



Global palliative radiotherapy: a framework to improve access in resource-constrained settings

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Abstract: Radiotherapy is an essential component of cancer therapy. Lack of access to radiotherapy in less-developed countries prevents its use for both cure and symptom relief, resulting in a significant disparity in patient suffering. Several recent initiatives have highlighted the need for expanded access to both palliative medicine and radiotherapy globally. Yet, these efforts have remained largely independent, without attention to overlap and integration. This review provides an update on the progress toward global palliative radiotherapy access and proposes a strategic framework to address further scale-up. Synergies between radiotherapy, palliative medicine, and other global health initiatives will be essential in bringing palliative radiotherapy to patients around the globe.

Keywords: Radiotherapy; palliative care; global health; universal health coverage (UHC); cancer care units; healthcare disparities

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Introduction

Cancer is a global problem, but there is enormous geographic variation in the resources to address it. In 2018, an estimated 43% of new cancer cases and 54% of new cancer deaths occurred in less-developed countries (1). In under-resourced health systems without widely available

screening programs, patients with certain cancers, such as breast, cervical, and colorectal cancers, are more likely to present at a late stage and often cannot be treated with curative intent (2,3). This makes comprehensive, palliative approaches that include radiotherapy essential and the dearth of access particularly detrimental.

In all health systems, radiotherapy is a critical part of

both curative treatment and palliation of pain and other symptoms for recurrent or metastatic disease (4,5). An estimated 50% of patients will require access to radiotherapy at some time during their treatment course, and this may be as high as 60–70% in low-income countries (6), where patients tend to present at a late stage (5,7).

In 2015, the Union for International Cancer Control's Global Taskforce on Radiotherapy for Cancer Control (UICC GTRCC) presented a comprehensive coverage and cost analysis of radiotherapy resources across the globe and a call to action for systematic scale-up (6). However, widely accepted global strategies and targets for radiotherapy access have not yet been developed and adopted. At the country level, among 158 countries with national cancer control or non-communicable disease plans, approximately 20% mentioned radiotherapy, and only 7% detailed how plans would be implemented and monitored (8). Further, while the Lancet Commission on Palliative Care and Pain Relief recently released its findings on access to pain relief and a basic package of palliative interventions, radiotherapy access was not included in the essential package of palliative care (9).

In our previous review, we described how powerful the integration of palliative medicine and palliative radiotherapy could be to improve care for cancer patients globally (5). We included the size of the need for palliative radiotherapy, an analysis of potential barriers and facilitators, and case studies on the emergence of integrated models. In this current review, we will briefly update the current status of access to radiotherapy and palliative care globally, including recent initiatives to quantify and expand access to each. We will then link global radiotherapy and global palliative care initiatives to outline possible next steps toward universal access to palliative radiotherapy with attention to potential synergies between palliative medicine, radiotherapy, and other global health initiatives.

Current status of global radiotherapy and palliative care

Radiotherapy infrastructure and recent developments

Access to palliative radiotherapy depends first on access to basic radiotherapy programs and equipment. The number of high-energy radiotherapy machines per million population has been used to monitor global access by the International Atomic Energy Agency (IAEA)—an international, United Nations-affiliated organization that

aims to promote the peaceful use of nuclear technology, including radiotherapy (10–12). The most recent estimates show a significant disparity between high- and low-income settings, with 11.4 machines per million in North America versus 0.05 machines per million in Central Africa (13). Further, there are no machines in nearly forty countries, most of which are low-income. In those countries, national public sector access to referral abroad for treatment is often cost-prohibitive (14).

The GTRCC estimated radiotherapy coverage per country by accounting for the number of machines per country and making assumptions on operational hours (6). Estimating a 12-hour machine workday in countries with any radiotherapy machines, coverage varied widely from less than 20% in countries with the lowest coverage to nearly 200% in countries with the highest coverage. These coverage estimates, however, may decline when there is a lack of conformity to international guidelines. For example, in a palliative radiotherapy survey of 15 African departments, long palliative radiotherapy schedules for uncomplicated bone metastases were frequently reported rather than the recommended single fraction, thereby decreasing machine availability (15). The authors hypothesize that shorter fractionation schedules are at times not used because of concerns about the possible need for retreatment for patients traveling long distances and because a second RT course is a strain on limited department resources. Further study is needed to define optimum palliative RT practices and indications at radiotherapy centers in low resource settings, findings of which could inform potential strategies for improving resource availability.

National governments and private business initiatives fund most radiotherapy services in the majority low- and middle-income countries (LMICs) (13) and these services also are supported by a number of international organizations. The IAEA supports country-driven initiatives to improve radiotherapy capacity (16) by offering comprehensive assessments of national cancer programs, technical assistance on facility design and financing, staff training and, in unique circumstances, support for machine purchasing. They have also supported numerous efforts to improve capacity, including provider education via virtual case conferences and country-specific assistance on advancing from one modality to another (e.g., two-dimensional radiotherapy to three-dimensional radiotherapy) (17). The IAEA further supports radiotherapy and general radioactive source safety across medical and non-medical applications.

Non-governmental and academic partners have also expanded radiotherapy initiatives over the past decade. There are numerous examples, including the International Cancer Expert Corps (ICEC), Radiating Hope, and the European Society for Radiotherapy and Oncology (ESRTO) Global Impact of Radiotherapy in Oncology (GIRO) initiative. The ICEC was founded in 2013 and aims to engage collaborators from high and low resource settings using a mentorship model to foster expertise and develop technology needed to improve radiotherapy and cancer care (18,19). Radiating Hope was founded in 2007 and aims to raise funds to purchase and donate machines and support equipment maintenance (20). Since its founding, it has expanded into radiotherapy implementation support. Finally, ESTRO's GIRO was founded in 2015 to utilize existing data to improve upon radiotherapy access with the ultimate goal of saving one million lives by 2035 (21). GIRO will partner with other organizations, including the IAEA, to tailor and strengthen the health policy and investment case for radiotherapy for individual countries worldwide (22). *Table 1* highlights the initiatives from these and other organizations and the barriers to implementing palliative radiotherapy in LMICs.

Despite these initiatives and organizations, there is still no international consensus on how to move forward at the global level. For example, the United Nations Sustainable Development Goals, an agenda for global health and development, include a number of targets for non-communicable diseases and access to healthcare, but they do not explicitly mention radiotherapy or access to cancer care (23). Further, for most LMIC governments, cancer care still remains dauntingly expensive, and any global initiative will require significant funding. There is no large donor fund to provide aid for cancer care similar to the US President's Emergency Fund for AIDS Relief (PEPFAR) or the Global Fund to Fight AIDS, Tuberculosis, and Malaria (The Global Fund), and many countries do not have universal health insurance to subsidize care (24).

Palliative infrastructure and recent developments

Access to even the most basic palliative care interventions is limited in LMICs. It is estimated that less than one tenth of one percent of all morphine-equivalent medications are distributed in low-income countries (9). National laws and regulations governing opioids typically focus on prevention of diversion and illegal use of opioids and make production importation, and prescription of morphine and

other opioids difficult or impossible (25). For this and other reasons, including supply chain logistics and a dearth of manufacturers, stock outs of this key, low cost medication are frequent (9,26). When short-acting formulations are available, patients are frequently given small supplies for fear of diversion (27-31). Long-acting opioid formulations are expensive and even less available in low-income countries (27-31). Often, patients or their family members must travel to central hospitals to refill prescriptions as health centers and regional hospitals are not licensed to dispense or are in short supply (9,27). While access to prescribed opioids for pain due to serious illness had been good in high-resource settings, the recent "opioid crisis" that has emerged in the United States and Canada is increasing fear of opioids and reducing legitimate access for some patients (32,33).

As with radiotherapy, national and local programs have provided most palliative care in low-resource settings. These are largely run by charitable organizations, such as Hospice Africa Uganda, founded in Kampala in 1993 and Pallium India founded in Kerala in 2003 (34,35). Recently, national governments have begun to integrate existing palliative care efforts into the public health system (36-38). Palliative care and hospice organizations in low-resource regional settings have created palliative care networks, including the African Palliative Care Association (APCA) founded in 2002 and the Indian Palliative Care Association (IPCA) founded in 1994 (35,39). These networks enable collaboration and coordination with research and implementation partners and donors from high-resource settings (35,39). They also enable peer support and diffusion of innovation such as more effective models of hospice care or morphine use (39). However, analogous, formal radiotherapy networks have not been established, and palliative care programs often are not integrated with curative therapy (5,40).

In 2017, the Lancet Commission on Palliative Care and Pain Relief published a landmark review of palliative care access in low-resource settings, estimates of palliative care need around the world, and recommendations for making palliative care universally accessible (9). However, although there were commissioners with expertise in radiotherapy and the critical nature of radiotherapy for palliation was discussed in detail, palliative radiotherapy was not included in the recommendations for the basic package. The recommendations focused on a low-cost essential package with small, simple equipment that would require minimal training to use, making it as widely and easily globally applicable as possible. While efforts are underway to simplify radiotherapy delivery through innovation

Table 1 Ongoing initiatives to overcome barriers to the integration of RT into palliative care in LMICs

Health system dimension*	Barriers	Initiatives
Governance	WHO definition of RT specifically distinguishes it from palliative care	WHO documents explicitly recognizing radiotherapy as palliative (e.g., WHO list of priority medical devices for cancer management) WHO Joint Programme on Cervical Cancer including radiation as both curative and palliative
	Undervaluing of RT within global health	Dedicated global advocacy and implementation efforts—e.g., Global RT [1], ICEC, GIRO
	Lack of comprehensive national cancer control plans in many LMICs	IAEA PACT program support in development of national cancer plans [2]
Finance	Erroneous assumptions that RT is too costly or not cost-effective	GTFRCO costing of radiotherapy
	Lack of commitment for large upfront investment in services	GTFRCO investment case for radiotherapy
	Poor financial protection, including inadequate health insurance coverage, high out-of-pocket expenditure, and poverty	WHO push toward universal health coverage
Delivery	Lack of RT equipment	Radiating Hope and other donor organizations IAEA support optimal equipment selection, some purchase
	Global shortage of RT professionals	Training efforts through IAEA, AAPM [3]
	Poor care linkages between primary care, palliative care, and cancer services	Local collaborations to improve referral processes, including involvement of community health workers
	Lack of understanding by other health professionals about the role of RT as a potential tool for palliation	Local continuing education initiatives (e.g., Zimbabwe Medical Association) [4]
Implementation	Variable security and geopolitical instability	FNRBA and other entities advocating for nuclear source safety [5]
	Limited assistance with travel and accommodation while receiving treatment at mostly urban centers	Local, site-based initiatives to subsidize housing, food, and/or travel (e.g., Partners in Health [6], National Cancer Association Zimbabwe [7])
	Cancer stigma and fear of radiation	Global Oncology patient education materials [8]

*, based on Effective Practice and Organisation of Care (EPOC). EPOC Taxonomy; 2015. Available at: <https://epoc.cochrane.org/epoc-taxonomy>. [1], <http://globalrt.org/>; [2], <https://www.iaea.org/services/key-programmes/programme-of-action-for-cancer-therapy-pact>; [3], <https://www.aapm.org/international/>; [4], <http://www.zimazw.org/2015-downloads-2/>; [5], <https://gnssn.iaea.org/main/FNRBA/Pages/default.aspx>; [6], <https://www.pih.org/country/rwanda>; [7], http://www.cancerzimbabwe.org/care_services.html; [8], <https://globalonc.org/patient-education-materials/>. RT, radiotherapy; LMICs, low- and middle-income countries; WHO, World Health Organization; ICEC, International Cancer Expert Corps; IAEA, International Atomic Energy Agency; PACT, Programme of Action for Cancer Therapy; GIRO, Global Impact of Radiotherapy in Oncology; GTFRCO, Global Taskforce on Radiotherapy for Cancer Control; AAPM, American Association of Physicists in Medicine; FNRBA, Forum of Nuclear Regulatory Bodies in Africa.

in machine design and automation (19), radiotherapy treatment is still dependent on large, stationary equipment that requires ongoing, high-cost maintenance and specialized expertise to operate.

“Five S” approach: linking analysis to action

The factors that determine access to palliative radiotherapy differ between countries and regions. For example, in many Western countries, palliative radiotherapy as a discipline

Table 2 “Five S” framework for improving global palliative radiotherapy access

Dimension	Definition	Key interventions
Synergies	Collaborations between palliative RT and other movements	Integration with efforts in global palliative care, global HIV care, and universal health coverage
Staffing	Cadre of trained personnel, including radiation/clinical oncologists, nurses, radiotherapist, medical physicists	Expansion of human resources for health training models Revision of payment and incentive schemes for public sector staff
Stuff	Commodities of radiotherapy including megavoltage machines, simulation machines (e.g., CT), and planning and verification system	Selection of optimal machines for case load and environment Consideration of nuclear safety, political stability, and legal framework for transport when selecting radioactive sources
Space	Construction needed for RT including bunker and other physical infrastructure	Dissemination of adaptable facility plans with standardized dimensions and materials Inclusion of plans for patient housing in facility design Non-hierarchical networks of existing centers to standardize reduce inequity in treatment
Systems	Connections between RT and other levels of the healthcare system, including bilateral referral systems to and from RT	Focus on health IT systems and medical records for patient tracking Implementation of central and satellite models to distribute care evenly for palliative RT Telehealth interventions for virtual patient triage and preliminary evaluation

RT, radiotherapy; CT, computed tomography.

arose in the context of well-developed radiotherapy systems. The goal was radiotherapy that maximizes symptom relief or prevention, minimizes short-term adverse effects, and minimizes treatment time and burden (41). Integration of palliative care with medical and radiation oncology is increasing (42,43). This integration has resulted in more training on relief of patient and caregiver suffering, on advanced care planning and bereavement care, and on the intricacies of radiotherapy planning (e.g., increased use of stereotactic or more “targeted” approaches) (42).

In LMICs, where radiotherapy often is underdeveloped or unavailable (5,6,15,16), planning for initiation or scale-up of radiotherapy much be integrated from its inception. Development of radiotherapy capacity should be based on an understanding of radiotherapy as an essential and synergistic part of comprehensive cancer care along with medical and surgical oncology and palliative care and on integration of cancer care with non-communicable disease and HIV/AIDS care and with primary care rather than as a separate programmatic silo.

Partners in Health, a non-governmental organization with a long expertise in building health systems in low-resource settings, developed a useful framework for implementing or expanding systems of care such as surgery,

mental health, obstetrics, or primary healthcare (44-46). The “Four-S” framework includes staffing, “stuff,” (the equipment and consumables), space (buildings and physical infrastructure), and systems (referral network and logistics). To improve access to global palliative radiotherapy, we propose to add synergies to create a “Five-S” framework (Table 2).

Staffing

Currently, specialist training in oncology or palliative care is rarely available in LMICs (47,48). However, increasing access to palliative radiotherapy depends on access to training. Regional centers of excellence in oncology could be established at sites already providing high-quality cancer care to train physician-experts in integrated oncology (medical and radiation oncology and palliative care) for a group of LMICs (38). Such centers also could offer basic and intermediate level training for physicians in palliative care, training in oncology and palliative care for nurses, that includes basic information about the palliative benefits of radiotherapy. Physicians and nurses with an understanding both of radiotherapy and of palliative care may help to increase appropriate access to both. In addition,

these centers could provide training in medical physics and training for radiation therapists and for biomedical technicians who maintain radiotherapy machines. Often, radiotherapy programs in LMICs rely on a technician employed by the equipment manufacturer who might be based in a distant country (49). Ensuring training and availability of local or national technical support would prevent minor malfunctions from causing long pauses in treatment that result in significant hardship and suffering for patients (50,51).

Within palliative care, there already exist several models for home-based care by health professionals or trained, lay providers. Hospice Africa Uganda, Pallium India, and the national palliative care programs referenced earlier provide a percent of their services to patients at home (36-38). CanSupport, a non-governmental organization in Delhi, provides home-based palliative care with multidisciplinary teams including physicians, nurses, and social workers (52). They provide pain and symptom management, psychosocial support, and bereavement care. From 2009–2010, 746 patients were provided care, with an average of 10 home visits per patient. Further, 71% of patients were self-referred. These existing networks would be amenable to explicit integration of radiotherapy side effects management for those patients referred from radiotherapy departments. They could also potentially be used to identify new patients that might benefit from further evaluation for palliative radiotherapy based on common symptoms (e.g., localized bone pain due to malignancy).

Stuff

In LMICs, reliable and cost-effective palliative care can be provided for most patients with a Cobalt-60 machine or a simple linear accelerator (53). Careful consideration should be given to the security situation in a particular country before choosing a radioactive source modality. Linear accelerators that support artificial intelligence-driven image processing, treatment planning, and quality assurance may enable “tele-radiotherapy”—or the use of telecommunications and information technology to provide radiotherapy support from a distance—and thereby improve both quality and access.

Space

Planning for regional and central cancer centers should include adequate space for radiotherapy.

The cost of establishing radiotherapy programs can be minimized in any setting by adapting for the standardized facility plans developed by IAEA (16). Space also should be designated for patient and family-caregiver housing. Patients and their family caregivers often travel long distances to receive care. Currently, they often sleep outdoors or must pay for admission to the hospital simply so that they may be housed, not for a medical indication. To address this problem at one site, the American Cancer Society (ACS) is raising funds in partnership with Kenyatta National Hospital to build a 62-bed hostel in Nairobi (54).

Systems

Radiotherapy should be thoughtfully and explicitly included in health care system referral patterns and telecommunications. In LMICs with widely distributed populations, telemedicine can enable informed decisions about indications for radiotherapy without requiring patients to make long, costly, and uncomfortable trips for evaluation. In addition, satellite radiotherapy centers capable of managing standard cases and providing palliative care could improve access to radiotherapy at lower cost (55,56).

Beyond telemedicine-based case discussion, other information and communication technologies (ICTs)—defined by Ngwa *et al.* (57) as technologies that are instrumental in capturing, processing, storage, and exchange of information—also show promise in improving radiotherapy access and quality. Automated contouring and planning could shorten time to treatment and improve standardization, allowing more patients to be treated efficiently. Remote, cloud-based plan review would then allow experts who are not on site to review and revise proposed treatment plans, especially for cases that may require stereotactic or other complex care. Delivered plans and clinical outcomes could then be analyzed using machine learning techniques to more quickly determine the optimal plans and to improve radiotherapy quality and symptom relief over time.

In addition, existing radiotherapy and palliative care centers can be linked in innovative, non-hierarchical ways to promote high-quality cancer care and to address disparities in care services. For example, the National Cancer Grid of India (NCG), founded in 2012, is designed to reduce disparities in quality of care across the country (52). The NCG now includes 143 cancer centers and draws on input from patient advocacy groups, researchers, and

other stakeholders to implement evidence-based cancer care guidelines such as those recently published for cervical cancer (53).

Synergies

Synergies are crucial to expansion and improvement of health care systems in LMICs. Synergies that break down traditional disciplinary barriers and integrate care for various conditions can help to optimize use of human resources and reduce costs. Palliative radiotherapy can and should be synergistic and integrated with medical and surgical oncology, palliative care, non-communicable disease, HIV/AIDS, and primary health care.

In LMICs, oncologists are typically trained in both chemotherapy and radiotherapy. In keeping with WHO guidance on integrating palliative care into the responsibilities of any health care provider who cares for people with serious illnesses, oncologists must provide pain and symptom relief (58-60). Especially in settings where there are no palliative care specialists and where patients may pay out of pocket or travel long distances for treatment, such care integration is imperative (15,61).

To promote integrated cancer care in LMICs, integrated cancer care education is needed. Currently, there are many myths and misunderstandings of radiotherapy including that radiation is inherently painful, that it will inevitably cause severe burns, or that it is not compatible with comfort-oriented (6,62,63). Integration of training in radiotherapy, chemotherapy, and palliative care may help to reduce “radiophobia”, improve access to radiotherapy, and promote more rational use.

Efforts to improve access to palliative radiotherapy in LMICs could be strengthened by better integration of radiotherapy with HIV/AIDS care. People with HIV/AIDS often develop cervical cancer, Kaposi sarcoma, anal cancer, or non-Hodgkin’s lymphoma, all of which are amenable to palliative and/or curative radiotherapy. Integration would facilitate care and may help to drive down the cost to the patient of treatment for HIV-related cancers that currently is unsubsidized and prohibitively costly in many LMICs (47). Advocacy for HIV/AIDS treatment that drove down prices and increasing availability of antiretroviral therapy also could improve access to radiotherapy (45,48).

Finally, efforts to achieve universal health coverage (UHC) should include efforts to assure access to radiotherapy (64). The essential package of publicly-funded

palliative care recommended by the Lancet Commission on Palliative Care and Pain Relief and by WHO as part of UHC should be augmented as soon as possible to include palliative radiotherapy because of the effectiveness and durability to radio-therapeutic treatment of symptoms such as bone pain and some types of dyspnea and because the same machines that provides palliation also can provide cure in many cases.

Promise and potential barriers

Costs of care

In a few low-income countries, radiotherapy has been funded successfully by the public sector (6,65). In Zambia, for example, close technical and financial collaboration between the government and the IAEA starting in 2002 led to opening the Cancer Diseases Hospital in Lusaka in 2007 with the first in-country radiotherapy services in 2008. Further collaboration is ongoing to develop satellite radiotherapy services to improve access to more of the population. However, because of the cost of scaling up radiotherapy programs, few low-income countries can meet the entirety of their radiotherapy needs with the public health budgets. A “global fund for cancer” has been proposed, modeled on the Global Fund to Fight AIDS, Tuberculosis, and Malaria, which receives four billion US dollars per year and saved an estimated 680,000 million lives from 2003–2007 alone (66-70). Such a fund could enable the lowest income countries to implement radiotherapy for the first time.

Public-private partnerships (PPP), or an agreement between the public sector and a private concern to collaborate on a healthcare endeavor, are another method for financing radiotherapy for low-income patients. This method has been implemented successfully on a small scale in several countries (5,65). Care must be exercised to ensure that these partnerships benefit vulnerable patients in the public sector and not only private enterprise (71,72).

Finally, funding would often be feasible within ministry of health budgets in some cases. Potential barriers, apart from competing health priorities, include knowledge of the benefits of radiation therapy and political will to invest in a service that may take years to implement (6,73). Zambia is an example of such successful commitment. Close technical and financial collaboration between the government and the IAEA starting in 2002 led to opening the Cancer Diseases Hospital in Lusaka in 2007 with the first in-country

radiotherapy services in 2008 (74). Further collaboration is ongoing to develop satellite radiotherapy services to improve access to more of the population.

Measuring progress

To assess progress and inform strategic planning, measures of access to palliative radiotherapy must be developed and integrated into routine data collection. In LMICs, these measures might include the need for palliative radiotherapy, current access, the number and distribution of providers trained in radiotherapy and in palliative care, frequency of evidence-based practice, patient outcomes, and costs to patients and families. A model set of indicators could be adapted from the Lancet Commission on Global Surgery, which has developed a comprehensive but concise set that is now being piloted (75). For example, the surgical indicators on timely access and protection of households from impoverishing expenditure could be used for palliative radiotherapy.

Conclusions

Access to palliative radiotherapy is badly needed in resource-limited settings. Without access to this treatment, millions of patients in LMICs and disenfranchised patients in HICs will continue to experience preventable suffering and diminished survival. Integration of radiotherapy, palliative care, medical and surgical oncology, HIV/AIDS care, can improve access and the quality of care. A global fund for cancer care and control could make such integration possible and promote UHC.

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Footnote

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