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Radiation Therapy for Cancer Treatment in Nigeria: Inception, Slow Progress and Challenges

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ABSTRACT
The steady increase in cancer cases in the world is quite alarming, with the developing countries experiencing a disproportionate share of the rise. Recent estimates indicate that a large population of about 50-60% of cancer patients are likely to require radiotherapy at some points. This article presents an evaluation of the current radiotherapy capacity for cancer treatment in Nigeria, analyzed the present and future challenges and also the potentials and opportunities in the cancer radiotherapy. We present a comprehensive information on each radiotherapy center in Nigeria, types of procedure or instrumentation for the cancer treatment as well as the number of the machines available. Furthermore, information on personnel in each center and its training capacity have also been reported. It would be seen that Nigeria, despites its slow progress, has several radiotherapy sources of which nine (9) are brachytherapy units which include Iridium-192, colbalt-60 and Iodine-131 as well as Twelve (12) LINAC machines for cancer treatment. Additionally, the current status of radiotherapy equipment in Nigeria is compared with the years 2001, 2005 and 2010 previous statuses, revealing a slow positive progress, especially in the recent years. There is also prospective arrival of new equipment in a number of hospitals in the next one year, with advanced preparation already well in place. Despites this prospect, considering the population increase, the cancer treatment units have to be rapidly developed. The units also could require the need for sufficient professional staffing and training for capacity building.

Keywords:
Cancer therapy,
Radiotherapy,
LINACs,
Brachytherapy,
Cobalt-60,
Irridium-I92,
Iodine-131.

INTRODUCTION

Nuclear medicines are a class of drugs that include radiopharmaceuticals and are used in the medical imaging field. Most radiopharmaceuticals contain a small amount of radioactive material. This material will accumulate in the area of the patient's body that is being imaged. The nuclear medicines are used to diagnose a wide range of conditions, which show up as areas of increased or decreased function. In the treatment sense, this capability to show function of the organ rather than simply its structure allows prescribers to adjust the patient's treatment for optimal effect. There is also a field called theranostics, which uses a combined strategy of diagnosis and treatment (Song et al., 2024). This strategy is normally associated with oncology and the physician uses a number of different scans to prepare the doses of radiation therapy that will help to treat the cancer. However, they could be used for patients with other conditions. As a treatment option, nuclear medicine has the benefits of the treatment occurring very quickly and a very specific amount of the body being targeted. This precise targeting points to much lower doses of radiation going to surrounding healthy tissues. In addition, many of nuclear medicine's treatments do not result in side effects that are particularly common with the other form of radiation therapy, such as tiredness or skin irritation. The radiation exposure risks for nuclear medicine treatments are often overstated by those who are against the technology, and it is important for healthcare professionals to be able to guide the patient through their decision-making. First widely used in the 1950s, nuclear medicines in recent years have provided some eye-catching development in terms of both imaging and treatment. For example, spectacular scanners help to create a 3-D visual of the body by using a gamma camera. Another example is a PET scan, which can show areas of the body that are functioning in a certain way, and this makes it great for early diagnosis of many conditions that show alterations in cellular activity (Wong et al., 2016).

MATERIALS AND METHODS

Linear Accelerators (LINACs)

Linear Accelerators (LINACs) represent a cornerstone of modern cancer treatment, particularly in radiotherapy. These machines generate high-energy x-rays or electrons that can be precisely directed to target cancer cells while minimizing damage to healthy tissues (Aruah et al., 2020, Adewuyi et al., 2013). As a critical component of External Beam Radiotherapy (EBRT), LINACs have become an essential tool in non-invasive cancer treatment (Aruah et al., 2020). However, access to LINACs varies significantly across different parts of the world, impacting treatment outcomes. In Nigeria, for instance, the availability of LINACs is strikingly limited. With a population exceeding 200 million, the country currently operates just 12 LINAC machines, of ten of them were purchased and installed by the Federal Government of Nigeria (FGN). Three at Lagos University Teaching Hospital (LUTH), Lagos, two at National Hospital Abuja (NHA), Abuja, one at Usmanu Danfodiyo University Teaching Hospital, Sokoto, two at University of Nigeria Teaching Hospital, Enugu, two at university of Maiduguri teaching hospital and the remining two are owned by private cancer centers, one at Marcelle-Ruth cancer center Lagos, and also one at Asi-ukpo cancer center Calabar (Arah & Adewuyi, 2020). This results in a ratio of 1 LINAC per 16.7 million people, a troubling figure that highlights a severe shortage of radiotherapy resources. Consequently, many patients face long delays for treatment or are forced to travel long distances, exacerbating the already high cancer mortality rate (Samiei, 2013).

In contrast, South Africa, with a population of approximately 60 million, has more than 70 LINACs, resulting in a much more favorable ratio of 1 LINAC per 860,000 people (Samiei, 2013). This significant disparity underscores the impact of healthcare infrastructure investment on patient outcomes, as timely access to radiotherapy is often critical for effective cancer treatment (IAEA, 2015).

Meanwhile, high-income countries like the United States and the United Kingdom are far better equipped in terms of LINAC availability.

In the U.S., there are more than 2,500 LINAsC machines for a population of roughly 330 million, creating a ratio of 1 LINAC per 130,000 people (ASTRO, 2020). This abundant access allows for timely radiotherapy, which is associated with higher survival rates among cancer patients (Zietman et al., 2010).

Similarly, in the United Kingdom, there are over 300 LINACs serving a population of 67 million, resulting in a ratio of 1 LINAC per 220,000 people, ensuring broad accessibility through the (National Health Service, 2020).

In India, which has a population exceeding 1.4 billion, there are approximately 700 LINACs, translating to a ratio of 1 LINAC per 2 million people (Indian Council of Medical Research, 2021). While this figure still reflects a shortfall in infrastructure, the Indian government has made strides in expanding access to radiotherapy, particularly in rural areas, where healthcare resources are often scarce (ICMR, 2021). By comparison, Australia, with its smaller population of around 26 million, has approximately 180 LINACs, resulting in one of the highest ratios globally--1 LINAC per 144,000 people (ARPANSA, 2021). This high ratio reflects Australia's strong healthcare system and its commitment to providing advanced cancer care, which plays a critical role in improving patient outcomes (Barton et al., 2013). These global disparities in LINAC availability reveal profound inequalities in access to cancer care. While high-income countries like the U.S., U.K., and Australia have widespread access to radiotherapy, low- and middle-income countries (LMICs) such as Nigeria continue to face significant challenges

due to insufficient LINAC infrastructure. Addressing these disparities is essential to reducing the global cancer burden, requiring targeted investment in radiotherapy facilities and healthcare infrastructure in underserved regions (Samiei, 2013).

Table 1: The Comparison of Linear Accelerators (Linacs) Availability in Nigeria and Across Different Countries (Aruah et al., 2020, Adewuyi et al., 2013)

Country	Population (Millions)	Number of Linacs	Linacs Per Population
Nigeria	200	12	1 linac per 16.7 million
Southafrica	60	70	1 linac per 860,000
United State	330	2500	1 linac per 130,000
United Kingdom	67	300	1 linac per 220,000
India	1400	700	1 linac per 2 million
Australia	26	180	1 linac per 144,000

This table highlight the disparity in the availability of LINACs in Nigeria compared to other countries, underscoring the need for increased investment in Nigeria's enabling radiotherapy infrastructure.

Brachytherapy

Brachytherapy has established itself as a vital method in nuclear medicine, enabling precise radiation therapy by placing radioactive sources within or adjacent to tumors. This technique allows for high doses of radiation to be delivered directly to cancerous tissues, significantly reducing exposure to surrounding healthy tissues. Brachytherapy is primarily classified into two types: High-Dose Rate (HDR) and Low-Dose Rate (LDR), each utilizing specific radioactive isotopes tailored to various clinical applications (Yavaş, 2019).

High-Dose Rate (HDR) Brachytherapy Sources

HDR brachytherapy is characterized by the provision of high radiation doses in short, well-defined treatment sessions, usually lasting only a few minutes. The following isotopes are commonly used in this unit:

1. Iridium-192 (Ir-192): Ir-192 is the most common isotope in HDR brachytherapy, recognized for its efficacy in treating a variety of cancers, including cervical, breast, and prostate cancers. With a half-life of 73.8 days, Ir-192 facilitates rapid delivery of radiation, improving local tumor control while minimizing damage to adjacent healthy tissues (Nag et al., 2004).
2. Cobalt-60 (Co-60): Co-60, with a half-life of approximately 5.3 years, is occasionally used in HDR brachytherapy. While its extended half-life can be beneficial, it is not as frequently utilized due to the availability of more effective isotopes (Datta et al., 2014).
3. Cesium-137 (Cs-137): Although primarily associated with LDR brachytherapy, Cs-137 can also be used in HDR applications. With a half-life of 30.1 years, it is suitable for long-term use, although advancements in HDR technology have reduced its application (Thomadsen et al., 2017).

Low-Dose Rate (LDR) Brachytherapy Sources

LDR brachytherapy involves the implantation of radioactive seeds that provide a continuous, low radiation dose over an extended period, often resulting in permanent placement within the tumor. The following isotopes are typically used:

1. Iodine-125 (I-125): I-125 is the primary isotope for LDR brachytherapy, notable for its half-life of 59.4 days. It is particularly effective for prostate cancer and certain brain tumors, as it emits low-energy gamma radiation that reduces damage to nearby healthy tissues (Nag et al., 2004).
2. Palladium-103 (Pd-103): With a shorter half-life of 17 days, Pd-103 is employed in treating prostate cancer. Its rapid decay allows for quicker radiation delivery, which may enhance treatment effectiveness (Nag et al., 2004).
3. Cesium-131 (Cs-131): A newer isotope in the LDR category, Cs-131 has a half-life of 9.7 days. Its rapid dose delivery capabilities make it especially useful in particular clinical scenarios, particularly in treating prostate and brain cancers (Haie-Meder et al., 2017).
4. Gold-198 (Au-198): While less commonly used, Au-198 is effective in LDR brachytherapy for prostate cancer, with a half-life of 2.7 days that enables prompt dose delivery (Eric Hall & Giaccia, 2012).
5. Iodine-131 (I-131): Best known for its use in nuclear medicine, especially for thyroid cancer treatment, I-131 has a half-life of 8 days. It is administered systemically to target thyroid tissues, showcasing its versatility beyond conventional brachytherapy applications (Tanderup et al., 2014).

The decision to use HDR or LDR brachytherapy sources depends on multiple factors, including the tumour's location, size, and specific treatment objectives.

According to the Directory of Radiotherapy Centers database (DIRAC), there are 160 radiotherapy centers in Africa that are equipped with a total of 189 linear accelerators (LINACS) and 88 cobalt-60 machines, with more than 60% in South Africa, Egypt, and Morocco (Samiei, 2013) but Nigeria, despites having an estimated population of 200 million people and experiences approximately 115,000 new cases of cancer per year and around 70,000 cancer deaths per year, was previously reported to have only nine brachytherapy units, eight of which were purchased and installed by the federal government of the Nigeria. They are located as follows: One at Ahmadu bello university Zaria (cobalt 60), one at university collage hospital Ibadan (cobalt 60), one at Lagos university teaching hospital (iridium 192), one at national hospital Abuja (cobalt 60), one at university of Maiduguri teaching hospital (cobalt 60), one at federal teaching hospital Gombe (iridium 192) another one at national hospital Abuja (iodine 131) and another one at university collage hospital Ibadan (iodine 131), and the remaining one is owned by the private brachytherapy unit.

Methodology

The present study examines and documented the number of radiotherapy centers, available equipment, personnel, and training capacity by surveying all radiotherapy centers in the country using a standardized pro forma. The data on equipment and personnel were analyzed and compered to established benchmarks, such as the number of LINACs per million populations. Additionally, the current status of radiotherapy equipment was compared to reports from 2001, 2005 and 2010, evaluating the improvement in recent years. The updated data on equipment presented in Table 4, which is the current work, was mostly obtained from direct information from relevant staff and also literature sources.

RESULTS AND DISCUSSION

The data of radiotherapy information in Nigeria reported earlier to the present study have been reported in Table 2, which presented the number and status of radiotherapy machines in Nigeria as of 2001. Another reported progress on the radiotherapy in Nigeria are available in Table 3 for the status up to 2010.

The recent update, after about fifteen-year progress, have been documented in Table 4, which provides the update up to the June, 2025. Comparing Table 2 through Table 4, it would be seen that the Nigerian progress is apparent, however, is relatively slow when we compare with other developed countries in the world. For example, the Nigerian total number of LINACs and brachytherapy sources have significantly been increased in 2025 relative to 2001 data (Table 2 and Table 4), and is even more so with the brachytherapy procedures. The progress is associated with government policies, which are important for the development of this important sector.

Table 2: The State of Radiotherapy Centers in Nigeria as 2001

Radiotherapy center	LINAC	Cobalt-60	Iridium-192	Iodine-131	Population served
LUTH, Lagos		2			
Eko, Hospital		1			
UCH, Ibadan		1			
ABUTH, Zaria		1			
NHA, Abuja	1				
Total	1	5			$120x10^6$
Brachytherapy classification		HDR	HDR	LDR	

LUTH-Lagos university teaching hospital, UCH-university collage hospital, ABUTH- Ahmadu bello university teaching hospital, NHA-National hospital Abuja

Table 3: The State of Radiotherapy Centers in Nigeria as 2010 (Adewuyi et al, 2013; Aruah et al., 2020)

Radiotherapy centers	LINAC	Cobalt-60	Iridium-192	Iodine-131	Population served
LUTH, Lagos	1	Decommissioned			
UCH, Ibadan				1	
ABUTH, Zaria		1			
NHA, Abuja	1				
EKO, Hospital Lagos		1			
UNTH, Enugu	1				
UDUTH, Sokoto	1				
UBTH, Edo	1				
FMC, Gombe			1		
Total	5	2	1	1	$155x10^6$
Brachytherapy classification		HDR	HDR	LDR	

LINAC-Linear Accelerator, LUTH-Lagos university teaching hospital, UCH-university collage hospital, ABUTH-Ahmadu bello university teaching hospital, NHA-National hospital Abuja, UNTH-University of Nigeria teaching hospital, UDUTH-Usmanu danfodiyo university teaching hospital, UBTH-University of Benin teaching hospital, FMC- Federal medical center

Table 4: The State of Radiotherapy Centers in Nigeria as 2025 (Serving the Population of $200x10^6$ Nigerian People)

Radiotherapy Centre	Linac	Cobalt-60	Iridium-192	Iodine-131	Ownership	Status
LUTH Lagos	3	-	1	-	PPP	Functional
NHA, Abuja	2	1	-	-	Government	Functional
UDUTH, Sokoto	1	1 (TBI)			PPP	Functional
UNTH, Enugu	1 (DC) 1 (OI)				PPP	
MRCC Lagos	1	-	1	-	Private	Functional
Asi-ukpo Calabar	1	-	-	-	Private	Functional
ABUTH zaria	-	1	-	-	Government	Decommissioned
UCH Ibadan	1 (DC) 1 (TBI)	1 (DC) 2 Brachy			Government	To be installed
UMTH Maiduguri	1	-	1	-	Government	Under maintenance
FTHK katsina	1 (OI)	-	1 (OI)	-	PPP	Ongoing installation
FMC Gombe	1 (TBI)	-	1 (TBI)	-	PPP	Under construction

Radiotherapy Centre	Linac	Cobalt-60	Iridium-192	Iodine-131	Ownership	Status
UBTH Benin	1 (OI)	-	1 (OI)	-	PPP	Ongoing installation
Kano Cancer centre	1	-	-	-	Private	Functional
JUTH jos	1 (TBI)	-	1 (TBI)	-	PPP	Under construction

ABUTH- Ahmadu Bello University Teaching Hospital Zaria, Kaduna State.
DC- Decommissioned.
FMC- Federal Medical Centre.
FTHK- Federal Teaching Hospital Katsina, Katsina State.
JUTH- Jos University Teaching Hospital Jos, Plateau State.
LINAC-Linear Accelerator.
LUTH- Lagos University Teaching Hospital Lagos.
MRCC- Merce-Ruth Cancer Centre Lagos state.
NHA- National Hospital Abuja.
OI- Ongoing installation.
PPP- Public Private Partnership.
TBI- To be installed.
UBTH- University of Benin Teaching hospital Benin, Edo State.
UCH- University College Hospital Ibadan, Oyo state.
UDUTH- Usmn Danfodio University Teaching hospital Sokoto.
UMTH- University o Maiduguri Teaching Hospital.
UNTH- University of Nigeria Teaching hospital Enugu

CONCLUSION

The rapid increase in cancer cases need to go hand in hand with early detection and management of cancer cases. Nigeria has not been doing enough when we consider its population relative to the available radiotherapy centers in Nigeria. However, despite the inactivity or slow progress, Nigeria have gotten a recent improvement in the nuclear medicine industry in recent years compared to the previous decades, with a number of new installations and proposals in a number of centers across the country. The recent improvement is still not enough, however, when we consider the large population of Nigeria being estimated to be over 200 million. More so, the trained personnel that Nigeria have are not sufficient enough to meet the demand of the said growing population, leading to another area of massive need of government attention. It is evident that despites this slow progress, the overwhelming challenges are also very clear, especially when we also look at the geopolitical distributions of the radiotherapy centers relative to the vast land of Nigeria. As the healthcare system strives to improve diagnostic treatment and capabilities, there remains a considerable gap in infrastructure and training. The inadequate established protocols and insufficient funding hinders the optimal use of recent advanced technology, leading to inconsistencies in radiation exposure and thus possible concern on patient safety. Therefore, the government needs have a political will to address the pointed issues in this studies such as poor funding, increased diagnosis and treatment facilities, provision of trained personnel and education of the populace on cancer to effectively record a positive progress on cancer management.

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