2 have been decommissioned. (Tables 2, 3, 4 and 5). There are a total of seventy five full time staff in radiotherapy and oncology in Nigeria consisting of twenty two Radiation oncologists, twenty eight medical physicist, twenty radiotherapy radiographers, five Engineers (Table 1). Of the 9 cancer centers in Nigeria, only 2 centers have a Nuclear medicine department (University College Hospital, Ibadan and National Hospital, Abuja) (Levin etal2001; Barton et al 2006; Nwankwo et al, 2013). This slight improvement in the number of megavoltage machines in Nigeria is still very small when compared to some other African countries and to the European standard of one megavoltage machine per population of 250,000 people (Sharma et al, 2008; UNIDO 1993; Madhvanath 1995; Nwankwo et al, 2013). This result in some people failing to access the benefit of radiation treatment due to long distance to treatment centers.

Table 2: The Status of Radiotherapy Centers in 2001

Radiotherapy Centre	Co-60 machine	LINAC	LDR branch therapy	Treatment planning/imaging machine	Population served	Megavoltage machine per million population

LUTH, Lagos	2		2			
EKO Hospital	1					
UCH, Ibadan	1		1			
ABUTH, Zaria	1		1			
NHA, Abuja		1	1	1 simulator		
Total	5	1	5 7	1	$160x10^6$	$20x10^6$

LUTH – Lagos University Hospital, UCH – University College Hospital, ABUTH – Ahmadu Bello University Teaching Hospital, NHA –National Hospital, LINAC – linear accelerator, LDR – Low dose rate, HDR – High dose rate.

Table 3: Status of Radiotherapy Centers in Nigeria as at 2014

Radiotherapy centers	**Cobalt-GO**	**LINAC**	**LDR brachy therapy**	**HDR brachy therapy**	**Treatment planning/ and imaging systems**	**Population**	**Population per megavoltage machine**
LUTH, Lagos	Decommissioned	1	Decommissioned		I CT-Sim		
UCH, Ibadan	Decommissioned			1			
ABUTH, Kaduna	1		1				
NHA,Abuja		1	1		I Simulator		
EKO Hospital, Lagos	1						
UNTH, Enu u		1			I CT-Sim		
UDUTH, Sokoto		1			I CT-Sim		
UBTH, Edo		1			I CT-Sim		
FUH, Gombe				1			
Total	2	5	2	2	5	>170xlO	21.3xlO

LINAC — Linear accelerator, IDR — Low-dose rate, I-IDR — High-dose rate.

Table 4: Number and Operational Status of External Bcarr) Radiotherapy (Teletherapy)

Operational Status Operational	**Number**
Decommissioned	2

Table 5: Number of Equipment for Brachytherapy and Operational Status

Operational Status	**Number**
Operational	2
Decommissioned	1

Table 6: Hospital that Provide Cancer Treatment and their Geo-political Regions

Hospitals	**Geo-political Region**
Abuth, Zaria	North-West
LUTH, Lagos	South West
UCH, Ibadan	South West
NHA, Abuja	North-Central

UDUTH, Sokoto	North-West
UNTH, Enugu	South-East
UBTH, Benin-City	South-South
FUH, Gombe	North-East
EKO, Lagos	South-West

Conclusion

Progress has been made in the establishment of radiation therapy services in Nigeria. In time, incidence data will change because of demographic changes, but also because of an increase in cancer awareness and improvement of cancer registration. These changes will directly affect the demand for radiotherapy services in Nigeria and reinforce the increasing need for cancer prevention, early detection, treatment, and palliation. Nevertheless, a large shortfall still exists for basic radiation services and much work is needed to keep pace with the burgeoning population of Nigeria. However, data registration could still be improved and other areas such as staffing, equipment, maintenance, quality assurance, optimization of resource use, and especially access to care continue to need special attention. Novel solutions to these issues have been made possible and continue through initiatives that allow collaboration between international organizations, local governments, and regional organizations. The IAEA has been collaborating with different regions of Africa to help to build capacity for cancer control through a comprehensive programme that includes national, regional, and inter-regional technical cooperation projects among others. The programme also provides technical assistance for the design, establishment, commissioning, implementation and expansion of safe and effective national radiation therapy services, as well as the development of education and training programmes. The agency also encourages advanced planning at a national level to prevent shortages of staff and to promote the procurement of equipment for radiation therapy centers (relevant imaging, treatment planning, dosimetry and quality items), within a comprehensive technical cooperation programme. The programme includes clinical, medical physics, and radiation safety components, review of local infrastructure (room layout, shielding, utilities, and radiation safety) and review of the availability of qualified staff members. This planning and execution process is an excellent model that provides solutions to the scarcity of radiation therapy resources while ensuring a safe and effective increase in radiation oncology facilities and resources. The IAEA has been collaborating with Nigeria with assistance for the development of feasibility studies, the design and construction of facilities, and the procurement and commissioning of teletherapy, brachytherapy, imaging, treatment planning, and dosimetry systems.

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