

SETTING UP A MODERN RADIOTHERAPY FACILITY IN A WAR-TORN REGION OF NIGERIA: UNIVERSITY OF MAIDUGURI TEACHING HOSPITAL EXPERIENCE

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ABSTRACT

Radiotherapy is a critical component of cancer care and its access in low- and middle-income countries is very poor. Of course, cancer is a global health problem and its incidence is rising in Africa with about 1.5 million case annually. Establishing a technical state-of-the-art radiation therapy facility in a region ravaged by Boko Haram insurgency for close to two decades posed even a greater challenge and due to an important role of radiotherapy in cancer management, an urgent requirement is needed to build an infrastructure that provides such services to address access challenge faced by patients. This work describes our experience in developing a modern radiotherapy centre at epicentre of Boko haram insurgency in Northeast Nigeria. We bring into light our source of funding, engagement with regulatory bodies, technical experts for construction of bunkers and installation of the linear accelerators and brachytherapy machines, manpower strength and training, our collaborations and clinical outcomes among other milestones recorded.

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INTRODUCTION

Cancer is a major public health disease and a leading cause of morbidity and mortality globally, with an estimated 20 million new cases and 10 million deaths in the year 2022.¹ Its incidence, morbidity and mortality have been of the steady rise over the years with approximately 65% to 70% of this increase occurring in low- and middle-income countries (LMICs).¹ The Sub-Saharan Africa region, which are predominantly LMICs, have a disproportionate burden of cancer when compared to high-income countries.¹ In 2022, the mortality-incidence ratio of cancer for Nigeria was 0.62 (79,542 / 127,763) compared to 0.25 (605,761/2,380,189) for the United States of America and 0.40 (181,807/ 454,954) for the United Kingdom.²⁻⁴

In Nigeria, cancer patients generally present late with advanced disease and poor survival outcomes.^{5,6} This is generally due to poor awareness of the general population on cancer; availability and accessibility of comprehensive cancer facility; inadequate skilled cancer health workforce; predominantly catastrophic out-of-pocket expenditure on cancer care.^{5,7}

Radiotherapy, along with surgery and chemotherapy, play critical roles as part of the comprehensive management of cancer patients.⁸ More than 50% of cancer patients will require radiotherapy during the course of their treatment.⁹ Radiotherapy can be administered for curative or palliative intent in cancer patients.¹⁰ It contributes to about 40% improvement of survival in cancer patients.¹¹ Radiotherapy can be in form of teletherapy (e.g., linear accelerators) or brachytherapy.¹² In LMICs, there is dearth of this essential treatment modality, especially in Sub-Sahara Africa and its accessed is highly inadequate with about 34% of optimal radiotherapy capacity in whole of the African

continent. Only 28 African countries out of 54 now have radiotherapy treatment machines to serve their population.^{11,13} Most of the countries in Sub-Saharan Africa with radiotherapy treatment machines have very few relative to their population.¹³ About 54% of these linacs are found in Egypt and South Africa.¹⁴ This is grossly inadequate particularly given the growing burden of cancer in Africa.¹⁴ Furthermore, at that time, only 21 African countries had access to brachytherapy machines with 60% located in South Africa, Egypt and Algeria. This development is happening amidst projected increase in burden of cancer in Africa with about 1.5 million cases per year from 2020 with possible doubling of the death rate.¹⁴

Nigeria has grossly inadequate radiotherapy facilities compared to its enormous population of over 230 million people, with gross disparity in its distribution across the geopolitical zones.¹⁶ According to the International Atomic Energy Agency criterion of one LINAC megavoltage machine for every 400 patients with cancer, Nigeria has a shortfall of around 280 LINACs.¹⁶

It was within this context that the University of Maiduguri which was established in 1982, as a foremost tertiary institution serving the entire North east geopolitical region and beyond built a modern radiotherapy facility to serve the North East geopolitical region and entire Nigerian population despite being rampaged by close to two decades of Boko Haram insurgency crisis that wrecked enormous damage to social infrastructure, caused deaths of thousands, and displacement of millions of people in the North East. We believe that sharing our experience in setting up this facility is noteworthy, and it can be used as a model for other unstable developing countries or regions.

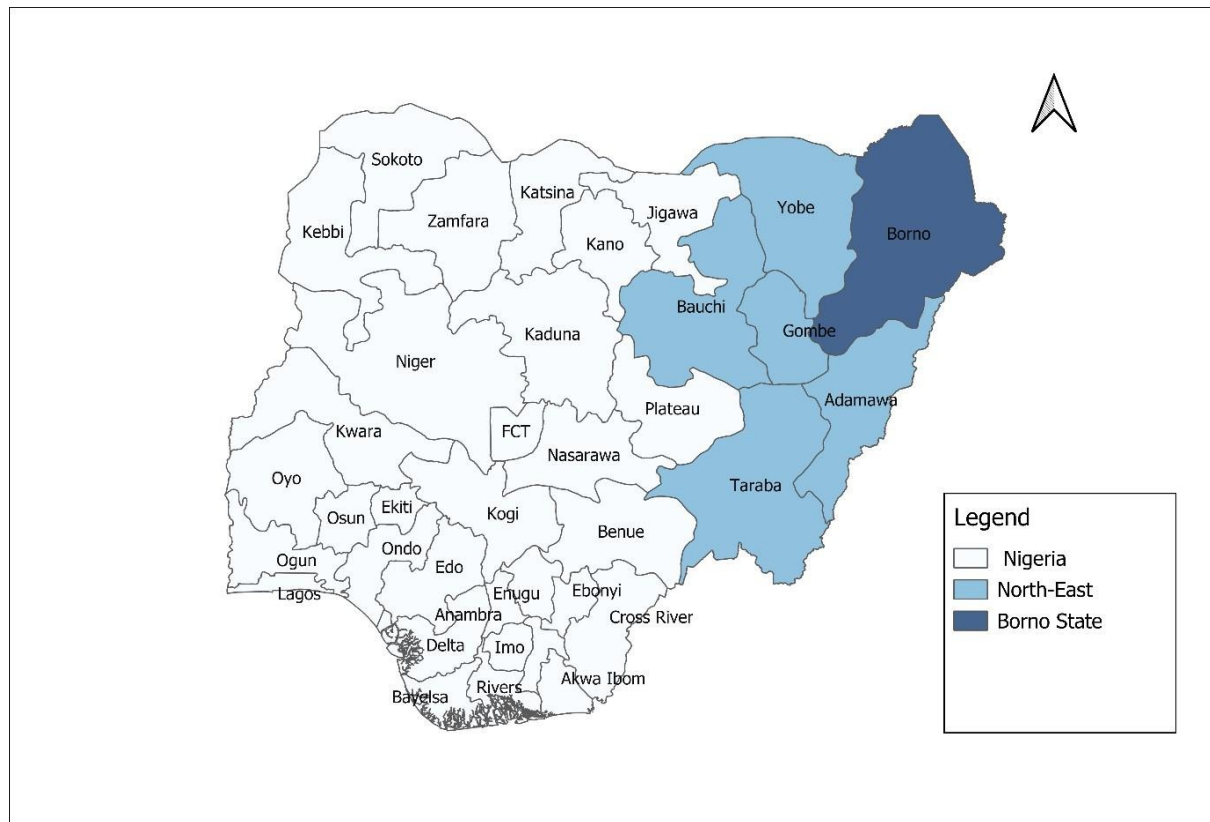


Plate 1. Map of Nigeria showing Borno State within the North East region

MATERIAL AND METHODS

This is a descriptive report of steps, approaches and challenges of establishment of University of Maiduguri Cancer Centre and outcomes associated with it. Tables, pictures and simple descriptive statistics were used to help drive the narrations.

RESULTS

Needs assessment

As at 2010, there were only 8 external beam radiotherapy and 5 brachytherapy machines in the entire country, with the North East geopolitical region having only one brachytherapy machine (Table 1).¹⁷ There was no comprehensive cancer centre that could offer radiotherapy to cancer patients from the Northeast geopolitical region

comprising of a population of over 21 million people who were mostly devastated by insecurity as a result of *Boko Haram* insurgency.^{18,19} Patients from this region had to travel hundreds of kilometers to access radiotherapy services in other regions of the country which were largely not affordable to majority of them. In addition, they had to contend with long queues of patients waiting for their turn on radiotherapy machine. There was a high dose rate brachytherapy machine situated in one of the North East states in Federal Medical Centre Gombe, but it was limited in function as it treated only cervical and other uterine cancers after receiving external beam radiotherapy from other radiotherapy centres. It was therefore very clear to stakeholders that even within the general impoverished setting of radiotherapy availability in Nigeria, the North East region was grossly underserved.

Table 1. Distribution of radiotherapy facilities in Nigeria at end of 2010.¹⁷

Geopolitical zone	Radiotherapy center	Radiotherapy facility				
		Cobalt-60	LINAC	LDR brachytherapy	HDR brachytherapy	Treatment planning/imaging system
South West	LUTH, Lagos	----	1	---	1	CT scan
	UCH Ibadan	1	---	1	---	---
	Eko Hospital, Lagos	1	---	---	---	---
North West	ABUTH, Zaria	1	---	1	---	---
	UDUTH, Sokoto	---	1	---	---	1 CT simulator
South East	UNTH, Enugu	---	1	---	---	1 CT-simulator
North East	FMC Gombe	---	----	---	1	----
FCT Abuja	NHA, Abuja	---	1	1	---	1 simulator
South South	UBTH Benin		1			1 CT- simulator
North Central	---	---	---	---	---	---

Table adapted with modification from Nwankwo et al 2013¹⁷

Conceptualization

The earliest documented attempt to establish a cancer center was in 2005 when the Federal Government approved of the inclusion of University of Maiduguri Teaching Hospital (UMTH) amongst the tertiary institution to be provided with external beam radiotherapy. To this effect, a site was identified and cleared within the

teaching hospital complex. However, the project was abandoned due to lack of funds backing. There were subsequent background attempts to draw attention of critical stakeholders from government and non- governmental organisations to establish a cancer center in UMTH, but with little success.

Early recruitment and training of manpower

In 2012, there was another strong wave by the management of UMTH to push further the agenda of establishing a cancer center and the idea of commencement of training of the cancer workforce was conceived. To this effect, the first set of healthcare workers including two resident doctors, two radiographers and one physicist, were sent to various institutions within and outside Nigeria for specialized training to become

Approval and funding

Through the special intervention of the then President of the Federal Republic of Nigeria, Muhammadu Buhari, and approval was granted in 2019 for the establishment of a comprehensive cancer center in UMTH, with full funding which was sourced by the Central Bank of Nigeria and given rapid appropriation by the National Assembly. The approval was to build a radiotherapy center with four bunkers to house two Linear Accelerators, two high-dose rate brachytherapy and one CT simulator.

Development of physical infrastructure

A new site for the cancer center was identified in 2019 by the management of the hospital which was relatively isolated from the central areas of the hospital. Environmental impact assessment was done by a combined team of geologists, physicists and civil engineers. After certification of fitness of the identified space, application for building license was made to the Nigerian Nuclear Regulatory Authority (NNRA). The building plan for the bunkers were approved after thorough review and adequate surveys. The construction of the bunker began late in 2019 in the midst of worsening insurgency, which led to interruptions in the smooth flow of work on many occasions. The construction of the bunkers was regularly supervised by officials of the NNRA. Upon completion of the bunkers, they certified its integrity after thorough checks.

Radiation Oncologist, therapy radiographers and medical physicist respectively. By 2019, they had largely returned which became an impetus for the management of UMTH to make another push for the establishment of the cancer center

Procurement, acceptance, installation, and commissioning of radiotherapy facilities

Importation of the radiotherapy facilities was done after obtaining license from NNRA in (specify month/year). The machines procured include Two Elekta linear accelerators, one Elekta high dose rate brachytherapy, one Varian high dose brachytherapy and a Canon CT simulator. They were formally accepted by the UMTH management on the (specify date). License for installation of the equipment were obtained and gradual installation of the radiotherapy machines began. The installation was painstakingly carried out over a period of (specify) months. At the end of the installation, the equipments were test run and certified to be in good working condition. Then another license for commissioning was obtained for commissioning of the facility. The commissioning took place in August 2023. The first person treated was a 68-year old prostate cancer patient with brain metastasis in August 2023 (Plate 4), thus began the journey of radiotherapy treatment in UMTH, Maiduguri, Borno State.



Plate 2. Setting up the foundation of the UMTH Cancer Center 2019



Plate 3. One of the two linear accelerators installed in UMTH Cancer Centre at commissioning in 2023



Plate 4. First patient treated with external beam radiotherapy in UMTH Cancer Center in August 2023

Collaborations and hands-on application trainings

There were numerous collaborations between UMTH Cancer center and many institutions within and outside Nigeria, mainly to train the various cadre of workforce in the new cancer center. The trainings were carried out abroad and locally on the machine. The radiation oncologists, therapy radiographers, physicists and oncology nurses were trained on the numerous aspects of operating of the radiotherapy machines. This included CT simulation, uploading data, contouring, treatment planning, patient set-up and actual treatment. The prominent institutions of formal collaboration with UMTH Cancer Center include Clatterbridge Cancer Centre,

Liverpool, United Kingdom, Clinic d' Oncologie 16 Novembre, Rabat, Morocco, The Centre International de Cancerologie de Lome, Togo, Usman Danfodio University Teaching Hospital, Sokoto and National Hospital Abuja.

Staff development and growth

Table 2 show the staff strength of UMTH Cancer Center from August 2023 and August 2024. There has been steady growth in the number and quality of staff. The clinical staff have been exposed series of training within and outside the hospital to improve their skills, effectiveness and efficiency in management of cancer patients.



Plate 5. During one of the hands-on training from international collaborations with UMTH Cancer Center

Table 2. Staff strength of UMTH Cancer Center over the period of one year

Staff Cadre	August 2023	August 2024
Consultant Radiation and Clinical Oncologists		
Resident Consultant	1	1
On Sabbatical	1	---
Visiting Consultant	2	5
Resident Doctors	---	4
Therapy Radiographer	4	14

Medical Physicist	4	6
Nurses		
Oncology Nurses	5	5
General Nurses	---	6
Support staff		
Administrative staff	3	3
Health information officers	4	4
Porters	2	2
Janitors	8	8
Security Officers	6	7
Total staff	40	65

Accreditation for residency training for UMTH Cancer Center

The UMTH Cancer Center applied for accreditation to commence training of radiation and clinical oncologists, as a way of producing needed manpower. The accreditation team from the West African College of Surgeons assessed the center and approved full accreditation to commence residency training. To this effect, the first set of resident doctors (four in number) were employed and have since commenced residency training from July 2024.

Clinical output of UMTH Cancer Centre

The UMTH Cancer Center within a short period of time, became a center for referral of cancer patients not just for patients from North east geopolitical region, but from across the states of the Federation. The center provided outpatient clinics on two days per week, CT simulation, Contouring, treatment planning, and actual external beam radiotherapy and brachytherapy. Furthermore, administration of chemotherapy to patients as well as admission in wards for

resuscitation and blood transfusion. At the peak of events, the Center attended to an average of 60

patients in the outpatient clinics per week which consisted of new patients, and those on treatment or follow up. An average of 56 (minimum 44, maximum 72) patients were treated on the machine for external beam radiotherapy per day (excluding weekends). Furthermore, an average of 6 cervical cancer patients were treated per week on high dose rate brachytherapy, while 15 patients receive chemotherapy per week on the average.

Evaluation of cancer patients who completed treatment with external beam radiotherapy from August 2023 to September 2024, about a year period, showed that a total 697 patients received external beam radiotherapy, with 539(77.3%) and 158(22.7%) being for curative and palliative intents respectively. The mean age of the patients was 49.06 ± 15.24 years. Figure 1 shows the age distribution of cancer patients receiving treatment at UMTH Cancer Centre. There were 408(59%) females and 289(41%) males (Figure 2).

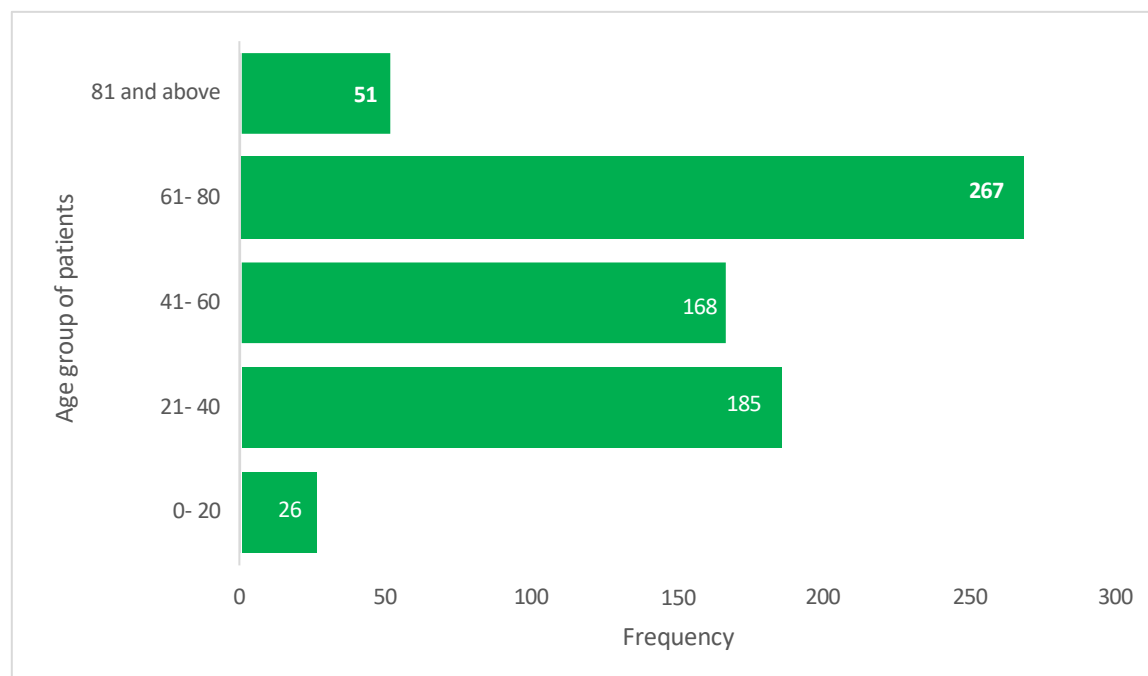


Figure 1. Age distribution of cancer patients who received external beam radiotherapy in UMTH Cancer Center August 2023 to September 2024

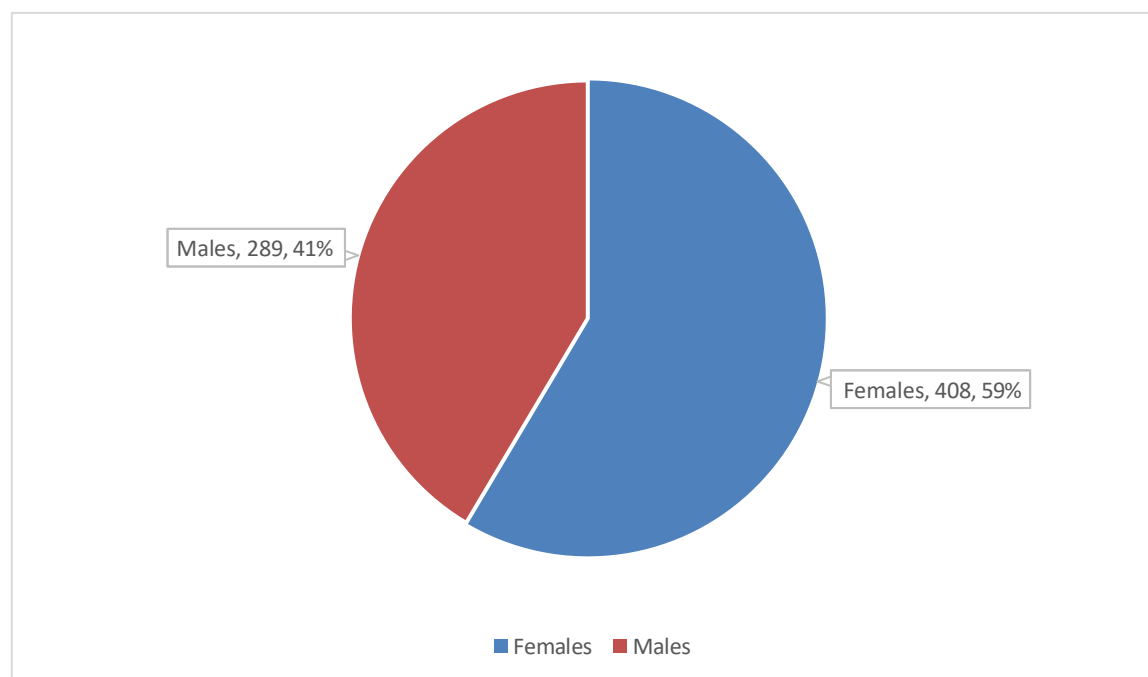


Figure 2. Distribution of gender of cancer patients who received external beam radiotherapy in UMTH Cancer Center August 2023 to September 2024

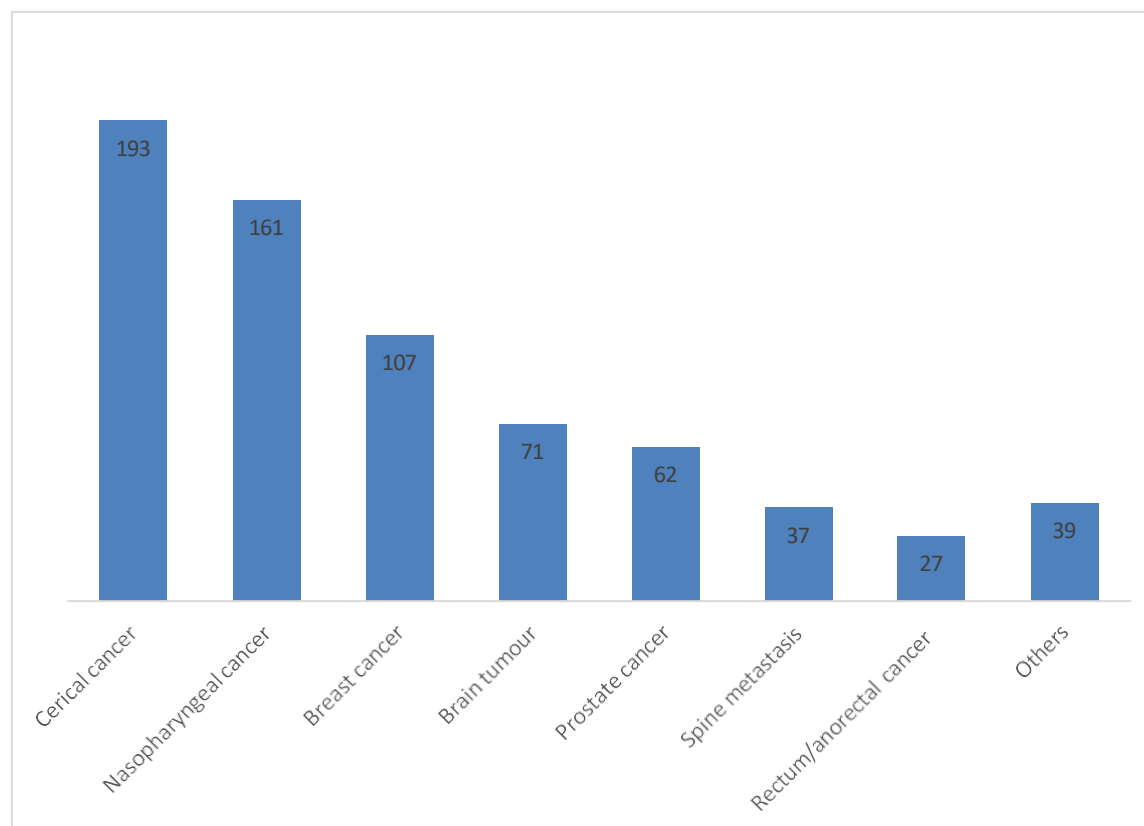


Figure 4. Distribution of site of cancer diagnosis of patients who received external beam radiotherapy in UMTH Cancer Center August 2023 to September 2024

Contribution of UMTH Cancer Center to management of cancer in Nigeria

Within a period spanning about a year from its commissioning in August 2023 to September 2024, the UMTH Cancer Centre treated 697 patients with external beam radiotherapy and 56 patients with high dose rate brachytherapy. Thus contributing significantly towards cancer management in Nigeria. The centre received referrals not just from North-eastern states but from all over Nigeria. Furthermore, the centre received and treated international patients from Niger, Chad Republics and Cameroon. The

UMTH Cancer Centre had the cheapest service fees and is one of the most patient-friendly radiotherapy center in the country, making it a top choice for many cancer patients from diverse socio-cultural backgrounds. Furthermore, the radiotherapy treatment waiting time was relatively shorter with a median duration of 10 – 14 days. The UMTH Cancer center, therefore contributed immensely to the provision of radiotherapy services to cancer patients in Nigeria (Table 2).

Table 2. Distribution of functional radiotherapy facilities in Nigeria as at September 2024

Geopolitical zone	Radiotherapy center	Radiotherapy Facility	
		Linear accelerator	High dose rate brachytherapy
South West			
	NSIA- LUTH, Lagos	3	2
	UCH Ibadan	---	2
	Eko Hospital, Lagos	1#	---
	Marcelle Ruth Cancer Center, Lagos	1	---
North West			
	ABUTH, Zaria	---	1
	UDUTH, Sokoto	1	1*
	Muhammad Buhari Cancer Center, Kano	2	1*
South East			
	UNTH, Enugu	1	---
	David Dave Umahi Cancer Center, Abakili Ebonyi	1	-
	American Cancer Hospital, Ikeduru, Imo State	1#	--
North East			
	FMC Gombe	----	1
	UMTH Maiduguri	2	2
FCT Abuja			
	NHA, Abuja	2	1
South South			
	UBTH Benin	--	1
	Asi Upko Cancer Center, Calabar	1	1*
North Central	---	---	---

#Do not have Linear accelerator but Cobalt-60

*Have HDR brachytherapy that has not been commissioned

Maduguri Flood Disaster and its effect on UMTH Cancer Center

The Maiduguri flood disaster was an overwhelming event that occurred on 10th September 2024 as a result of the collapse of the Alau Dam due to torrential rainfall. Over half of the land mass of Maiduguri and Jere Local Government Areas were submerged in the flood for days before it receded. It led to displacement of significant proportion of the populace who

faced numerous health risks and food insecurity. The flood also damaged many infrastructure including roads, bridges, buildings and the zoo. There were over 100 deaths from the flood and several people unaccounted for.

Unfortunately, the entire UMTH complex was submerged in the flood for days and the radiotherapy facilities were not spared. The linear accelerators, high dose rate brachytherapy, CT simulator and many of their accessories were

partly submerged in the flood water for days. All the radiotherapy facilities could no longer function due to the damages from the flood, thus bringing an abrupt stop to radiotherapy. After the flood receded, some of the patients on treatment who returned back to the Center were referred to other functional radiotherapy centers, while skeletal outpatient clinics, chemotherapy and ward admissions were retained, along with residency training.

Post flooding recovery

The Maiduguri flooding has generally attracted attention of the federal Government, international and local non-governmental organizations. There has been outpouring of sympathy on the damaged radiotherapy facilities. Various teams from Federal Ministry of Health, and other partners have come to the UMTH Cancer Center to assess first-hand the level of damage. There are currently high-level engagements with Federal Ministry of Health, national Agency on Cancer Research and Treatment (NICRAT), the International Atomic Energy Agency (IAEA) and other partners on the cost of replacing or repairing the damaged the radiotherapy facilities; and strategies to mobilise the required funding.

Currently, the activities of the UMTH Cancer Center has been grossly reduced. The referral from centers across the country have stopped as external beam radiotherapy and brachytherapy are temporarily non-functional. However, the weekly outpatient clinics, chemotherapy administration, and residency trainings are still being conducted.

DISCUSSION

The University of Maiduguri Teaching Hospital (UMTH) Cancer Center was indeed a very successful project, which recorded instant impact, and gained wide acceptability by stakeholders in cancer care and was a favourite choice for cancer patients from diverse socio-economic backgrounds. This is demonstrated by the high level of patronage of UMTH for radiotherapy services from across all the geo-

political zones of Nigeria and neighbouring countries like Chad, Niger and Cameroun Republics. Within a span of a year, 697 cancer patients were treated in UMTH Cancer Center. Furthermore, relieved cancer patients from Borno State and other North Eastern States who mostly had travel over 400 kilometers to access chemotherapy and radiotherapy services in other geo-political regions, by bringing comprehensive cancer care to their vicinity. At the peak of its operation, the center was one of the few centers in the country that offered chemotherapy, external beam radiotherapy and brachytherapy, thus sealing its position as a comprehensive cancer centre. The successes of the UMTH Cancer Center were achieved as a result of a combination of factors. First, visionary, dedicated and proactive leadership of the UMTH management led by the Chief medical Director, Prof. Ahmad Ahidjo. Second factor was the buy-in of the Federal Government and other critical stakeholders who provided the huge funding and support for the building and purchase of the radiotherapy equipment. Third, is the general ownership of the project by the healthcare workers, community and even specialists from neighbouring tertiary health centers who put in efforts to support the cancer center in numerous ways and also helped fill in critical gaps in healthcare workforce. These factors together with the relative cheaper fees of radiotherapy services at UMTH Cancer Center led to the overwhelming patronage from Nigerians, far and wide. These successes were similar to those recorded in establishing new radiotherapy facilities in some LMIC in Africa, including Rwanda, Ethiopia, among others.^{14, 20}

Despite, the enormous successes recorded by the UMTH Cancer Center, there were many challenges faced in running the centre. First, skilled manpower to run the centre was limited. There was general shortage of radiation oncologists, medical physicists, therapy radiographers and biomedical engineers across Nigeria, and difficulty in attracting these few from other regions to practice in Maiduguri, a town devastated by the *Boko Haraam* insurgency. Secondly, most of the cancer patients requiring radiotherapy are indigent patients. Many are unable to afford radiotherapy ab ignition, while

others struggle to pay for the different radiotherapy services, as they experience financial toxicity while undergoing treatment. The only available mode of payment for the radiotherapy services in UMTH Cancer Center was out-of-pocket expenditure. The center was not included as part of those enrolled in the Cancer Health Fund (CHF), which is a scheme of the Federal Government that enrolls indigent cancer patients to finance their cancer treatment. Neither does the National Health Insurance cover for radiotherapy treatment of patients. These factors have made access to radiotherapy difficult or limited for many of the patients who have to pay out-of-pocket for these services. These challenges are very similar to what is obtainable in other low-income countries.²¹⁻²⁴ For instance, in Rwanda, the health insurance covered 90% of cost of radiotherapy treatment, but most cancer patients are still indigent and struggle to pay for the 1remAINING 10% of cost, out-of-pocket.¹⁴

The Maiduguri flood disaster that brought to a halt the radiotherapy treatment of patients in UMTH Cancer Centre, was a natural disaster that

was novel to our setting. To the best of our knowledge, there has been no other radiotherapy centre in the country that has been affected by a natural disaster previously. It has brought to the limelight the need for the design of our radiotherapy centres to be more robust and resistant to disasters like flood, fire outbreaks; and also, the congenit need for the radiotherapy facilities to be insured against unforeseen incidences and natural disasters.^{22, 25}

CONCLUSION

The UMTH Cancer Centre project has been a huge success with great impact, providing access to radiotherapy to Nigerians and increasing the cancer workforce and facilities in the country. There are many challenges faced in running the Cancer Centre which include shortage of qualified skilled health workforce and out-of-pocket expenditure of cancer patients. There is need for similar efforts to be replicated across various regions of Nigeria and also other low-and-middle-income countries to help bring access to radiotherapy services available, accessible and affordable.

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