VCDNP

ADVANCING ACCESS TO RADIOTHERAPY IN LOW- AND MIDDLE-INCOME COUNTRIES

Case study
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Photo: Dean Calma / IAEA

Summary

Radiotherapy plays a critical role in combating cancer worldwide. In low-and-middle income countries (LMICs) a disproportionate number of cancer patients do not have access to radiotherapy treatment. Zambia's approach to ensuring and advancing access to radiotherapy illustrates the unique challenges LMICs face, and the ways in which these challenges can be understood, addressed, and overcome. The objectives of this case study are to

a) raise awareness of the equity gap in access to cancer care,
b) examine the challenges to accessing radiotherapy in low- and middle-income countries and
c) draw on lessons learned by Zambia and make recommendations on improving access to radiotherapy in LMICs.

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Introduction

The global cancer crisis is growing. The numbers are staggering. Today, one in five people worldwide will develop cancer during their lifetime. According to the World Health Organization (WHO), one in six deaths globally are related to cancer, accounting for nearly 10 million deaths in 2020[1]. WHO estimates that the overall number of diagnosed cancer cases nearly doubled in the past two decades, from an estimated 10 million in 2000 to 19.3 million in 2020[2]. Also, that 16.3 million cancer-related deaths are projected by 2040[3]. An estimated 70% of these deaths will occur in low- and middle-income countries (LMICs).[4]

Over 40% of cancer patients in low- and middle-income countries have no access to radiotherapy treatment and only 5% of global resources for cancer are spent in these countries. Radiotherapy is a critical component of curative and palliative cancer therapy and more cost effective than either surgery or chemotherapy.[5] Depending on the type of cancer, on average 50%–60% of all cancer patients require radiotherapy during treatment. Given these considerations, we must ask ourselves why these patients are not getting the access to the care they need, and how we can bridge the gap.

Data show that higher incidence of death due to certain cancers in LMICs correlates with the lack of radiotherapy facilities. In particular, cervical cancer kills nearly 300,000 women every year in LMICs even though it is largely preventable and curable in high income countries, where it can be detected early and managed effectively. According to WHO, 19 of the 20 countries recorded with the highest cervical cancer burden in 2018 were in sub-Saharan Africa where more than 20

What is Radiotherapy?

Radiation therapy (radiotherapy) is a type of cancer treatment, used alone or in combination with other treatments. High doses of ionizing radiation, delivered either externally (external beam radiotherapy/EBRT) or internally, in close proximity to the tumour (brachytherapy), are used to destroy cancer cells and limit cell growth. Two of the most commonly used EBRT machines are Cobalt-60 (Co-60) teletherapy units and linear accelerators (LINACs). These machines use radioactive sources and electricity respectively to produce radiation.

1 World Health Organization. (2022, February 3). Cancer Key Facts. https://www.who.int/news-room/fact-sheets/detail/cancer

2 World Health Organization. (2021, February 3). Breast cancer now most common form of cancer: WHO taking action. WHO News. https://www.who.int/news/item/03-02-2021-breast-cancer-now-most-common-form-of-cancer-who-taking-action

3 Elflein, J. (2021, May 4). Forecasted number of deaths from cancer worldwide from 2020 to 2040. Statista. https://www.statista.com/statistics/1031323/cancer-deaths-forecast-worldwide/

4 World Health Organization. (2022, February 3). Cancer Key Facts. https://www.who.int/news-room/fact-sheets/detail/cancer

5 Samiei, M. (2013). Challenges of Making Radiotherapy Accessible in Developing Countries. Cancer Control. http://cancercontrol.info/wp-content/uploads/2014/08/cc2013_83-96-Samiei-varian-tpage-incld-T-page_2012.pdf

countries have no access to radiotherapy.[6] The equity gap in cancer care could not be more glaring.

A complete spectrum of care is needed, including prevention, screening, diagnosis, treatment and long-term follow-up, of which radiotherapy is a vital part.[7] A national cancer control programme that includes the building blocks for sustainable radiotherapy — infrastructure, equipment, training, human and financial resources, long term planning, and regulatory oversight — is essential[8]. This case study will examine the issue of access to radiotherapy in the LMIC context and discuss how Zambia is addressing these challenges and making cancer care available to its to 19 million citizens. This southern African country is one of 46 countries worldwide classified as a least developed country (LDC) by the United Nations Department of Economic and Social Affairs (UN DESA), namely a low-income country that faces severe structural impediments to sustainable development.[9]

Zambian oncologist Dr Kennedy Lishimpi has made it his life's work to change the narrative on cancer and improve access to radiotherapy in his country. This case study is not meant to be exhaustive, but rather illustrative. It focuses on External Beam Therapy used to treat cancer and examines lessons learned from the Zambian experience and draws on recent discussions with national cancer experts in LMICs and their international counterparts. Finally the case study identifies key takeaways on how to bridge the equity gap and save lives.

What is the equity gap in access to cancer care?

Where you live should not determine whether or not you survive cancer; however, for many cancer sufferers this is the case. Not everyone has access to radiotherapy. As of 2022, cancer patients in more than 20 African countries have no access to radiotherapy in their country.[10] One study estimated that the supply of

> *Half of cancer patients who need radiotherapy in low- and middle-income countries do not have access to it. This is a sobering statistic. And it is unacceptable.*
>
> Rafael Mariano Grossi,
> IAEA Director General

6 The Union for International Cancer Control. (2019, November 5). Cancer Control in Africa: Paving the way to Universal Health Coverage. https://www.uicc.org/addressing-cancer-burden-africa

7 Organisation for Economic Co-operation and Development. (2020) Development Assistance Committee List of ODA Recipients. https://www.oecd.org/dac/financing-sustainable-development/development-finance-standards/daclist.htm

8 Gilley, D. (2021, February 25). Effective and Sustainable Radiotherapy in Africa. VCDNP Workshop on Ensuring Access to Nuclear Technology for Human Health. https://vcdnp.org/ensuring-access-to-nuclear-technology-for-human-health/

9 United Nations Department of Economic and Social Affairs. https://www.un.org/development/desa/dpad/least-developed-country-category.html

10 International Atomic Energy Agency. (2022, February) Rays of Hope, Cancer Care for All. https://www.iaea.org/sites/default/files/22/02/rays-of-hope-v2.pdf

radiotherapy machines in Africa was sufficient to meet only 18% of the need for cancer treatment in the continent.[11]

Childhood cancers represent the starkest area of inequity with survival rates over 80% in high income countries and as low as 20% in low income countries.[12] Women are particularly hard-hit by the disparity in access. Breast cancer deaths in sub-Saharan Africa have increased by 70% since 2000 and, combined with cervical cancer, are the cause of one out of every five cancer deaths in the region. In contrast, breast cancer mortality rates have fallen in high-income countries.[13] Given that many cancers are preventable and curable, these breast cancer deaths have a far-reaching impact on families, communities, and development. However, data on the socioeconomic impact of the problem are insufficient. African cancer experts have identified the lack of sufficient data volume and inconsistent data collection to enable needs assessment and analysis for informed policymaking as an obstacle to expanding access to cancer care.[14]

In 2006, Zambia established a National Cervical Cancer Prevention Programme, and in 2007 President Levy Mwanawasa opened the Cancer Diseases Hospital (CDH) in Lusaka, which treats over 25% of Zambians. As an LDC, Zambia is leading by example in integrating radiotherapy into its cancer care programme and saving lives. Available statistics show that by 2035, if every cancer patient needing radiotherapy has access to it, at least one million more lives will be saved every year worldwide.[15]

"I did not set out to treat cancer. When the Ministry of Health established its first radiotherapy treatment centre in 2000 with only one oncologist in Zambia, they recognized that more were needed. The burden of cancer weighed heavily on my country at the time. Some 5000 Zambians were on a waiting list for cancer treatment abroad. Everyone I knew, was either affected or knew someone who was affected, and more than 70% of those diagnosed with cancer dying from the disease. I trained as a paediatrician. After witnessing first-hand the devastating impact of cancer on children, I decided to study oncology. I attended University in South Africa from 2003 and returned to Zambia after qualifying as an oncologist in 2007. At the time, not many doctors wanted to train in oncology, but I enjoyed the highly technical field, especially as it enabled me to use technology like radiotherapy to treat and help people. I made it my life's work to ensure that all Zambians have access to cancer care and that our radiotherapy services continue to expand." Dr. Kennedy Lishimpi

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11 Grisold, W., Soffietti, R., Oberndorfer, S., and Cavaletti, G. (2020). Effects of Cancer Treatment on the Nervous System, Volume I. https://www.cambridgescholars.com/resources/pdfs/978-1-5275-5888-5-sample.pdf

12 Union for International Cancer Control. (2022, February 4). World Cancer Day. https://www.worldcancerday.org/equity-access-cancer-services-0.

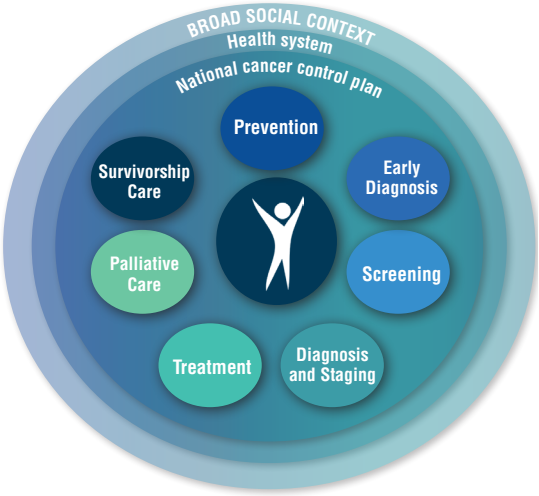
13 World Health Organization. (2018). Cervical Cancer. https://www.afro.who.int/health-topics/cervical-cancer

14 Wilton Park. (2020, February). In Support of Africa's Agenda 2063: Pathway Forward for Expanding Peaceful Uses of Nuclear Energy and Nuclear Technology in Africa. https://www.wiltonpark.org.uk/wp-content/uploads/2020/09/WP1763-Report.pdf

15 Atun R, Jaffray DA, Barton MB, et.al. (2015). Expanding Global Access to Radiotherapy. Lancet Oncol. https://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(15)00222-3/fulltext

The cancer care continuum

To be effective, radiotherapy as a treatment must be linked to other components in the cancer care continuum, like prevention, early diagnosis, screening, survivorship care and palliative care,[16] and also be supported by policies within a national cancer control programme. One of the benefits of Zambia's cancer control programme has been the establishment of 200 screening clinics that led to a reduction in fatality rates from cervical cancer.



"Comprehensive cancer prevention and control requires inclusion of all elements across the cancer continuum, framed by the health system and supported by effective financing strategies, monitoring systems and quality management."[17] Image credit: IAEA

Challenges to accessing radiotherapy in low- and middle-income countries

Lack of radiotherapy equipment

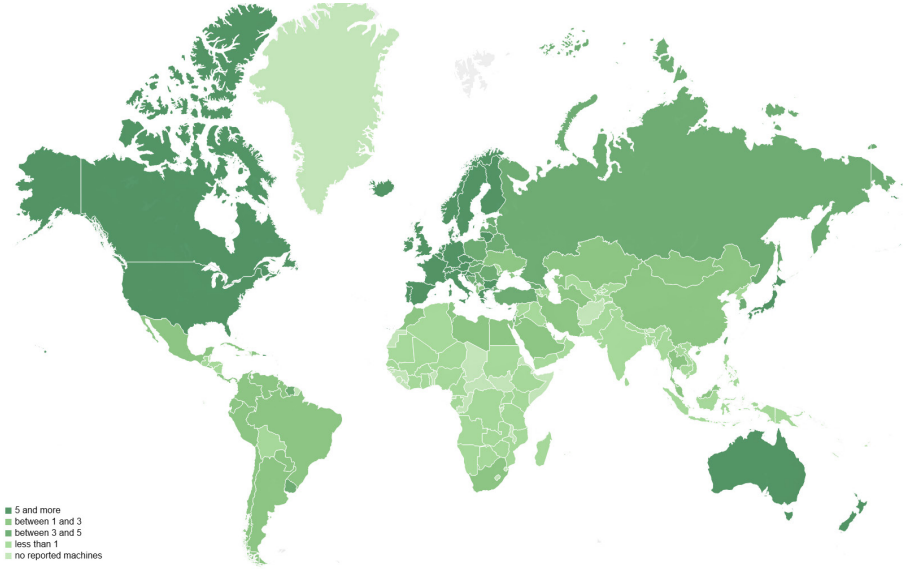
Despite being home to 84% of the world's population, LMICs have only about 6,650 radiotherapy machines, less than 38% of the world's radiotherapy facilities. In 63 countries, independent territories and islands, cancer patients have no access to potentially life-saving radiotherapy treatment in their own countries. Radiotherapy also alleviates cancer symptoms such as pain and improves quality of life. By comparison, North America and Western Europe have five or more machines per one million people.[18]

16 International Atomic Energy Agency. (2019). Roadmap towards a National Cancer Control Programme. https://www.iaea.org/sites/default/files/19/10/milestones-document-2019.pdf

17 International Atomic Energy Agency. (2019). Roadmap towards a National Cancer Control Programme. https://www.iaea.org/sites/default/files/19/10/milestones-document-2019.pdf

18 IAEA Directory of Radiotherapy Centres. https://dirac.iaea.org/

Africa, with a population of over 1.2 billion people, has only 385 radiotherapy machines.[19] This is compounded by a wide gap between optimal and actual utilization. In many LMICs, radiotherapy is available but its use is not optimized. Geography matters in this context. For example, many patients in Zambia were not getting treatment due to the geographical distance from the provinces to the Cancer Diseases Hospital in Lusaka. For some patients, the distance was more than 1500 km. A first step to increasing utilization is to improve the distribution of sites around a country. Zambia is expanding its programme and plans to establish treatment centres in all ten provinces, which will increase access to cancer care from 25% to 60% of the population.



Source: IAEA Directory of radiotherapy Centres [accessed 3 May 2021][20]

19 International Cancer Expert Corps. (2020, June 11). Innovative Technologies Towards Building Affordable and Equitable Global Radiotherapy Capacity (ITAR). https://www.iceccancer.org/designing-new-radiotherapy-technologies-to-treat-cancer-in-low-and-middle-income-countries/

20 IAEA Directory of Radiotherapy Centres. https://dirac.iaea.org/

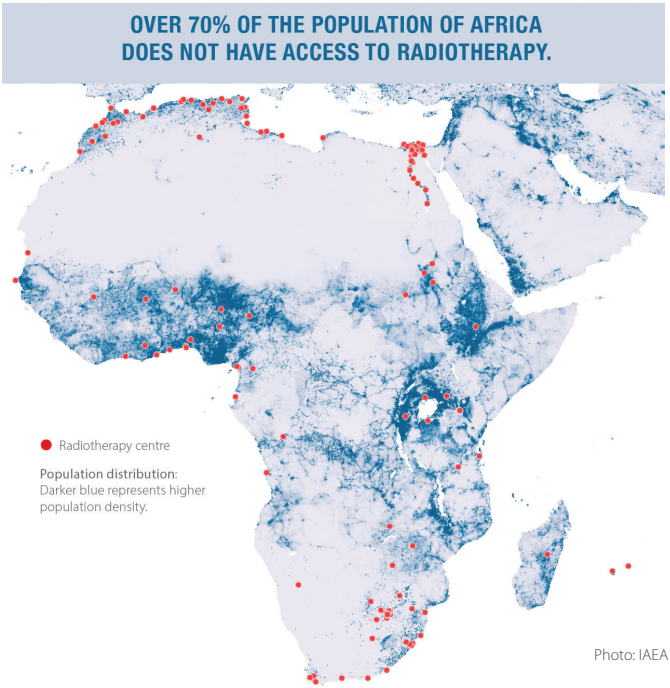


Photo: IAEA Rays of Hope[21]

Lack of investment in radiotherapy

Establishing a radiotherapy centre requires an investment of approximately six million US dollars. It also requires additional investments in the national healthcare system, in the policy and regulatory frameworks that support a radiotherapy programme, and in human resource development. While these long-term investments ultimately result in national cost-savings, including savings in healthcare, governments often do not make these investments. There are various reasons for this. Aside from financial constraints inherent to LMICs and cancer being one of many competing priorities to which scare resources must be allocated, peaceful nuclear applications such as radiotherapy are often not prioritized at national level because their benefits are not well understood by policymakers. As a result, many countries do not make provision for the establishment of radiation facilities in their national budgets, and do not have formalized strategies for human resource development in radiotherapy or other related policy frameworks.[22] This is one of the reasons why countries, when engaging with their bilateral development assistance partners, do not request support for the establishment of radiotherapy centres. Aid packages from development agencies/ banks to countries that qualify for official development assistance (ODA) often address

21 Rays of Hope, Cancer Care for All, brochure, IAEA 2022 available at: https://www.iaea.org/sites/default/files/22/02/rays-of-hope-v2.pdf

22 Wilton Park. (2021, May 18) Advancing Best Practices for Radiation Therapy. Consultations with international radiotherapy experts and industry. https://www.wiltonpark.org.uk/event/advancing-best-practices-for-radiation-therapy/

applications where radiation technology can be used (for example, strengthening health systems or wastewater management), but these projects rarely include radiation technologies. The reason could be that radiation technology may not be necessary for the exact project, or because the country has not identified the technology as a need or priority for the project. While it is more common for countries to direct their requests for support related to nuclear science and technology to the IAEA, some countries have received radiotherapy equipment under development bank (e.g. World Bank) projects.[23] Because each organization operates under a limited budget, a diversification of funding sources is essential to improving the availability of radiotherapy.

Lack of capacity

FACTS[24]

- The world today is short of 7.2 million healthcare workers and without specific efforts to address this shortage, this figure will reach 12.9 million by 2035.
- While progress is being made towards the basic threshold of 23 skilled health professionals per 10,000 people, 83 countries still fall below this threshold.
- The pool of skilled workers is also unevenly distributed, with high concentrations in urban areas and many working in the private sector rather than in public healthcare.
- While the greatest shortages in numerical terms are expected to be in parts of Asia, they are especially acute in sub-Saharan Africa. For example, in the 47 countries of sub-Saharan Africa, just 168 medical schools exist. Of those countries, 11 have no medical schools, and 24 countries have only one medical school.
- Globally, a failure to take action to address shortages in cancer healthcare professionals will have a lasting impact on the accessibility and quality of care, with delays in diagnosis and treatment; care provided by inadequately trained professionals; fragmentation of services; and worsening of disparities in cancer outcomes.

23 Wilton Park. (2021, May 18) Advancing Best Practices for Radiation Therapy. Consultations with international radiotherapy experts and industry. https://www.wiltonpark.org.uk/event/advancing-best-practices-for-radiation-therapy/

24 International Cancer Control Partnership. Human Resources for Health. https://www.iccp-portal.org/human-resources-health

As of 2018, only an estimated 664 oncologists were practicing in LMICs.[25] To accommodate the growing cancer burden and to train the number of oncologists needed will be challenging for several reasons, including a lack of trained medical staff and of qualified teaching faculty in many LMICs, a high demand for radiation oncologists in high-income countries; the high cost of education and training, and the emigration of skilled personnel from LMIC's to better paid positions in high-income countries. Potential university students often face financial barriers to attending university, where subjects related to nuclear science in general, and radiotherapy in particular, are studied. Even among students enrolled in universities, there are difficulties in many cases generating enough interest to justify establishing separate classes for these subjects.[26]

This is complicated by the fact that not only oncologists are needed. Trained staff, such as medical physicists, clinicians, nurses, technicians and other support personnel are required in each radiotherapy centre. The implications for a shortage in trained staff are not just on delivery of treatment. In the case of medical physicists, who are also in short supply, they are needed even in the initial procurement of equipment. They are critical to the integration of selected systems and equipment.[27]

Determining suitable radiotherapy technologies for LMICs

There is significant debate about the use of Co-60 teletherapy and LINACs for the delivery of external beam radiotherapy treatment. Many LMICs provide radiotherapy using Co-60 technology because these treatment units are easier to operate and maintain, are less expensive, hardier in harsher environments, and less dependent upon local infrastructure (clean water and electricity). However, LINACs offer state-of-the-art treatment which is preferred by radiation oncologists in clinical situations where complex treatments are required.[28] LINACs also offer shorter treatment times and generally result in less dose to surrounding tissues thanks to the ability to control and tailor the beam. Both these technologies are clinically acceptable and have a long history of successfully treating cancer patients. However, the technical factors that pose particular challenges in LMICs must be considered. Complex economics, physical infrastructure, societal priorities and workforce shortages can influence the ability of these countries to provide cancer treatment using LINACs instead of or in addition to Co-60 teletherapy.[29]

25 Wendling, N. (2022, February 4). Improving Access to Radiotherapy in LMICS. https://www.youtube.com/watch?v=A3GfZvf5H_0

26 Wilton Park. (2021, May 18) Advancing Best Practices for Radiation Therapy. Consultations with international radiotherapy experts and industry. https://www.wiltonpark.org.uk/event/advancing-best-practices-for-radiation-therapy/

27 Wendling, N. (2022, February 4). Improving Access to Radiotherapy in LMICS. https://www.youtube.com/watch?v=A3GfZvf5H_0

28 Ige TA et al. (2021, June 8). Surveying the Challenges to Improve Linear Accelerator-based Radiation Therapy in Africa: a Unique Collaborative Platform of All 28 African Countries Offering Such Treatment. Clinical Oncology. https://doi.org/10.1016/j.clon.2021.05.008

29 Healy BJ, van der Merwe D, Christaki KE, Meghzifene A. (2016, November 28) Cobalt- 60 Machines and Medical Linear Accelerators: Competing Technologies for External Beam Radiotherapy. Clinical Oncology. https://doi.org/10.1016/j.clon.2016.11.002.

Factors that pose a challenge to the use of C0-60 teletherapy relate to the security of radioactive sources. Radioactive sources are categorized by the IAEA according to the risk they pose to human health if not managed safely and secure. Category 1 and 2 sources pose the highest risk and this category includes Co-60 used in radiotherapy treatment. On the basis of this categorization, risk informed decisions can be made by regulators for the purposes of safety and security.[30] After the terror attacks on the United States in September 2000 international efforts were focused on strengthening the security of particularly category 1 and 2 sources in transport, use, storage, and disposal as they could cause death or injury if used in a radiological dispersal device (dirty bomb) or left exposed in a public place. The economic and psychological consequences of such an incident would result in widespread panic and the necessary clean-up of the area could also amount to millions of dollars.[31] The transportation of these sources was affected when radioactive cargo was increasingly subject to denials and delays at harbours and other ports of entry caused by increased risk perception and complicated regulatory processes, among other factors. This resulted in a growing reluctance among shipping companies to transport radiological cargo which is making these sources more expensive and harder to obtain. The International Radiation Association noted at a meeting at the IAEA on denials and delays of shipment in 2019 that regardless of industry's compliance with national regulatory requirements and good transportation practices, fewer shipping companies are willing to take the risk of transporting radiological cargo.

Another factor increasing the costs and challenges related to the use of radioactive sources is the management of radioactive waste. Many LMICs do not have national nuclear waste management facilities; therefore, the most sustainable disused source management solution for the country and the user would be to return their disused sources to a producer. In fact, many users have radiotherapy re-sourcing/source take-back agreements with a vendor. However, if costs are not planned for, or a vendor goes out of business, the return of disused sources becomes especially costly and logistically and technically complicated. In these cases, assistance is often requested from national authorities, the IAEA, or other international partners such as the Off-Site Source Recovery Program, which is sponsored by the U.S. Department of Energy/National Nuclear Security Administration's Office of Radiological Security. In total since 1997, OSRP has been able to recover over 45,000 sources from more than 1588 sites (including all 50 states, D.C., Puerto Rico and 28 foreign countries.[32]

30 International Atomic Energy Agency. (2004). Categorization of Radioactive Sources. https://www.iaea.org/publications/7237/categorization-of-radioactive-sources

31 United States Nuclear Security Regulatory Committee. (2022, February 23) Backgrounder on Dirty Bombs. https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-dirty-bombs.html

32 Los Alamos National Laboratory. Off-Site Source Recovery Program, https://osrp.lanl.gov

Each radiotherapy machine has certain advantages and disadvantages to consider in the development of a cancer control programme, as illustrated below.

COBALT-60 TELETHERAPY MACHINES	MEDICAL LINEAR ACCELERATOR
Costs	
Less expensive to purchase and install	More expensive to acquire and install
Lower operational and maintenance costs	Higher operational and maintenance costs
Replacement, storage and disposal of disused Co-60 sources — additional cost	No source replacement costs
Security system installation and maintenance – additional cost	No costs for physical security (no high activity radioactive material)
Infrastructure requirements	
Not dependent on reliable electricity supply	Require a reliable, stable electricity supply, clean water and air conditioning
Operation and maintenance	
Simpler to use, less dependent on infra-structure resource requirements, have less machine down-time	More complex to operate, higher require-ments for skilled workforce and maintenance, can result in prolonged downtimes and high service costs
Infrequent calibration required	Requires regular calibration and high level of technical support
Sources need replacing every 5–7 years	Spare parts not readily available in LMICs
Treatment	
At disadvantage where complex treatments are needed, can damage surrounding tissue. Continued treatment with sources that are depleted due to challenges related to their replacement result in longer treatment times per patient and a reduction in number of patients treated	Can offer better localization of radiation dose to tumour, limiting damage to adjacent tissue and shorter treatment times.
Increased radiation side effects	Fewer radiation side effects
Safety and security	
More complex radiation safety procedures	Less complex radiation safety requirements
Replacement, storage and disposal of disused Co-60 sources problematic for many LMICs	No security issues related to sources

It is projected that about 12,600 radiotherapy therapy machines will be needed globally over the next two to three decades to meet the needs in LMICs[33]. The debate on which technology should be used should not, therefore, detract from the point that patients are dying in Africa and elsewhere and that urgent action is required to expand access to radiotherapy. The factors affecting the effective use of Co-60 teletherapy and LINACs in LMICs should be addressed and the decision on which technology to use should be based on suitability, affordability, sustainability and provision of appropriate treatment. For Certain cancersthere is no viable alternative treatment currently available. For example, brachytherapy can be effectively delivered only when a radioactive source is placed in the cervix.[34] Considering the high burden of cervical cancer in LMICs, these countries will continue to rely on radioactive sources in the foreseeable future.

Lessons learned by Zambia

1. High-level support translates awareness into action

Awareness of the cancer burden in LMICs is undeniably important for many different stakeholders, including patients, healthcare providers, and decision-makers. However, it takes political will at the highest level to translate awareness into action. President Levy Mwanawasa was the driver of Zambia's success in advancing radiotherapy nationwide. He called it the "culmination of a vision," whereby his government was directed to ensure that all Zambians could access treatment for free and to cover the cost.

2. Long-term planning is the key to sustainability

Long-term planning has been identified as central to the provision of radiotherapy treatment within the cancer continuum. The IAEA contends that non-sustainable plans lead to loss of life and lack of confidence in government to provide adequate healthcare and together with the WHO supports countries in this regard.[35]

33 Ige TA et al. (2021, June 8). Surveying the Challenges to Improve Linear Accelerator-based Radiation Therapy in Africa: a Unique Collaborative Platform of All 28 African Countries Offering Such Treatment. Clinical Oncology. https://doi.org/10.1016/j.clon.2021.05.008

34 National Academies of Sciences, Engineering, and Medicine. (2021.) Radioactive Sources: Applications and Alternative Technologies. https://nap.nationalacademies.org/catalog/26121/radioactive-sources-applications-and-alternative-technologies

INGRID: GOING THROUGH THE WEBSITE RELATED TO THIS CITATION, IT LOOKS LIKE WE NEED PERMISSION. ?

35 Gilley, D. (2021, February 25). Effective and Sustainable Radiotherapy in Africa. VCDNP Workshop on Ensuring Access to Nuclear Technology for Human Health. https://vcdnp.org/ensuring-access-to-nuclear-technology-for-human-health/

Dr. Lishimpi has the following lessons to share from Zambia's experience with long-term planning:

"I learned many valuable lessons one of which is that when entering into a contract with the equipment supplier, it is very important to include provisions for the supply of spare parts, maintenance and technical support, the replacement and repatriation of spent radioactive sources, if relevant, and the final decommissioning of the machine at the end of its useful life. The second phase is the period when the centre is functional, treatment is being provided and the equipment is being maintained, for which there is IAEA and WHO best practice guidance[36], and also guidance from other organizations. The third phase is when the radiotherapy equipment needs to be replaced. We cannot avoid replacement at some stage. According to the WHO/IAEA, the indicative lifetime of a LINAC is 10–15 years, while that of a Co-60 teletherapy machine is a minimum of 15 years, including three radioactive source exchanges. But there is still a need to provide the radiotherapy service while replacing the machine. My advice to other countries is that a strategy should be developed for replacement well in advance (perhaps already 10 years in advance), including how treatment will continue during the replacement activities, and also how the replacement machine will be financed."

3. Technology challenges can be resolved

Zambia's approach to choosing appropriate radiation technologies was informed by their own needs and conditions. The decision was made to use both a Co-60 teletherapy machine and a LINAC at the inception of their cancer control programme. Dr. Lishimpi explains how Zambia continues to meet the challenges related to these two technologies.

"In Zambia, at the Cancer Diseases Hospital (CDH), we have two Co-60 teletherapy machines and one linear accelerator (LINAC) to administer treatment. We have been using the machines for 15 years, and in the first 10 years we had very good performance. But now only one Co-60 teletherapy machine is functional, and the therapists have to work extra shifts to try to treat as many patients as possible. We cannot get spare parts for the LINAC, so it will have to be replaced.

Cancer treatment is covered by national health insurance in Zambia, so the strategy for us has been for the national health authority to provide funds for new LINACs, which will be repaid through charging for the treatment. The plan is to have two new LINACs at the CDH and one at each of the two new regional centres. We will also continue to use the 60Co teletherapy units, which have nuclear safety and security implications.

36 World Health Organization. (2022). Setting Up a Cancer Centre: A WHO–IAEA Framework. https://www.iaea.org/publications/15052/setting-up-a-cancer-centre-a-who-iaea-framework

For the LINAC, electricity supply and access to the centres are not concerns. The electricity supply is reliable, and access is good either by road or air (most regional centres have a small airfield). But the service contracts for LINACs, whether at the CDH or the regional centres, is likely to be more expensive. The machines come from different suppliers, none of which are in Africa. Local engineers and technicians competent to maintain and repair these machines are in very short supply in Zambia, with the implication of extended downtime when machines need repair due to the unavailability of the technical support. This has a major impact on providing treatment to the patients who need it. I think a regional approach to replacement of spare parts and maintenance of equipment is desirable to minimize the interruption of care to our patients. That is the end goal."

4. Partnerships matter

International Atomic Energy Agency

The IAEA takes an active role from the inception to the implementation and completion of radiotherapy projects worldwide. Over the past four decades, it has developed robust technical expertise and acquired unrivalled experience in supporting more than 100 LMICs in gaining access to radiotherapy for cancer diagnosis and treatment. Through its Technical Cooperation Programme, its Division of Human Health in the Department of Nuclear Sciences and Applications, and its Department of Nuclear Safety and Security, the IAEA provides assistance to its Member States to establish safe and effective national cancer care programmes, and enhance their diagnostic radiology, radiotherapy and nuclear medicine capacity to provide treatment and higher quality diagnosis and care to cancer patients.

In 2004, the IAEA established the Programme of Action for Cancer Therapy (PACT) in support of the World Health Assembly's call to action against cancer. PACT is the IAEA's umbrella programme for combating cancer and builds upon the IAEA's extensive experience in radiation medicine knowhow and technology. PACT works closely with WHO, its regional offices and other key cancer control stakeholders through the WHO-IAEA Joint Programme on Cancer Control. The Joint Programme was established in 2009 to enable Member States from LMICs to improve their cancer control and care capabilities by integrating radiotherapy and nuclear medicine investments into a comprehensive national cancer control programme. Apart from WHO, the IAEA also works closely with the International Agency for Research on Cancer (IARC), the Union for International Cancer Control (UICC) and others to build a coalition of global partners committed to addressing the challenge of cancer in LMICs.

The IAEA had developed guidance documents on radiotherapy to support radiation oncologists working in centres with limited resources and regional workshops are conducted to support these oncologists and other healthcare professionals in diagnosis and treatment of cancer. A PhD Sandwich Fellowship Programme was launched for Africa universities in 2018 to train a critical mass of PhD holders in different nuclear science and technology disciplines, including oncology.[37]

In terms of ensuring the security of radioactive sources used in cancer therapy and the safe and secure use of radiotherapy equipment, the IAEA provides training, technical advice, peer review and other advisory services to its Member States upon request. It also supports physical protection upgrades of facilities in which radioactive sources are used and stored. The IAEA Code of Conduct on the Safety and Security of Radioactive Sources and its Supplementary Guidance, together with IAEA Safety Standards, and Nuclear Security Series publications provide international requirements, consensus recommendations and guidance for an appropriate and sustainable system to control radioactive sources.

On 4 February 2022, the IAEA launched its Rays of Hope initiative on the eve of an African Heads of State Summit at the African Union headquarters in Ethiopia. Director General Grossi and Senegalese President Macky Sall, the 2022 Head of the African Union, called for action at the highest level in Africa and globally to address the current cancer crisis in the region. The initiative, developed by the IAEA in cooperation with WHO, focuses primarily on providing cancer care to Africa where the need is greatest, and prioritizes a limited number of high-impact, cost-effective and sustainable interventions in line with national needs and commitments. Prospective donors can contribute to three indicative packages for funding, comprising optimal combinations of radiation equipment (Co-60 teletherapy or LINAC), costs for building a facility, purchasing equipment and training personnel. The funding includes the operating costs for two years to continue support for planning services and sustainability. For example, an optimal entry package at US $7.5 million is provided, which includes a Co-60 teletherapy unit for countries that lack radiotherapy and have limited financial and human resources. The packages include IAEA support for the development and strengthening of national radiation safety and nuclear security infrastructure, as appropriate. In addition, the packages provide innovation and support for regional anchor centres, which are established and experienced radiotherapy centres working closely with the IAEA.[38]

37 Edwerd, M. (2018, September 10). African Universities Meet to Prompt Human Resource Development in Nuclear Science and Technology with IAEA Support. IAEA. https://www.iaea.org/newscenter/news/african-universities-meet-to-prompt-human-resource-development-in-nuclear-science-and-technology-with-iaea-support

38 Rays of Hope, Cancer Care for All, brochure, IAEA 2022 available at: https://www.iaea.org/sites/default/files/22/02/rays-of-hope-v2.pdf

This initiative makes a compelling case for Development Assistance Committee (DAC) donors to support the establishment of radiotherapy services in LMICs through the IAEA.

Partnership in pursuit of innovative radiotherapy technology for use in challenging environments

Project STELLA is a unique global collaboration between the International Cancer Expert Corps (ICEC), the European Council for Nuclear Research (CERN), the Science and Technology Facilities Council (STFC UK), Lancaster University and the University of Oxford. It is predicated on collaboration with users in LMICs, including doctors, patients, and policy makers. It seeks to improve access to radiotherapy in LMICs by adapting LINAC technology to their infrastructure and environmental conditions, by strengthening their healthcare systems through training and mentoring programmes, and by increasing workforce capacity and capability to ensure the delivery of the full spectrum of cancer care in LMICs.[39] Some of the opportunities to improve LINAC design that are being explored include extending the life of LINAC subsystem components, making components easier to replace, reducing the dependency on highly trained internal staff or external service personnel to avoid associated delays in the repair of equipment and minimizing the impact of a highly variable electricity supply.[40]

Industry support

Varian and Elekta are the providers of radiotherapy equipment. As awareness has grown regarding the challenges related to the use of LINACs in LMICs, specifically those related to the availability of a highly trained staff, these companies are providing training to radiotherapy professionals in LMICs in the more advanced techniques required for using LINACs.

39 International Cancer Expert Corps. (2020, June 11). Project STELLA: Smart Technology to Extend Lives with Linear Accelerator https://www.iceccancer.org/innovative-radiotherapy-technologies.

40 Ige TA et al. (2021, June 8). Surveying the Challenges to Improve Linear Accelerator-based Radiation Therapy in Africa: a Unique Collaborative Platform of All 28 African Countries Offering Such Treatment. Clinical Oncology. https://doi.org/10.1016/j.clon.2021.05.008

Conclusion and recommendations

Everyone everywhere deserves equitable access to cancer care. This is a moral imperative. People are dying from cancers that can be treated with radiotherapy which is a proven and cost-effective intervention that saves lives. Experience shows that high-level commitment at national, regional and international level to ending the disparity in access to radiotherapy between high income countries and LMICs, is critical to combating cancer worldwide. Commitment to this cause must, however, translate into action. The following are key takeaways drawn from the Zambia case study and from discussions with experts and policy makers reflected in this study:

1. Global awareness should be raised regarding the critical role of radiotherapy in combating cancer.
2. Sufficient and consistent data collection is urgently needed to better inform decision makers about the socioeconomic cost of cancer deaths and to drive changes in policy to improve access to cancer care in general and to radiotherapy in particular.
3. Countries seeking to provide cancer treatment should develop sustainable national cancer control programmes.
4. Countries should bring all stakeholders to the table when they are developing their national cancer control programme (including national departments of education, finance and planning, bilateral development partners, international financial institutions, the private sector, the IAEA and WHO) in order to ensure long-term sustainability and to leverage regional and international partnerships.
5. Investment in the establishment of radiotherapy centres particularly in those countries that have none should be prioritized and DAC donors should include support for radiotherapy in their development programmes. IAEA's Rays of Hope initiative is a vehicle for ODA funding that will deliver high-impact, cost-effective and sustainable interventions.
6. LMICs should request support for funding for radiotherapy from their development partners and international financial institutions such as the World Bank.
7. Co-60 teletherapy and LINACs are critical in the effective treatment of cancer. Each technology has distinct advantages and disadvantages, and countries should choose the technologies that are right for their specific needs and conditions.
8. International donors should be guided by local needs and conditions when supporting LMICs in the establishment of radiotherapy facilities.

9. National policymakers and regulators should take note of the challenges faced in the transportation of radioactive cargo and the impact of the potential unavailability of these sources on cancer treatment and should (1) harmonize transport regulations between countries and improve national transport regulations to facilitate the transport of radioactive cargo; (2) promote regulations for the Safe Transport of Radioactive Material (SSR-6 Rev.1.) among all national stakeholders; and (3) improve communication about the transport of radioactive material with the general public, carriers, handling agents, and others within the supply chain.[41]
10. The IAEA and technology holders should invest in supporting the adoption by LMICs of LINACs, which would include finding solutions to the challenges related to use and maintenance of these machines.
11. LMICs should consider adopting a regional approach to solving problems related to procurement of technologies, maintenance of equipment, replacement of parts and training of cancer care professionals, among others.
12. Countries should adhere to the IAEA Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, and implement the provisions contained in the Code of Conduct on the Safety and Security of Radioactive Sources and Supplemental Guidance on the Management of Disused Radioactive Sources and implement the IAEA nuclear security guidance.
13. Training and education for cancer should be prioritized. This includes identifying and supporting existing training centres/hospitals/universities that have a proven track record for skills development as regional centres of excellence.
14. Twinning and mentorship opportunities between institutions responsible for research, training and education, hospitals, atomic energy agencies and regulatory authorities should be promoted and supported as a mechanism for capacity development and knowledge sharing and the establishment of regulatory and legislative frameworks in LMICs.[42]
15. Success stories like that of Zambia should continue to be highlighted as an example of how high-level commitment, long-term planning, and strong regional and international partnerships translate into effective cancer care, of which radiotherapy is an essential part.

41 VCDNP Task Force on Peaceful Uses of Nuclear Science and Technology, Report and Recommendations, December 2021, https://vcdnp.org/wp-content/uploads/2021/12/vcdnp_task_force_report_final_15-Dec.pdf

42 VCDNP Task Force on Peaceful Uses of Nuclear Science and Technology, Report and Recommendations, December 2021, https://vcdnp.org/wp-content/uploads/2021/12/vcdnp_task_force_report_final_15-Dec.pdf

It is appropriate to conclude this case study with these reflections offered by Dr. Lishimpi:

"Our President demonstrated political commitment at the highest level for access to cancer care in Zambia. This was a defining component of the success of our national fight against cancer. Ongoing coordination and collaboration between different government and non-governmental sectors has been critical to growing and sustaining our programme. And with funding guaranteed in the National Cancer Control Strategic Plan, Zambia has been able to invest in capacity building in radiotherapy and radiation oncology and also benefit from training and advisory services offered by the IAEA. The journey continues, but I am proud of how far we have come and, most of all, of how many lives we have saved along the way."