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AMPATH-Oncology: A model for comprehensive cancer care in sub-Saharan Africa

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ABSTRACT

Increased awareness of cancer as a health crisis facing less developed healthcare systems has led to recent calls for increased investment in cancer care infrastructure in low resource settings. However, operational descriptions of well-functioning cancer care systems in resource-constrained settings are limited. AMPATH-Oncology is the result of collaboration between North American, European, and Kenyan partners to develop a comprehensive cancer care model that supports screening services, cancer treatment, and palliative care. This article describes the approach taken by the AMPATH-Oncology program to deliver cancer care in a resource-constrained setting. A review of other 'high-income – low-income' collaborative models identifies successful strategies to implement cancer care in low resource environments.

Introduction

In 2005, 60% of worldwide deaths were attributable to chronic disease (cardiovascular disease, cancer, chronic lung disease, and diabetes), and 80% of these deaths occurred in low and middle income countries (LMICs) [1]. Chronic diseases affect younger populations in these settings, and cause longer suffering and a higher loss of life-years than in high-income countries (HICs) [2,3]. Transitioning from a healthcare system designed to address acute care, to one engineered to tackle chronic care, is forcing health care systems in LMICs to restructure and reallocate resources to prepare for their changing healthcare needs [4]. This is a particular challenge where governments spend 6% or less of their gross national budget on healthcare [5]. Cancer care, as it is delivered in HICs, is one of the most costly areas for healthcare delivery. In light of their economic constraints, it is daunting to contemplate effectively addressing the needs for comprehensive cancer care in LMICs. However, models for the delivery of cancer care in under-resourced environments must be developed to meet the rapidly growing need for these services.

Cancer already accounts for more deaths in the developing world than tuberculosis, malaria, and HIV/AIDS combined [6]. In 2008, the American Cancer Society estimated that 56% of incident cases and 64% of deaths due to cancer occurred in LMICs, and in pediatrics, the numbers are even more skewed, with 80% of incident cases and deaths due to childhood cancers in LMICs [7]. Within the next decade, global cancer rates are predicted to more than

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Table 1
Comparison of key economic and social indicators between Kenya and AMPATH-Oncology partner nations.

Country	Kenya	United States	Canada	The Netherlands
Population (millions)	39.8	298.6	34.5	16.7
Gross national income per capita (US$)	760	46,360	45,560	43,140
Infant mortality rate (per 1000 live births)	55	7	5	4
Life expectancy at birth (years)	54	79	81	81
Health expenditure per capita (US$)	33	7410	5222	5593
Health expenditure (% of gross domestic product)	4.3	16.2	11	12
Out-of-pocket health expenditure (% of private expenditure on health)	77.4	24.2	50	38

Source: The World Bank.
Numbers reflective of 2009, 2010, or 2011 data.

double, but this burden will not be borne equally; death rates in LMICs are expected to be 5-fold higher than in HICs [8]. Within the next two decades, shifts in habits (i.e. increases in smoking, obesity), transitions from rural to urban living, economic transition from an agricultural to industrial base, and aging populations, have led to predictions that 70% of all incident cancers will occur in LMICs [9–11].

Cancer will also continue to rise in mortality tables for LMICs. Unlike HICs where the ratio of incidence to mortality is approximately one-third, 80% of patients diagnosed with cancer in LMICs will die of their disease [12]. It has been predicted that by 2030, 15% of all deaths in LMICs will be attributable to cancer; 16% of those deaths will occur in those under 70 years old; and these deaths will account for 7% of all the disability-adjusted life years (DALYs) [1]. The promulgation of guidelines and calls to action for cancer research, prevention, and control in LMICs reflects awareness of current needs and future demand [2,11,13,14].

However, implementation of cancer control strategies has lagged behind recommendations and guidelines, and there is only limited published literature to guide programs in the development of LMIC cancer programs. In prior publications we have described specific aspects of a cancer-care program being developed in western Kenya (i.e. cancer nursing skills [15], cancer pharmacy [16]). Herein, we present a more comprehensive picture of AMPATH-Oncology as a collaborative HIC-LMIC program that provides cancer service in a resource-constrained setting that has delivered care to thousand of Kenyans.

The setting

By World Bank definitions, Kenya is a low-income country with over 39 million citizens and a gross national income per capita of $769 annually (2009 US dollars). Table 1 summarizes key indicators for Kenya in comparison to the countries partnered in this cancer care collaboration. In 2007/2008, the Government of Kenya (GoK) allocated 8.4% of its total national budget to health, translating into roughly $8.30 per capita annually spent on each citizen [6,17]. Kenya has a national health insurance plan available to all citizens, the National Health Insurance Fund (NHIF), which covers a substantial portion of in-patient hospital fees in governmental hospitals, but lacks coverage for outpatient services. Fees for enrolling in NHIF range from less than US$2 per month to around US$25 per month, but fewer than 10% of the population is enrolled [18,19]. Further, enrollment in NHIF takes at least 2 months between enrollment and initiation, a delay that frequently encompasses a critical period for a newly diagnosed cancer patient.

The GoK recently passed a National Cancer Control Strategy to be implemented between 2011 and 2016, but it is still too early to define the impact this document will have on care for cancer patients [20]. The existing infrastructure for cancer surveillance, screening, and diagnosis is limited: two International Agency for Research in Cancer (IARC)-initiated regional cancer registries only cover a portion of the population; no national screening programs exist; limited diagnostics are available, both in terms of expertise (i.e. pathologists, technologists, and radiologists) and resources (pathology and radiology equipment). Even when a diagnosis of cancer is possible, access to care is difficult. The GoK recently determined there were only three medical/pediatric oncologists and four radiation oncologists in the entire country, and just five of them worked in the public sector [21]. In the public sector, there are two cobalt-60 radiation oncology machines, both housed in Kenyatta National Hospital (KNH) in Nairobi. Cancer drugs (chemotherapeutics and supportive medications) are frequently unavailable in governmental hospitals, and while they are available on the open market, remain unaffordable to many.

A brief history of AMPATH and AMPATH-Oncology

Over the past decade AMPATH-Oncology evolved from an existing HIV program to meet the cancer care needs of western Kenya. AMPATH-Oncology development occurred over four periods: a limited pediatric cancer start-up; development of an AIDS-related cancer agenda; rapid expansion into a chemotherapy-provision program; and a period of strategic restructuring into the present comprehensive care model. Programmatic growth has been driven by Kenyan clinicians, with increasing service demands impelling interactions between Kenyan clinicians and North American and European oncologists. The foundational program for AMPATH-Oncology, a locally initiated pediatric oncology program, provided chemotherapy for child cancer patients funded by local businesses. Care was provided on the general pediatrics ward by one generalist pediatrician and a nurse with limited additional training in palliative care and cancer nursing. However, with the remarkable growth of the United States Agency for International Development – Academic Model Providing Access to Healthcare (USAID-AMPATH) HIV treatment program, the needs for cancer care shifted.

USAID-AMPATH was created in 2001 through a collaboration between Moi University School of Medicine (MUSM; the second medical school in Kenya), Moi Teaching and Referral Hospital (MTRH; the second governmental tertiary referral hospital in Kenya), and a consortium of North American academic medical centers to combat HIV/AIDS in western Kenya [22]. Utilizing the expertise of MUSM faculty and North American academic physicians, combined with the clinical facilities and personnel of MTRH, USAID-AMPATH developed a successful model for HIV/AIDS treatment which currently delivers care to over 140,000 patients with 2000 new patients enrolling monthly [23,24]. With the provision of anti-retroviral therapy, however, clinicians faced patients developing HIV/AIDS-associated malignancies (e.g. Kaposi's sarcoma, non-Hodgkin's lymphoma).

In order to address this new patient population, AMPATH-Oncology developed from the pediatric cancer program into an HIV malignancies program, increasing the number of nurses and clinicians and incorporating the expertise of North American medical oncologists. This marked the transition from a small local effort addressing specifically pediatric cancers into a HIC-LMIC

Table 2
Infrastructure developed by USAID-AMPATH repurposed for cancer care.

- NIH-certified grants management office with existing procedures for transparent transfer and utilization of funds in Kenya
- Educational institute facile in arranging short- and medium-term training workshops
- Good Clinical and Laboratory Practices (GCLP) and ISO 9000-certified clinical laboratory, as well more limited clinical laboratory facilities in remote clinic sites
- Motor pool with maintained vehicles, and network of transportation to move clinical personnel remotely and remote patients to higher-level care facilities
- An informatics development and support group, the primary product of which is an open-source electronic medical record system, AMRS [56,57,58,59]
- An existing monitoring and evaluation program

Table 3
Current organization and services of AMPATH-Oncology.

Theme	Present activities	Planned activities
Screening and prevention	• Breast cancer screening • Cervical cancer screening	• Immunization campaigns • Anti-smoking campaign
Diagnosis and treatment	• Immunohistochemistry • Medical oncology services • Gynecology oncology services • Pediatric oncology services	• Radiation oncology • Tissue bank
Palliative care	• Palliative care outpatient clinic • Palliative care in-patient consult service	• Coordination of hospice services

collaborative cancer project with the objective of treating AIDS-related malignancies. However, once cancer diagnosis and treatment infrastructure was in place patients began to present with non-AIDS-related cancers, forcing the program to expand its scope. The rapid growth in patient population threatened to outstrip the available personnel and resources, forcing the nascent cancer care services to move away from a program simply providing chemotherapy into program managing cancer patients throughout their disease course. The present AMPATH-Oncology program developed out of the need to implement resource-conscious system-wide improvements while delivering comprehensive cancer care.

Extending care: a cancer care program created from existing resources

The cancer care program was built on the backbone of the extant infrastructure that was developed to address the HIV pandemic. USAID-AMPATH superstructure, a hub-and-spoke model of care delivery developed to increase accessibility of services to an impoverished rural population, was repurposed to address cancer [25]. More than 50 remote sites, housed in GoK Ministry of Medical Services (MoMS) facilities ranging from permanent buildings with reliable electricity and in-house laboratory services to basic clinical venues – at times, a simple tent in a field – serve as a distributed, accessible network for population-based cancer screening and prevention activities [26]. This network also has processes in place for referral of more complex cancer cases to the higher-level care centers, and facilitates adequate follow-up. The transportation and communication schema serving the HIV/AIDS network funnels patients to more resourced sites that offer cancer care, and can move cancer personnel out to the village. Additional key resources developed by USAID-AMPATH that support the cancer care program are outlined in Table 2.

USAID-AMPATH's existing relationship with the GoK facilitated targeted, cost-effective governmental involvement via MTRH in support of the development of cancer services. Through creation of the MTRH Department of Hematology & Oncology, onto which AMPATH-Oncology was overlaid, the MoMS shares clinical infrastructure and personnel costs. Critically, this frees non-governmental funds for targeted infrastructure development and personnel training. Ministry employees assigned to the department include administrative staff, pharmacy technicians, nursing, clinical officers, medical officers, and physicians. This also allows dedicated space for oncology including: outpatient clinic space (shared with other USAID-AMPATH chronic disease programs); a chemotherapy pharmacy; chemotherapy administration areas; and a pediatric in-patient oncology unit.

To efficiently utilize limited personnel and resources, the clinical services of AMPATH-Oncology are supported by a core infrastructure comprised of a cancer registry, a cancer nursing service, a chemotherapy pharmacy service, administration (tasked with scheduling, educational development, and programmatic monitoring and evaluation), and research support (responsible for data management, institutional review liaison, research assistants). The cancer registry, established by IARC in the early 1990s, required additional investment to support the personnel to update the registry, improve stability of the information storage, and re-evaluate quality controls in registry data. The first two projects were addressed by hiring registry personnel and investing in new hardware. The latter project, a work in progress, is using programmatic mentoring between North American registries and the Eldoret Cancer Registry to supplement ongoing support by IARC.

While nursing and pharmacy services were eager to engage in cancer care initiatives, neither service had personnel with specific training in cancer care or chemotherapy. Therefore, an agreement was made with MTRH nursing and pharmacy administration to train specific personnel in the care of cancer patients, safe handling and administration of chemotherapeutics, and supportive care. These personnel were trained through short-term, on-ground educational programs created by North American oncology nurses and clinical pharmacists who had spent time working with these nurses to identify current practice areas in need of improvement. In developing these workshops it was critical to work with experts who could spend time on-ground so that educational objectives could be framed within the constraints of the practice environment. Ongoing educational programs focusing on pediatric oncology have been facilitated both in Kenya and Amsterdam through the Doctor2Doctor collaboration between VU University Medical Center (VUmc), KLM Healthcare and MTRH.

Finally, recognizing that cancer care in resource-constrained settings lacks an evidence base to guide decisions, AMPATH-Oncology developed a core service to support research. Coordinating with the existing resources within AMPATH (an NIH-certified institutional review board, an AMPATH research coordination office, a large data management infrastructure), AMPATH-Oncology hired research assistants and data managers to help maintain databases and work with the larger AMPATH research agenda. Presently, this group is supporting both health services research as well as clinical trials and translational studies to help define cancer in Kenya, with rapid feedback of local outcomes to inform the development of care strategies. Additionally, strategic investments have been made to improve the diagnostic capabilities of MTRH, with the coordination of expertise and resources to improve the reliability of pathologic diagnosis and creation of an immunohistochemistry laboratory.

Supported by these core services, AMPATH-Oncology is divided into three major organizational structures: Screening & Prevention; Diagnosis & Treatment; and Palliative Care. Table 3 summarizes the current and planned activities of each administrative group.

Table 4
Cancer categorization for resource allocation and treatment protocols.

Priority	High	Medium	Low
Criteria	• Curative intent	• Palliative • High RR • Long PFI	• Palliative • Low RR • Short PFI
Examples	• Pediatric acute leukemias and lymphomas • Locally advanced breast cancer	• Kaposi's sarcoma • Ovarian cancer • Metastatic breast cancer	• Pancreatic cancer • Gastric cancer

Abbreviations: RR, response rate; PFI, progression free interval.

The first, and most established services (Medical, Pediatric, and Gynecologic Oncology), were initially developed to provide safe chemotherapy delivery, but have evolved over time to encompass other aspects of active care, including limited diagnostics (i.e. punch biopsy service for Kaposi's sarcoma) and surgical services in gynecologic oncology. With each of these treatment-oriented groups, an early effort was made to rationalize treatment based on balancing limited budgets and limited availability of drugs against the need to optimize benefits.

Using the essential drugs for cancer therapy list published by the WHO as a starting point, North American and Kenyan clinicians reviewed the local epidemiology and weighed clinical benefit of potential regimens against cost [27]. A rank-ordered list of diseases was created using a categorization schema prioritizing: curative therapy above palliative; in palliative settings, longer progression free intervals over shorter; and, cheaper over more expensive regimens. This list was subsequently used to dictate treatment patterns and fund allocation for chemotherapy. Table 4 presents a selection of this prioritization schema.

With development of standardized protocols for chemotherapy delivery and definition of patient groups for whom chemotherapy was not indicated (i.e. advanced cancers with limited benefit for chemotherapy), development of a palliative care service was critical both for cancer patients, but also for cancer care providers – who frequently felt that not being able to provide chemotherapy equated to not being able to provide care. Providing surgery, chemotherapy, and palliative services enabled AMPATH-Oncology to move into active case detection and preventative services. In a resource-limited setting, most screening activities identify not only pre-malignant conditions, but also relatively advanced cancers. Having the possibility of treatment made population-based screening acceptable to both the medical providers and the community at-large.

There are insufficient physicians trained in oncology to provide these services, therefore AMPATH-Oncology has relied heavily on alternative models of care. Palliative care is a nurse-driven service, as are the breast and cervical screening programs, in which nurses have been trained in clinical breast exam, cervical visual inspection under acetic acid (VIA), and cryotherapy. Cancer care is delivered by tiered service-providers – the limited physicians see complex cases, but physician extenders deliver routine care and follow-up. The less experienced providers are supported by explicit protocols, which address resource-appropriate diagnostics, standardized (and flat-dosed) chemotherapy regimens, and clear start-stop rules. Finally, program-wide guidelines, recognizing the finite program resources, define limits to the care AMPATH-Oncology will deliver, but temper these limits with a robust palliative care program.

With this organizational structure AMPATH-Oncology has been able to deliver reasonably comprehensive cancer care. To date, AMPATH-Oncology has provided care to over 30,000 patient visits between screening services, the 4 clinical services, and an in-patient consultation service. Screening services include clinical breast exam with facilitated FNA biopsies, as needed, and a cervical cancer screening service using visual inspection under acetic acid in a "screen and treat" model using cryotherapy (although colposcopy and loop excision and appropriate surgical services are available as needed). Delivery of chemotherapy, both in-patient and out-patient, is a major role of AMPATH-Oncology, but consultation individually and through multi-disciplinary tumor boards serve key roles in improving outcomes in cancer patients. The programmatic indicators are presented in Table 5.

Table 5
Programmatic indicators for AMPATH-Oncology.

	Cervical screening	Breast screening
Prevention and screening[a]		
Number screened	17,651	3699
Pre-malignant lesions identified	476[b]	N/A
Cancer identified	347	50

Pediatric oncology	Gynecologic oncology	Adult oncology
Diagnosis and treatment[c]		
Top diagnoses (number of patients)		
SCD (100)	CC (250)	KS (230)
ALL (35)	OVC (64)	BRCA (200)
NHL (26), RTB (22)	ENDO (24), VC (8)	HL (77)

Palliative care[c]	
Number of patients under treatment	1020
Liters of morphine dispensed	98

Abbreviations: SCD, sickle cell disease; ALL, acute lymphoblastic leukemia; NHL, non-Hodgkin's lymphoma; RTB, retinoblastoma; CC, cervical cancer; OVC, ovarian cancer; ENDO, endometrial cancer; VC, vulvar cancer; KS, Kaposi's sarcoma; BRCA, breast cancer; HL, Hodgkin's lymphoma.
[a] Reflective of service inception to December 2012.
[b] Inclusive of CIN I, II, and III.
[c] Reflective of December 2011 to December 2012.

Discussion

Literature documenting successful implementation of resource-constrained cancer care programs created through HIC-LMIC collaborations is limited. The best documented are those of the Monzas International School of Pediatric Hematology/Oncology (MISPHO, Italy), the St. Jude International Oncology Program (Memphis, USA), the VU University Medical Center in Amsterdam (VUmc – The Netherlands), and the Ethiopia Breast Cancer Project (EBCP). St. Jude and MISPHO have published extensively on nursing education, program development, and outcomes – but are limited in scope to pediatric oncology and are geographically centered in Latin America [28–31]. Similarly, VUmc's work is focused on pediatric oncology and in a fairly dissimilar setting [32–34]. The EBCP has documented strategies, successes, and challenges of developing a breast cancer program in Ethiopia – however, while the Ethiopian healthcare system similar to the Kenyan system, this program is oriented to a single disease [4,35–37]. AMPATH-Oncology represents a comprehensive approach to cancer care in a resource-constrained setting. However, similarities between these programs identify themes to successful implementation of HIC-LMIC collaborations for cancer care.

Access to cancer therapy in LMICs is limited [38]. However, cancer care in HIC-LMIC collaborations is not simply about donating drugs. Indeed, it might be judged irresponsible to simply increase access (and often sporadic supplies) of therapeutics that have narrow therapeutic margins and large potential to inflict harm on patients without investing in local capacity development [36]. Collaborative training to increase the workforce and creation of standardized protocols is a critical first step. Combining LMIC process expertise (i.e. how to get something done in a resource-constrained setting) with HIC content expertise (defining

an international gold standard for a given cancer) offers the opportunity to develop locally appropriate standardized protocols and a baseline standard of care. Implementation of this standard creates locally relevant outcomes data against which new efforts can be compared. Additionally, protocols compensate for differences in practitioner education and levels of clinical experience with cancer treatment, giving increased safety margins to task shifting. Finally, these protocols can be designed to facilitate system-wide demand assessment, efficiency in ordering, and waste reduction.

Protocols must balance local feasibility against best-practices [39–41]. Treatment of cancer in HICs has evolved to progressively more complex chemotherapy regimens with higher rates of toxicity. However, toxicity is not as well tolerated in systems with inadequate access to supportive services (i.e. poor blood transfusion capabilities, lack of antibiotics), and can lead to unexpectedly high morbidity and mortality in resource-constrained settings [42]. Therefore, it is critical to focus on developing appropriate care models for the available resources, an approach best exemplified by the recommendations of the Breast Health Global Initiative's "resource-stratified matrix" approach [43].

To support the implementation of protocols in LMICs there must be investment in skill development and infrastructure to deliver cancer care. Cancer specialists at all levels of health care delivery in LMICs are rare. As previously noted, Kenya reports only five public sector cancer physicians, or one oncologist to roughly 7 million population, therefore task shifting is required to meet patient demand for cancer services. In Kenya, the physician is typically responsible for the preparation and administration of chemotherapeutics – both of which are time-intensive duties. Dividing tasks into the domain of pharmacy personnel and nursing staff helps ensure both task-specific expertise and frees clinicians to utilize their expertise in patient management. Task shifting, however, must be done in conjunction with training and explicit care protocols [27,36].

Recognition of patient-level, as opposed to system-level, limitations is also critical to delivery of cancer care. MISPHO, recognizing treatment abandonment as a point of failure in pediatric cancer care delivery, has developed patient-family hostels, transport fees, and other innovative approaches to reduce barriers of access to care [30,44]. Similarly, VUmc has focused on parental education to increase patient retention [45]. The EBCP has published focus group analyses offering insight on barriers to patient utilization of their program [46]. AMPATH-Oncology, with its distributed network of care delivery, is able to make use both of the remote clinics to deliver care and the transport infrastructure already in place to facilitate patient referrals to a centralized care site. Nonetheless, our experience resembles those described in Sri Lanka, in which travel to cancer services can be up to a two day journey – although in our case it is by mini-bus as opposed to train – and remains an area in need of development [47]. Treatment abandonment, rare in HICs, remains a significant source of mortality for cancer patients in LMICs – further research is needed to develop abandonment reduction strategies.

Finally, these successful HIC-LMIC collaborations have clearly defined research as integral to their care delivery systems. Trial data on treatment and outcomes for cancer patients in LMICs are sparse [48–50]. While generating LMIC-specific trials is important, it is equally important to fill in our understanding of current standards of care. In LMICs access to antibiotics, transfusions, and other supportive care measures readily available in HICs is not guaranteed, therefore outcomes in LMICs at current standards of care may be less than expectations generated by trials data, and routine care outcomes must be defined [51,52]. All of these collaborations recognize this implicitly and have built systems to analyze outcomes in the context of routine clinical care.

Conclusion

Success of AMPATH-Oncology has led to growth in referrals from western Kenya and beyond, which has necessitated rationing of care to focus limited resources on those patients expected to have best outcomes, and implementation of fee schedules to offset costs. This programmatic growth has outgrown the infrastructure of AMPATH and MTRH – ground has been broken for a new building to house cancer care. Additionally, there are still gaps in the care AMPATH-Oncology can deliver because of missing vital infrastructure – there is no radiation oncology. KNH and the Uganda Cancer Institute, in Kampala, Uganda, are the closest sites for radiation therapy, each many hours to days away. In order to address this, AMPATH-Oncology is working with the IAEA, the GoK, donors, and radiation equipment manufacturers to create a second hub for radiation therapy in Kenya.

Use of existing infrastructure, coordination with GoK healthcare, treatment protocols developed around affordable off-patent chemotherapeutics, and task-shifting have allowed AMPATH-Oncology to provide services in a cost-conscious manner. Presently, AMPATH-Oncology services 10–15,000 patient visits a year at a cost of US$750,000 generated through research and service grants. Much of this investment has been in training and infrastructure, both of which offer durable returns. AMPATH-Oncology's chemotherapy is not expensive, certainly not by American standards, and is likely similarly cost-effective as other AMPATH programs [53]. However, chemotherapy remains a major programmatic budget-line – one that will continue to grow in an unsustainable manner as the patient population continues to increase. AMPATH-Oncology is one solution for cancer care in LMICs, and has managed to provide extensive service to a large population at a low initial cost. However, it remains an area of active research and thought to find sustainable methods to maintain these services.

Mutual trust, shared decision-making, local ownership, programmatic evaluation and feedback leading to practice changes, and development of local capacity have been proposed as guiding principles for HIC-LMIC collaborative cancer research projects [54]. The principles have guided the development and organizational structure of AMPATH-Oncology and other successful HIC-LMIC care-driven collaborations. One of the fundamental differences between HIV care and cancer care is the large additional infrastructure necessary to prevent, diagnose, and treat cancer patients [55]. AMPATH-Oncology's development of comprehensive services was driven by connecting multiple components of a healthcare system to deliver appropriate care. It is from these principles that AMPATH-Oncology will continue to offer care while exploring solutions to deliver sustainable comprehensive care for cancer patients in western Kenya.

Conflict of Interest

None declared.

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