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Closing the Cancer Divide Through *Ubuntu*: Information and Communication Technology-Powered Models for Global Radiation Oncology

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Introduction

"The chance for a cure, the chance to live, should no longer remain an accident of geography" (1). This is one of the key messages in "Closing the cancer divide: A blueprint to expand access in low and middle income countries" (1). This article highlights the growing burden of global cancer disparities and makes a compelling case that the time for unified action to close this divide is now.

There is growing consensus that information and communication technologies (ICTs) have tremendous potential to catalyze global health collaborations. Advanced ICTs can be used to leverage the recent major upsurge in global health interest into greater space-time flexible collaborative action against cancer and for enhancing greater effectiveness of existing global health initiatives. The recent call for greater action in closing the cancer divide through collaborations, including that in *International Journal of Radiation, Oncology, Biology, Physics* (IJROBP), inspired the 2015 Global Health Catalyst cancer summit, which brought together a unique combination of global oncology leaders, diaspora leaders, and ICT and palliative care experts, industry, nonprofits, and policy makers. The summit provided a forum for networking, knowledge sharing, and discussion of some of the emerging models for ICT-powered global health collaborations in radiation oncology care, research, and education, as well as avenues for complementary outreach, including engagement with the diaspora. This article summarizes the discussions and recommendations from the summit and highlights the emerging ICT-powered models for radiation oncology global health, avenues for greater outreach (*ubuntu*, a term signifying the idea that "I am because we are," or human connectedness [see discussion below]) for greater impact and sustainability, as well as emerging areas for scaling up and increased action toward closing the cancer divide.

At the primary level, a distressing illustration of the cancer divide can be seen in Africa, where most of Africa's more than 2000 languages do not even have a word for cancer (2). Thus, in that geography, many people die painfully of cancer and, sadly, do not know it. In areas more familiar with cancer, a great lack of cancer prevention education or awareness of the importance of early detection contributes to over one third of preventable cancer deaths (3). This problem is further exacerbated by a culture of silence and strong social stigma associated with the disease (4); even young doctors do not want to specialize in oncology, a

medical area that talks only about pain and death. The stigma also means that the overwhelming majority of patients only present late with the disease when it is too late to cure them; the ensuing deaths then further reinforce the stigma that cancer is essentially a death sentence.

At a secondary level, the cancer divide is illustrated by the lack of capacity to manage patients once their disease is diagnosed, a problem inherent in poor health care systems. For example, approximately half of Africa's 54 countries still have no radiation therapy services typically needed in the treatment of more than 50% of cancer patients (5). Limitations to radiation therapy in low- and middle-income countries (LMICs) include the number of radiation therapy centers, the number of treatment units, the critical shortage in health care workforce, the lack of safety regulatory infrastructure, and the perception that radiation therapy is a complex and expensive solution. Without greater investment and collaboration in radiation therapy services, this will only exacerbate the burden of cancer and make the cancer divide worse.

Meanwhile, at the tertiary level, the cancer divide is appropriately captured by what has been called "the pain divide" (6). Here, many people dying with cancer do so in excruciating pain, due to a lack of basic pain medication and other palliative options. Such harrowing deaths with needless suffering bolster the physical and social trauma of cancer and the reason why many people in LMICs do not even want to talk about cancer.

A word of African origin, which people do like to talk about, is *ubuntu*. Popularized worldwide by African Nobel Prize winners Desmond Tutu and Nelson Mandela, *ubuntu* signifies the idea that "I am because we are," or human connectedness. This ethos rings particularly true in today's hyperconnected world, where we all share in the bounty of the expanding internet or ICTs and where local health has become global health and vice versa. *Ubuntu* also represents an operating system underlying ICTs used for cloud computing, including in radiation oncology.

The recent call for greater action in closing the cancer divide through collaborations (1, 7–9), including more recently in radiation oncology (8), inspired the 2015 Global Health Catalyst (GHC) cancer summit (10), which brought together a unique combination of global oncology leaders, industry, policy makers, and African diaspora leaders. Here the African diaspora refers to Africans settled outside of the African continent. Building on a recent publication (11), a central theme of the summit was the use of ICTs to catalyze high-impact international collaborations in cancer care, research, and education with Africa. This article summarizes the summit proceedings and highlights the emerging ICT-powered models for radiation oncology global health, avenues for greater partnership (*ubuntu*), and outreach beyond the traditional, as well as emerging areas for scaling up and increased action toward closing the cancer divide.

Ubuntu in Radiation Oncology

In today's hyperconnected world, ICTs will play an increasingly integral role in health care and have great potential to elide spatiotemporal distances that limit collaborations and

catalyze global health collaborations in cancer care, research, and education (12–14). Table 1 lists some of the emerging models for ICT-powered radiation oncology collaborations, along with links or references for more information. For simplicity, these models are divided into 3 main categories: care, research, and education. However, some of these model programs may have activity beyond just 1 category. Under cancer care, these include: Botswana Oncology Global Outreach (BOTSOGO) (15), Chartrounds.com, Quality Assurance Review Center (QARC), Cure4Kids, and Radiating Hope (16). Under education, these include the International Atomic Energy Agency's Virtual University for Cancer Control (IAEAVUCCnet), the American Association of Physicists in Medicine (AAPM), the American Society for Radiation Oncology (ASTRO), and Treat Safely. In research, these include QARC, University of Massachusetts medical physics program, and others.

Cancer care

Tumor boards, highlighted in Table 1 by the BOTSOGO model initiative, represent an excellent area for scaling up. This currently involves monthly tumor boards through WebEx and, sometimes, remote consultation and second opinion, benefiting the treatment of patients in Botswana. Such a model can facilitate new partnerships given the relatively low costs involved in setting up the infrastructure for ICT-powered international tumor boards. Impact here includes improvements in the quality of patient care and saved lives. For many LMIC institutions, this could be transformative, to promote a multidisciplinary approach to care and break the culture of silos, against which many young doctors in LMICs have lamented. In many LMIC health care institutions, where resources are scarce and support systems largely unavailable, younger professionals face daunting challenges, and seeking a second opinion from senior colleagues is viewed as a weakness. The experience from tumor boards also shows that this could be one way to introduce global health to residents, who, arguably, can in real time learn a great deal from LMIC health care professionals who manage patients with limited resources. It certainly can help concretize some of the valuable but more historical lower-tech techniques that are learned but rarely used in more developed countries. Remarkably, an overwhelming 89.6% of residents surveyed recently expressed interest in participating in global radiation oncology experience during their residency training (17). More institutions are already conducting regular tumor boards with African LMICs, such as the Fred Hutchinson Cancer Center, Seattle, WA, with Uganda Cancer Institute, Kampala. Following the GHC Summit, more East Africa and Dana Farber/Harvard Cancer Center institutions are working to scale this model. Other institutions are encouraged to do the same, because these are potential (win-win) areas in which to begin global radiation oncology partnerships with relatively low-cost investment. Moreover, this model can lead to mutually beneficial impact in patient care and experience for residents and other cancer care professionals.

Other areas with major promise and enthusiasm for scale-up include remote support, treatment planning, and quality assurance, following the model of Radiating Hope and QARC (Table 1). Many institutions in Africa have expressed interest in this model and are in need of partners. Some have indicated this would also benefit their residency training programs. Chartrounds.com (Table 1) is a Health Insurance Portability and Accountability Act-compliant (HIPAA; US Pub. L. 104–191 HIPPA, Stat. 1936; August 21, 1996), secure

website-based conferencing project offering radiation oncologists a scheduled 1-hour live case review session over the internet with disease-specific specialists in radiation oncology. Through ICT capabilities, Chartrounds.com has helped bridge the knowledge gap between community physicians and specialists in their field, resulting in overall improved patient care and reduced costs of cancer care. Efforts are ongoing to secure requisite funding for scale-up in these areas. Radiating Hope is also working on a model that will pay the salary of a Western-trained radiation oncologist to lead the development of a "Radiating Hope Cancer Centers of Excellence" on the African continent. The Radiating Hope model has had significant impact in Ghana, Tanzania, and Senegal, including continuing remote weekly quality assurance or technical support, as well as remote training sessions on treatment planning using screen-sharing software. Partnerships with industry or companies providing radiation oncology technology could be mutually beneficial.

Education and training

Building capacity will be crucial in closing the cancer divide, and there is growing agreement that online education is a powerful paradigm for education and can significantly complement face-to-face learning where needed. There is also a major appeal from many practicing health professionals, who work in the clinic and have practical training but would like to gain instruction toward a Masters or Doctoral degree or to undergo training to conduct research more effectively. Currently, the main structured diploma or online certificate education model in radiation oncology directly benefiting LMIC institutions is IAEA's VUCCnet (Table 1). Launched in 2014, more than 500 students have accessed and completed online courses through the VUCCnet. The major professional societies, including ASTRO (18) and AAPM, have also developed online learning content tailored to LMIC. ASTRO, within the International Education Subcommittee, has established through its organizational structure a multifaceted forum of volunteers, experts, and stakeholders from around the globe to assess educational needs, obstacles, and development of opportunities in global radiation oncology education. Furthermore, there are also subspecialty resources available through Cure4Kids, Treat Safely, and other organizations. The GHC program at the Dana Farber/Harvard Cancer Center is now working with faculty at the University of Pennsylvania, Health First Cancer Institute, Memorial Sloan Kettering Cancer Center, John Hopkins University, University of Texas MD Anderson Cancer Center, among a growing list of interested partners to begin a structured online learning program delivered through EdX/Coursesites. Stephen Avery and other medical physicists are leading efforts to help develop a relevant medical physics curriculum availing both continuous education and award of a degree or certificate. Funding has been secured for this effort, and there is already movement to scale it up in partnership with the VUCCnet program and the International Organization for Medical Physics (IOMP). Twalib Ngoma of the Muhimbili University of Health and Allied Sciences is leading efforts to incorporate various components of ICT-powered radiation oncology education to benefit trainees in the East Africa region.

Recently, ASTRO's Educase online contouring breast modules were incorporated into a pilot curriculum for the implementation of 3-dimensional (3D) conformal breast radiation therapy in Armenia. Three-dimensional conformal radiation therapy (3DCRT) has been in widespread use in developed nations since the 1990s. In contrast, radiation therapy centers in

developing nations are just beginning to adopt this technology. Standardized means for assisting radiation oncologists as they transition from 2D planning to 3DCRT are lacking. The pilot curriculum is aimed at training radiation oncology professionals in the key processes associated with 3DCRT implementation for breast cancer. Through online exercises, radiation oncologists practice the proper delineation of tumor target volumes and organs at risk for radiation damage. The utility and feasibility of online learning have been demonstrated through the pilot curriculum, and it can be used at other centers seeking to transition from 2D to 3DCRT.

To optimally advance global radiation oncology and global oncology efforts as a whole, education through knowledge sharing by the various volunteers, contributors, and stakeholders, as exemplified at the GHC summit, (10) will be very useful. Such knowledge sharing should also better inform, engage, and facilitate participation of those interested in global health, with *au courant* recommendations on how best to address any challenges or limitations based on learning from the experience of others. Major national conferences such as those held by ASTRO and AAPM now regularly feature sessions on global health, and IJROBP has published a large series of articles on global health in the past year (8). It is imperative that leading radiation oncology journals, such as IJROBP, *Medical Physics, Radiotherapy & Oncology*, and others continue to serve as the conscience of the specialty in this emerging area by advocating and maintaining awareness of global radiation oncology. Regular meetings like the GHC summit should also serve as avenues for knowledge sharing from the experiences of leaders of the different emerging models.

Beyond the radiation oncology community, such knowledge sharing or cancer education can also be carried out by radio, as highlighted by the work of Karen Wink-field, a radiation oncologist who uses this medium to reach minority populations in the Boston area (19). Such models can be replicated in developing countries, including the use of Suitcase Radio stations. Leveraging ICTs, for example, social media, to share evidence-based information and engage practical discussion would also be a powerful tool in education and sensitization. One organization currently implementing this is Radiation Nation (Table 1), with educational collaborative discussions on radiation oncology, which are greatly appreciated in LMICs.

Another recommendation is to set up programs to help train African radiation oncologists and other oncology leaders to be more competent in the use of ICTs. Institutions like ICT University (20) with growing infrastructure and programs in LMICs in Africa could help in delivering such training. The advantage of the ICT University model is that it provides the option for studies through its e-learning platform. Covenant University Nigeria, one of Africa’s leading ICT institutions, is also working to become a major hub for facilitating ICT-powered global oncology in West and Central Africa. Members of the African Organization for Research and Training in Cancer (AORTIC) and Federation of African Medical Physics Organization have expressed interest in such training, and the AORTIC Education and Training Committee is leading a needs assessment effort that can serve as a reference for developing and maximizing the benefits of such training.

Of the estimated 200,000 new cases of children with cancer per year, more than 80% live in "less-developed" or low-and middle-income settings (21). The real number of children with cancer in Africa is not known due to the absence of cancer registries. Cure4Kids (Table 1) is a model online resource for health care professionals dedicated to enhancing the care of children who have cancer and other life-threatening diseases in countries around the globe. Cure4Kids offers online education and collaboration tools for all interested. The program has led to more than 2400 professional seminars, full access to select journal articles, self-paced and instructor-led courses, and a platform for accessing online meeting space with more than 2000 live meetings per year. Closing the survival gap by a collective effort that uses the emerging ICT-powered model is assisted also by twinning programs particularly effective in pediatric oncology. Developing twinning programs between African countries is possible and is encouraged: a modification of the classic example of partnership of 2 units from high- and low-income settings.

Research

ICT-powered models for global radiation oncology research are only beginning to emerge. One model is the planned launch of the GHC microgrant competition referencing the model of the United States National Cancer Institute's Beginning Investigator Grant for Catalytic Research (NCI BIG Cat) (22) but incorporating a component of crowdfunding. The program will particularly promote transatlantic research collaborations and comentorship between LMIC faculty in Africa and faculty at NCI comprehensive cancer centers such as the Dana Farber/Harvard Cancer Center. A major goal for this effort is to promote submission of results in conference abstracts and publications with coauthors from both LMICs and US institutions. A primary focus is to grow trans-Atlantic partnerships with LMICs in sub-Saharan Africa, help grow visibility for LMIC partners, and generate new knowledge or preliminary data that could lead to more grant funding or new hypotheses. The crowdfunding approach (11) will also deliberately grow engagement with the African diaspora. It will enhance appreciation of highly meritorious cancer research that transcends continents, advancing health care and economic development.

Development of low-cost technologies in radiation oncology that can be used and/or easily maintained in LMICs, including mobile health technologies, are also needed, for example, for treatment, quality assurance, imaging, dosimetry, and others. Some of these technologies continue to be developed as highlighted at the GHC summit. The NCI currently has a funding mechanism for supporting such research, and this should be encouraged for both developed countries and LMIC researchers. Elzawawy has recently highlighted some of such resource sparing, cost-effective radiation therapy techniques and methodologies that would lead to increase affordability of radiation therapy cancer care for more patients who are in need (23).

Other emerging initiatives and recommendations

Table 2 highlights other emerging radiation oncology global health initiatives. A Global Cancer Project Map (GCPM) has been developed to benefit global oncology as a whole (24). The GCPM is a website-based platform that catalogs international cancer research, cancer

care, and cancer outreach programs, including radiation oncology. This will be very useful in highlighting who does what and where in global oncology, to minimize duplication and facilitate the building of collaborations.

There are also emerging nonprofit organizations (NGOs) that can help advance global radiation oncology. One of them is the International Cancer Expert Corps (ICEC) (9), whose mission is to reduce mortality and improve the quality of life for people with cancer in LMICs and regions worldwide. In the ICEC model, groups or individuals from LMIC communicate a particular problem or question or need to the ICEC, and the ICEC assembles a multidisciplinary team of experts to address that specific need, with salary support to encourage sustainability and long-term partnership. Another new nonprofit focused on medical physics is Medical Physicists Without Borders (MPWB), whose mission is to support activities which will yield effective and safe use of physics and technologies in medicine through advising, training, demonstrating, and/or participating in medical physics-related activities, especially in LMICs. These initiatives are most welcome additions to the growing field of global radiation oncology. Quite naturally, ICTs should also be able to enhance or complement the work of such non-profits eg, in online learning to complement training, in remote treatment planning support to complement health care delivery efforts in the field, and so forth.

Efforts focused on advocacy for global radiation oncology should also be encouraged because there is a great need in this area. Given current limitations in funding, advocacy especially for radiation oncology would be helpful. There is a particular need for reaching out to policy makers to increase investment to ensure sustainability, especially in African countries, where both political support and government funding are critical for success. An excellent illustration of how this can be effective is exemplified by President Tabaré Vázquez, MD, of Uruguay, a radiation oncologist by training, whose understanding of the importance of the need and consequent efforts have helped to close the cancer divide in radiation oncology between Uruguay and developed countries like the United States. The Union for International Cancer Control's Global Task Force on Radiotherapy for Cancer Control (25), initiated under the leadership of Mary Gospodarowicz, is also working to help integrate cancer control into the world health and development agenda and to drive advocacy with radiation oncology as a major component.

One expressed limitation to global radiation oncology, unfortunately, still comes from radiation oncology department leaders (17). There is correspondingly growing expressed need for these leaders to work toward integrating a global radiation oncology experience into residency training programs and for greater recognition of radiation oncology in global health activity by their faculty and staff. If possible, such recognition could be factored in when considering promotion, at least as part of an outreach or community service. For example, international tumor boards could be considered a part of education, benefiting resident education as earlier highlighted. It is increasingly evident that such global radiation oncology efforts result in greater visibility of the department, and with the recent upsurge in interest, ICTs could greatly facilitate participation. ICTs, as highlighted by the emerging models, provide space-time flexible collaboration opportunities for contributing to this effort, especially for those who are interested but are limited by space-time constraints. For

example, ICTs could be employed to enable those who are interested to: contribute in teaching a course online for less than an hour a week, or participate in monthly ICT-powered tumor boards, or co-mentor a Masters/PhD student remotely aided by periodic video-conferencing, or participate in other activities more fitting to their schedules. Such contributions pooled together can cumulatively help advance global radiation oncology efforts, build capacity, and save lives.

Diaspora *Ubuntu*

Complementary outreach, beyond what is traditional for radiation oncology, has been proposed, for example, through purposeful engagement and partnerships with the African diaspora in global health efforts (11). Many Africans in diaspora (AiD) feel a strong sense of connection (*ubuntu*) and want to contribute to health care and development in their native countries. As an example, even when the recent Ebola crisis was at its peak, AiD were still travelling to their families in Africa when many of the non-Africans heeded the prudent calls of their governments to evacuate. The AiD constitute one of the most educated diaspora groups in North America, remitting over $40 billion per year to Africa, which is more than yearly global aid to the continent, while saving another $53 billion annually (26). Community outreach involvement of the highly skilled, educated, and resource-laden AiD would, undoubtedly, spawn and catalyze stronger collaborations and help turn the currently devastating African brain drain to gains against cancer.

The diaspora can help address the primary level disparities in cancer education and prevention as well as the stigma associated with cancer in Africa. As Mohammed et al. have shown (27, 28), LMIC citizens are more likely to listen to cancer prevention education and awareness talk from those who share their social fabric and belief system. The diaspora can also contribute in communicating cancer prevention education and awareness by helping develop appropriate words for cancer, where there are no words for cancer, and in translating the language from American Cancer Society or NCI flyers into the appropriate language and cultural context. This was highlighted by Harriet Shangarai, who attended the GHC summit along with the Tanzanian ambassador to the United States and other Tanzanian diaspora members uniting against cancer. Recognizing the significance of communicating cancer in the local languages, and knowledge sharing, Ms. Shangarai started a Swahili health education blog (www.nesiwangu.com) to benefit her native country, Tanzania, and its immigrant population in the United States, with presently more than 9000 viewers. Such ability to communicate has potential to alleviate the formidable and unresolved access to care challenge through the pathway of cancer prevention. Once their cancer has been diagnosed, those who can afford therapy may need to trek hundreds of miles to a center with radiation therapy services and then endure enormously long wait times to receive care. More than one third of cancer deaths can be prevented altogether through awareness and early diagnosis. Therefore, given such limited specialty care and radiation therapy services in LMICs, more complementary efforts that can promote cancer prevention are imperative to reduce late diagnosis. This would broaden timely access to limited radiation therapy resources and, most importantly, save lives.

On a secondary level, the diaspora can help strengthen the poor health care systems manifested in the disparities in radiation therapy services highlighted by the shortage of radiation therapy infrastructure. The diaspora can be encouraged to invest in the development of such needed infrastructure. This is exemplified by members of the Ethiopian-American Doctors Group, currently working to build a cancer center with a radiation therapy facility in Ethiopia that could significantly increase access for many East Africans. Another proposal to strengthen health care systems is to encourage the AiD to develop a pan-African affordable health care insurance scheme. The more economically viable diaspora would be encouraged to enroll into this system with the possibility of extending coverage to their sending country family members, including coverage for cancer care like radiation therapy, and support for preventive health care, palliative care with provision for basic pain medication, and others. Such proposals are only a representative sample of the proceeding dialogue with the diaspora.

On the tertiary level, diaspora Africans like Christian Ntizimira, who serves on the Scientific Advisory Committee at Lancet Commission-Global Access for Pain Control and Palliative Care, is working with Felicia Knaul to champion complementary palliative care efforts to close the pain divide. “During the genocide [1994 Rwandan genocide], a part of our humanity (*ubuntu*) was lost along with the one million who perished. However, I’m still convinced that the concept of palliative care will bring back this part of humanity lost and will teach us to understand the deep perception of being a ‘human being’ in extending hope for the Rwandan post genocide society.” Partnership with such diaspora members can complement global health efforts in radiation oncology palliative care.

Another avenue for engaging the diaspora is in crowd-funding, mentioned earlier. Given the tens of billions of dollars in remittances and more tens of billions in savings, the diaspora has enormous potential to crowdfund research, in an approach that is growing in popularity in the United States as seen by many crowdfunding organizations (eg, Rockethub, Kickstarter, and others). Crowdfunding would be particularly beneficial in resource-poor settings, where even small amounts of funds can lead to many years of fruitful research for cancer researchers with otherwise no funding. Such crowdfunding can be used to generate preliminary data to be more competitive for even international funding, like that provided by the US National Institutes of Health. These preliminary data would also engender new hypotheses for more globally beneficial research, create greater visibility for African researchers working with their developed country compeers to publish this data. Cancer research in LMICs will also help in driving public policy, in the generation of new knowledge or technologies for clinical translation, and in participation in clinical trials and benefit economic development. Rifat Atun and others are leading global health efforts to highlight the economic and development benefits for investing in closing the cancer divide (29, 30).

AiD can also be excellent partners for cancer advocacy efforts that can benefit greater investment in radiation oncology and associated global health efforts to close the cancer divide. One example is that of Folakemi Odedina, who is leading major efforts in this area with AORTIC and some of whose work is accessible through the African cancer advocacy consortium (31). Such advocacy efforts are especially needed in patient safety. Recent

workshops and surveys (32) have highlighted major patient safety issues in the use of radiation technologies in LMICs. When the *New York Times* reported such incidences in the United States (33), there was a major outcry leading to testimonies in the US Congress by AAPM representatives to address the issue. Imagine the situation where many African countries do not even have a medical physicist. It is crucial to raise public awareness, as the *New York Times* did, and advocate recognition of the importance of medical physicists in ensuring patient safety, safety of the health care staff, and safety of the general public when radiation technologies are used in imaging and treatment. Such advocacy could buttress efforts to train more medical physicists or radiation medicine staff benefiting sustainable global oncology (34).

In addition to advocacy, public-private partnerships for greater investment in sustainable cancer control programming should also be promoted. Public-private partnership for global oncology has been a good model championed by Doyin Oluwole, a diaspora African serving as the Executive Director of Pink Ribbon Red Ribbon (PRRR) initiative at the George W. Bush Institute. PRRR's leading public-private partnership model is aimed at reducing deaths from cervical and breast cancer in sub-Saharan Africa and Latin America. The model could be adapted to strengthen global radiation oncology along the continuum of cancer care, and embedding it in the existing national health systems and funding mechanisms. A number of informed grassroots movements in favor of this are emerging from the recent GHC summit, which can complement the efforts of global RT (35), a grassroots movement led by radiation oncology residents. AiD grassroots movements include Tanzanians United Against Cancer, Nigerians United Against Cancer, and Cameroonians United Against Cancer. There are plans to expand this movement to other African countries with regular mobilization and knowledge sharing at GHC summits. Some AiD organization leaders are already leading cancer prevention education and advocacy campaigns in LMICs involving high school and university student leaders who get to learn about cancer, cancer prevention and the benefits and need of treatment modalities like radiation therapy among other things. One goal in addition to cancer education and awareness is to change the perception that oncology is a specialty for pain and death. Following the summit, the GHC is also supporting an African diaspora Leaders Symposium at the AORTIC 2015 conference, with planned representation from the African Union, to promote greater engagement with diaspora leaders in public-private partnerships that can enhance global oncology.

Conclusion

The growing cancer divide is a major obstacle to human development. It is characterized by millions of painful deaths, many of which can be prevented, as well as rising annual economic costs on the order of trillions of dollars (11). The cost of inaction is enormous and unsustainable, so we must invest in action characterized by increased partnership building and collaborations. We have highlighted emerging ICT-powered models that can facilitate global radiation oncology collaborations in a variety of aspects and have made related recommendations for moving forward, and avenues for outreach to the diaspora as partners. These are by no means exhaustive but can provide a useful reference to expand global radiation oncology programs with scalable activities catalyzed by ICTs and effective outreach that can save lives. It is evident that, for greater impact and sustainability, global

radiation oncology partnerships should reach vertically through the levels from individual volunteer to supranational organizations like ASTRO and AAPM, and horizontally in consonance with other oncology areas. Such connectedness, captured by the African word *ubuntu*, will advance efforts for more efficacious and sustainable collaborative global health action toward closing the cancer divide, saving lives.

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Table 1

Model programs in global radiation oncology powered by ICTs

Model programs (Available at) (reference)	ICT-powered activities
Cancer care	
BOTSOGO (http://www.botsogo.org/) (15)	Monthly tumor boards and remote support for radiation oncology care.
Chartrounds.com (https://www.chartrounds.com/default.aspx)	Chartrounds brings together academic disease site specialists from leading cancer treatment institutions and connects them with the Chartrounds network of over 1300 physicians and medical physicists. On a scheduled basis, they discuss patient management and treatment plans with trusted colleagues in real time.
Cure4kids (https://www.cure4kids.org/)	Cure4Kids is an online resource for health care professionals dedicated to enhancing the care of children who have cancer and other life-threatening diseases in countries around the globe.
QARC (http://www.qarc.org/)	Provides radiation therapy quality assurance services; potential for facilitating international “Chart Rounds,” maintaining a registry of patients discussed, connecting radiation oncologists who have questions about patient treatment with experts in the field, using website-based technology, and facilitating design of appropriate protocols.
Radiating Hope (http://www.radiatinghope.org/) (16)	Remote treatment planning using screen-sharing software; remote quality assurance and technical support through Brainlab’s Quentry system; remote discussion of difficult cases, contouring, and treatment planning.
Cancer education	
IAEA PACT and VUCCnet (http://cancer.iaea.org/)	Online training of radiation therapy technicians, cancer prevention community health workers, screening workers, pathologists and pathology technicians, oncology surgeons, palliative care practitioners, and data collectors.
Cure4kids (https://www.cure4kids.org/)	Cure4Kids offers online education and collaboration tools that are freely available to registered users.
Radiating Hope (http://www.radiatinghope.org/) (16)	Remote training of residents and staff in Africa, including on PLATO; data sharing.
ASTRO International Education subcommittee (18)	Oversees ASTRO’s international education efforts with initiatives including: coordination of educational efforts with regional societies including ALATRO, SEAROG, CSTRO, AROI and others. Focus on integrating advanced technologies in LMICs. Remote learning initiatives such as contouring on a website-based platform. Support of ARRO for a 3D CRT online learning curriculum for breast cancer (with Dr Onyinye Balogun) and lymphoma and gynecological tumors (in an upcoming ALATRO conference). Development of educational courses in Spanish and Mandarin at the ASTRO annual meeting.
AAPM (http://www.aapm.org/)	International Education Committee, AAPM Online Learning Center, virtual education library with over 155 educational resources for developing countries, with

Model programs (Available at) (reference)	ICT-powered activities
	continuous education credit for medical physicists.
Dr Karen Winfield website Listening to the Heart of the Community (drkarenwinkfield.com)	Leveraging ICTs to improve access for medically underserved communities in Boston: radio; online courses; audience participation: suitcase radio station; Crank Radio; digital satellite radio, and others.
Global RT (http://globalrt.org/)	Provides a virtual platform for education, exchange, and action around the essential nature of radiation therapy for cancer care.
Cancer research	
QARC (http://www.qarc.org/)	Remote review in support of cancer clinical trials; potentially connecting arrays to appropriate research databases.
University of Massachusetts, Lowell, MA	Remote mentorship of medical physics graduate students with weekly skype meetings to evaluate progress and guide students.
Global Oncology (http://globalonc.org/Projects/global-cancer-project-map/)	Global Cancer Project Map: provide resources to view and better understand international efforts in cancer research.

Abbreviations: AAPM = American Association of Physicists in Medicine; ALATRO = Asociación Latinoamericana de Terapia Radiante Oncológica; AROI = Association of Radiation Oncologists of India; ARRO = Association of Residents in Radiation Oncology; ASTRO = American Society for Radiation Oncology; BOTSOGO = Botswana Oncology Global Outreach; CSTRO = China Society for Radiation Oncology; IAEA = International Atomic Energy Agency; ICT = information and communication technology; LMIC = low- and middle-income countries; PACT = Programme of Action for Cancer Therapy; QARC = Quality Assurance Review Center; VUCCnet = Virtual University for Cancer Control; SEAROG = South East Asia Radiation Oncology Group.

Table 2

Other global health initiatives in radiation oncology

Model programs (available at) (ref)	ICT-powered activities
ICEDOC (http://www.icedoc.org/)	International Campaign for the Establishment and Development of Oncology Centers (ICEDOC); "ICEDOC's Experts in Cancer without borders" offers free consultation and advice to authorities, colleagues and cancer patients on volunteer basis.
Radiation Nation: Collaborative Conversations in Radiation Oncology (http://radiationnation.com/purpose)	To improve cancer care through discussion of clinically important aspects of radiation oncology, with focus on: patient education, collaborative medical practice, and improving quality and safety.
ICEC (http://www.iceccancer.org/)	To reduce mortality and improve the quality of life for people with cancer in low- and middle-income countries and regions worldwide.
Medical physicists without borders (http://www.mpwb.org/)	To support activities which will yield effective and safe use of physics and technologies in medicine through advising, training, demonstrating, and/or participating in medical physics-related activities.
Pink Ribbon Red Ribbon (http://pinkribbonredribbon.org/)	A leading public-private partnership aimed at catalyzing the global community to reduce deaths from cervical and breast cancer in sub-Saharan Africa.
ARA (http://www.araforchange.com/)	Engaging the diaspora and students in developing countries to become catalysts or advocates for global oncology in LMIC.
Treat Safely (http://www.treatsafely.org/)	TreatSafely is dedicated to the development of novel teaching and mentoring programs that improve quality and safety in radiation medicine.
GTFRCC (http://gtfrcc.org) (25)	To unite the cancer community to reduce the global cancer burden, to promote greater equity, and to integrate cancer control into the world health and development agenda.

Abbreviations: ARA = African Renaissance Ambassador; GTFRCC = Global Task Force on Radiotherapy for Cancer Control; ICEC = International Cancer Expert Corps; ICT = information and communication technology; LMIC = low- and middle-income countries.