**Title:** Broken Machines or Broken Systems: The Road to Meaningful Global Radiotherapy Access

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Uganda has no radiotherapy. The sole workhorse machine, installed in 1995 at the country’s national hospital, stopped functioning in April 2016 and is beyond repair, a fact that rose to international attention.\(^1\) The absence of this machine means that hundreds of patients who were in the middle of cancer treatment were not able to complete it and many patients who could have lived with their cancers will now die of them. Yet, lack of access to radiation therapy is a daily reality for most patients with cancer in low- and middle-income countries (LMICs) across the globe. Nowhere is this dearth of access greater than in Africa. Nearly 30 African countries do not have a single radiotherapy unit. An additional eight have fewer than 0.1 machines per million people.\(^2\) The International Atomic Energy Association recommends between four and eight machines per million people; North America has 14.89 machines per million.\(^2\) Before this month, Uganda had one machine serving its 37 million people, in addition to referrals from Burundi, Rwanda, and further afield.

Machine number does not always equate to practical access. Although neighboring Kenya has eight machines, only two serve public-sector patients at low cost. Both of these machines have been repeatedly out of service throughout 2015 and early 2016, a fact that reached national news outlets but did not rise to international attention.\(^3\),\(^4\) Uganda’s single external-beam radiation machine operated on a radioactive cobalt source that was last exchanged in 2002. Because the half-life of cobalt-60 is roughly 5 years, patient treatments would take four to five times longer than a younger source would have required. There has also been an increase in the number of patients with cancer seeking radiotherapy treatment, from approximately 250 in 1995 to nearly 2,000 in 2015. In part because of the dying cobalt source and in part because of the relentless patient volume, Uganda’s machine ran for more than 20 hours per day, in three shifts, straining against the impossible demand. A team of radiation oncologists, physicists, technicians, and nurses all worked these hours, striving to provide the best possible care in adverse circumstances. The work was just too important to stop—this one machine was the only hope for tens of thousands of patients in the region.

The loss of Uganda’s only machine is an unequivocal tragedy, albeit a predictable one. Jackson Orem, MMed, PhD, Director of the Uganda Cancer Institute (UCI), reported 2 years ago that logistic concerns, and not funding, were the primary issues in ensuring a new, reliable radiotherapy machine. The asking price of a machine is an all-too-common way to start and end the discussion on providing radiotherapy to those who need it.

Radiotherapy facilities require a complex support system, so complex that people are often intimidated by the magnitude of the task. Early in the HIV/AIDS crisis, antiretroviral medications were also deemed too complex to deliver in low-resource settings, even as the epidemic raged across the subcontinent. But people who believed it was possible made it possible on a broad scale. If there is anything to learn from this situation, it is not that radiotherapy in LMICs is too difficult to sustain. In East Africa alone, Mulago and Kenyatta, Nairobi’s public hospitals, have treated hundreds of thousands of patients with minimal foreign assistance for decades, whereas the rest of the world has argued about the feasibility of radiotherapy in LMICs.

There is a current action to revive radiotherapy services in the country. The government of Uganda, in collaboration with the UCI, has embarked on building six new radiotherapy bunkers at the UCI site adjacent to Mulago Hospital. There are also plans to formally decommission the non-functional cobalt machine and replace it with a
modern cobalt unit. In addition, a new cobalt-60 high-dose-rate brachytherapy unit and a computed tomography simulator were commissioned in March and April and are fully functional.

Uganda’s radiotherapy facility was an inspiring place, and its successors will be even more so. The lesson from Uganda is not that machines break, but that systems do. We are in need of more robust mechanisms to ensure that radiotherapy is a part of planning for cancer care and control in all LMIC settings.

There are several essential steps. The International Atomic Energy Association’s Programme of Action for Cancer Therapy needs a bigger budget, staff, and mandate to ameliorate the numerous logistical complexities of acquiring and maintaining radiotherapy machines. Currently, they rely primarily on volunteers with varying experience in the LMIC context to conduct their national assessments and follow-up. Furthermore, the numerous North American and European academic and nongovernmental organizations that have taken up the mantle of global cancer care must prioritize radiotherapy as part of their work with national programs.

Common malignancies in LMICs—including head and neck and cervical cancers—are incurable without radiation therapy, especially in the absence of highly specialized surgical care. Furthermore, patients with painful, large masses often benefit from palliative radiotherapy; these patients also suffer because of a profoundly limited supply of opiates. Yet, many international partnerships that attempt to strengthen cancer care in LMIC focus preferentially on chemotherapy.

Above all, we need more brains and bodies—doctors, physicists, and radiation therapists from across the globe who are dedicated to this mission. There are many hopeful national and international strides toward broader access to radiotherapy. This has been particularly true over the last few years, with the Union for International Cancer Control’s Global Task Force on Radiotherapy for cancer control publishing a comprehensive assessment of what is needed to set up a basic radiotherapy service. Furthermore, Datta et al provide a compelling road map of how these services can be established, improved, and maintained.

Radiotherapy was functional in Uganda and will be again, and it is support for partnership and systems of care that are bringing this to bear, not simply machines. Machines will break. Downtime and decommissioning are a part of the process of radiotherapy in radiation oncology departments across the globe. We should expect them to be and should have better support and strategies from national and international bodies to address these realities. Uganda provides us with a sobering reality and a ray of hope. Uganda’s machine is broken, but so is our system for ensuring access to radiotherapy for patients with cancer across the globe.

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