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The oncology pharmacy in cancer care delivery in a resource-constrained setting in western Kenya

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Abstract
The movement to deliver cancer care in resource-limited settings is gaining momentum, with particular emphasis on the creation of cost-effective, rational algorithms utilizing affordable chemotherapeutics to treat curable disease. The delivery of cancer care in resource-replete settings is a concerted effort by a team of multidisciplinary care providers. The oncology pharmacy, which is now considered integral to cancer care in resourced medical practice, developed over the last several decades in an effort to limit healthcare provider exposure to workplace hazards and to limit risk to patients. In developing cancer care services in resource-constrained settings, creation of oncology pharmacies can help to both mitigate the risks to practitioners and patients, and also limit the costs of cancer care and the environmental impact of chemotherapeutics. This article describes the experience and lessons learned in establishing a chemotherapy pharmacy in western Kenya.

Keywords
Africa, oncology pharmacy, Kenya, resource constrained, developing world, capacity development, cancer

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Introduction

Cancer kills more patients globally than HIV, TB, and malaria combined, yet remains an under-recognized and under-resourced cause of morbidity and mortality in resource-constrained settings (RCSs).[1,2] Predicted increases in incidence will lead to up to 8.8 million new cases annually in less than a decade, only exacerbating this situation.[3] These predictions have led to a growing call to create the research and care infrastructure sufficient to meet this challenge – a movement given voice by the London Declaration in 2007. This document outlined six elements of cancer control: cancer intelligence units; tobacco control; early diagnosis and prevention; cure the curable (cancer treatment); palliative care; training and education.[3] The hurdle of creating affordable cancer care in developing world settings has been more specifically addressed in several recent publications.[4,5] However, despite the urgency to deliver affordable chemotherapeutics in RCSs, it is critical to address occupational safety concerns early on in the planning stages through the development of an oncology pharmacy.

Without doubt, cost of care is a major obstacle to overcome in the drive to develop cancer care systems in resource-constrained areas – in resource-replete settings, steeply rising costs of chemotherapy have been of concern for nearly a decade.[6] However, this hurdle is not insurmountable; programs have shown that cost-effective and clinically effective care can be delivered in RCSs.[7] Like the HIV paradigm, improved access programs combined with novel funding strategies will likely increase the availability of chemotherapeutics in resource-constrained settings, and this will subsequently lead to reduced local costs. In fact, there are published success stories of programs that have overcome these financial barriers to deliver appropriate care to cancer patients in resource-limited settings.[8–11] However, no publication to-date addresses the chemotherapy pharmacy, a key component of the cancer delivery infrastructure responsible for ensuring safe handling of chemotherapeutics in order to limit personnel and environmental exposure. In this article, we describe our experience with establishing an oncology pharmacy as part of a cancer treatment program in western Kenya and outline the issues to be considered in developing oncology pharmacies in resource-constrained settings.

Current practice environment

The practice environment in many resource-constrained settings is not dissimilar to that described in the early 1980s from a cancer treatment facility in the United Kingdom, where preparation and administration of cytotoxics were handled by practitioners under-trained in the risks these drugs presented to themselves and their patients.[12] However, in the interim 30 years, there have been substantial changes in practice in North America and Europe, driven largely by the concern for accurate dosing, proper administration, and occupational exposure.

In the 1970s and 1980s, a series of studies showed increased risk of adverse events amongst professionals who prepared therapy, attributable to chemotherapy exposure, including risks of infertility, miscarriage, and acute toxic effects from exposure.[13–18] In the literature there remains ongoing concern about long-term adverse effects leading to increased incidence of cancer amongst the population of practitioners exposed to this pre-regulatory work environment. The response to these concerns took several forms: the implementation of safer working conditions, mandated by regulatory bodies (i.e. Occupational Safety and Health Administration);[19] the creation of a safer work environment via the use of personal protective equipment, type II laminar flow hoods, and use of closed-system admixture products; and the creation of safe practice guidelines for personnel involved in the handling of chemotherapeutics (i.e. International Society of Oncology Pharmacy Practitioners).[20] Many of these changes engendered a shift from *ad hoc* cytotoxic preparation to creation of formal chemotherapy pharmacies and the training of oncology pharmacists and pharmacy technicians.[12]

The setting

The Academic Model Providing Access to Healthcare (USAID-AMPATH), is a comprehensive healthcare program, encompassing HIV care, primary healthcare, and chronic disease management, created out of the collaboration between Moi University School of Medicine (MU), Moi Teaching and Referral Hospital (MTRH), and a consortium of North American academic medical centers.[21–23] Created in 2001, USAID-AMPATH covers a catchment area of approximately 2 million Kenyans living in Uasin Gishu and Rift Valley Provinces. Cancer care services, initially through the Department of Pediatrics, have been offered at MTRH since the 1990s; however, infrastructure to support these services resembled the state of cancer services in much of sub-Saharan Africa, noted above.

USAID-AMPATH provided limited cancer care from 2005, but expanded its cancer services with the formation of AMPATH-Oncology in 2008. Embedded in the Department of Oncology of MTRH, AMPATH-Oncology offers screening for cervical and breast cancers, palliative care services, as well as treatment for cancer via medical, gynecologic, and pediatric oncology

Table 1. Most common diagnoses seen in AMPATH-Oncology, 2010.

Medical oncology	$N = 777$	Pediatric oncology	$N = 84$	Gynecologic oncology	$N = 61$
Kaposi's sarcoma	406 (48%)	Benign hematology	27 (32%)	Cervical cancer	44 (72%)
Breast cancer	91 (11%)	Lymphoma	18 (21%)	Ovarian cancer	12 (19%)
Lymphoma	62 (7%)	Sarcoma	12 (14%)	Uterine cancer	3 (5%)
Gastrointestinal malignancies	61 (7%)	Acute leukemia	8 (9%)		
Carcinoma NOS	34 (4%)	Kaposi's sarcoma	7 (8%)		

services. As of 2010, AMPATH-Oncology was seeing approximately 1000 unique patients annually. The most common diagnoses seen in AMPATH-Oncology are presented in Table 1. Since 2006 AMPATH-Oncology has been served by a chemotherapy pharmacy service.

Before the creation of an oncology pharmacy service, decentralized ordering and distribution by ward pharmacies of cytotoxic drugs, along with underfunded mandates to deliver cancer care, led to frequent stock shortages. This, in turn, led to an *ad hoc* system of procurement in which short-falls by the hospital were supplemented by patients' purchasing drugs from the private sector. Overall, this made needs assessment and evidence-based procurement impossible. Once the patient procured drugs, preparation of chemotherapy for administration was performed by the attending physician or the intern at bedside, frequently with limited to no prior experience in handling or administering cytotoxics and without protection in place for either practitioner or patient. Development of the chemotherapy pharmacy was driven by the need to address four issues: patient safety; practitioner safety; inventory and procurement centralization; and environmental containment of hazardous drugs. However, additional benefits insofar as practice standardization and cost-containment arose from this structure.

The AMPATH-Oncology Pharmacy Service: Present practice and challenges

The AMPATH-Oncology Pharmacy Service (AOPS) consists of pharmacy technicians trained in the safe handling and preparation of chemotherapeutics, the space in which chemotherapeutics are stored and reconstituted, and the policies and procedures that govern all activities within the AOPS. These three components work together to ensure drug availability and security, patient and practitioner safety, and proper waste disposal. We present the identified issues within the pre-AOPS practice environment in Table 2, along with the current solution, as well as the currently identified problems that are yet to be solved. Many of these solutions were achieved through the development of training materials and standard operating procedures that are readily exportable to other resource-constrained settings.

Procurement

Prior to the creation of the AOPS, there were substantial difficulties with mismatches between the needs of the cancer program and available drugs, with costs of drugs making private purchase on the part of patients rare. Presently, the AOPS uses donated funds to purchase drugs via the governmental supply process. The use of centralized data collection, centralized procurement of all oncology-specific drugs used within AMPATH-Oncology, and use of the local supply chain has allowed the AOPS to ensure both available and cost-effective therapy. The implementation of annual demand-based procurement plans, revised with monthly use statistics, have facilitated bulk ordering of chemotherapeutics and supportive care medications quarterly, limiting risk of stock-outs and costs of drugs. Unfortunately, as a major purchaser of chemotherapeutics in Kenya, and having highly centralized care delivered by experienced practitioners, lack of expected adverse events or expected efficacy has highlighted the risks of using the local supply chain. Like much of the developing world, Kenya is plagued by counterfeit drugs where it reports a counterfeit rate of approximately 30% of all drugs on the market.[24] Chemotherapeutics may be particularly vulnerable to this, given their relatively high cost and the fact that they are frequently colorless liquids given intravenously with minimal directly measurable effects (notable exception with highly emetogenic agents such as cisplatin). With these unique setting dynamics counterfeit

Table 2. Development of AMPATH-Oncology Pharmacy Service by Chemotherapy 'Life Cycle'.

'Life Cycle' stage	Problem	Solution	Newly identified challenges	Plans
Procurement	• Mismatch between patient needs and available chemotherapy • High cost of drugs when ordered in low volume	• Centralized Inventory and Use Data Collection • Quarterly bulk-ordering based on inventory and utilization data	• Counterfeit chemotherapy	• Collaboration with the Kenya Pharmacy and Poisons Board to Identify potential Counterfeit drugs
Storage	• Decentralized chemotherapy storage • Lack of proper storage conditions (no direct light, refrigeration)	• Centralized Secure Storage • SOPs for stock management and security	• Theft	• Implementation of a RCS-specific pharmacy information management system
Preparation & dispensation	• Unsafe preparation conditions • Routine drug waste	• Fixed-dose regimens rounded to vial size • Protocol-driven dispensing • SOPs for personnel and patient safety • Investment in class II laminar flow hood	• Possibility of transcription errors • Need to confirm procedural compliance and efficacy of interventions	• Implementation of pre-printed order sets
Administration	• Lack of clinician education of safe administration of chemotherapeutics	• Dispensing only to trained clinical personnel • AOPS as information clearing-house for chemotherapy administration	• Lack of dispensed drug labeling system	• Development of a low-cost product labeling system
Disposal	Disposal of hazardous drugs in routine waste	• Identify procedures to isolate chemotherapy-contaminated waste • Designate special disposal procedures for contaminated waste	• Final disposal by the hospital hampered by inadequate functioning of incinerator	• Investment in incinerator repair

chemotherapeutics represent an ill-defined risk to cancer care in the developing world.

Storage

Prior to the creation of the AOPS, chemotherapy was stored in several clinical areas, often with little regard to security or proper storage conditions. The AOPS presently stores all chemotherapeutics in a secure space, with access limited to AOPS personnel. Within the storage space is a refrigerator, connected to the back-up generator system in case of power failures. Standardized operating procedures (SOPs) require tandem stock-takes quarterly, responses to stock discrepancies, and procedural security. In spite of best efforts, AMPATH-Oncology has suffered loss of expensive therapeutics, and is presently revising SOPs and access policies to limit opportunity for diversion. However, given the present value of chemotherapy in many RCSs, security of inventory will continue to be a pressing issue.

Preparation and dispensing

There are no extant standards for chemotherapy preparation and dispensing throughout much of the developing world. In order to limit the risk of contamination of drug in preparation, risks to practitioners, and waste of expensive drugs, the AOPS implemented a series of practice changes and procedures in the handling and dispensing of chemotherapy. Initially, there was not a defined aseptic area to reconstitute chemotherapy; therefore, a pragmatic decision was made to reconstitute drugs outside, based on the logic that this would allow any aerosolized chemotherapy to rapidly dissipate to nonharmful concentrations in the atmosphere, limiting personnel exposure. In mid-2010, a Class II laminar flow hood was installed in a room with appropriate physical security, relative low patient and staff flow, and direct access to the administration area. Protocols were created to ensure use of the laminar flow hood, reduce risk behaviors (i.e. venting vials prior to reconstitution), and strengthen physical security with procedural security.

In addition to these physical and procedural changes implemented within the AOPS to improve practitioner and patient safety, protocol-based fixed-dosed regimens were implemented for all cancer treatment in adults to improve resource utilization efficiency (pediatrics utilized fixed protocols, but performs BSA-based dose calculation). To further limit waste, these doses are rounded to vial size to encourage efficient use of drugs by minimizing waste. Rounding typically resulted in less than 10% change from the fixed dose protocol. SOPs for the reconstitution of drugs also limit waste in preparation by requiring that the pharmacy technician crosscheck the diagnosis against the ordered regimen, and determine that relevant laboratory values are within acceptable limits for dispensing prior to reconstitution.

With these changes it is felt that the baseline safety of the oncology staff and patients has been improved. However, similar to any practice environment, there is a need to both ensure compliance to safety practices and procedures, as well as determine the efficacy of these interactions in a quantitative manner.

Administration

The AOPS provides information to the nurses regarding administration, that is, time of administration, duration of infusion, proper vein selection, and compatibility with other intravenous fluids. Finally, the AOPS maintains emergency drugs for nurses' use in case of allergic reactions and extravasations. Having this distributed system of drug preparation, with a clinical staff administering the drugs has highlighted the risk of misidentification of the patient. At present the AOPS does not have the means to create patient-specific product labels and therefore chemotherapy is verified with the corresponding patient orders prior to administration. This system does run some risk of misidentification and errors in administration.

Disposal

The AOPS is also responsible for the safe disposal of chemotherapy-contaminated waste. In resource-replete settings, medical waste management is a growing issue, and in spite of having waste management strategies in place, there is recent increased attention to the environmental impact of chemotherapeutics in hospital effluvia.[25] This issue, and unintended environmental consequences, will be magnified in RCSs, where the limited available literature indicates medical waste management is in its infancy, particularly when discussing potential teratogens.[26] The importance of this cannot be overstated – in the case of AMPATH-Oncology, when MTRH transitioned to a cost-containment strategy for intravenous fluids that entailed local production and re-usable glass containers, the AOPS alerted the administration to the risks in re-using bottles which had been used for chemotherapeutics administration. The subsequent dialogue highlighted these risks to MTRH, and allowed the mutually agreeable outcome of chemotherapy being exempted from this policy, and continuing to use disposable bottles. Additionally, it was determined the MTRH incinerator does not achieve an adequate temperature to safely incinerate chemotherapy. Therefore, the AOPS has

coordinated with the hospital waste disposal service to store grossly contaminated waste. Finally, the AOPS maintain spill kits, and are responsible to help in the clean up and disposal of accidental spills.

Human capacity development

A key to the success of AMPATH-Oncology, and specifically to the AMPATH-Oncology Pharmacy Service has been the personnel who see patients and maintain clinical operations. The importance of working with local healthcare providers cannot be overestimated, while generally not versed in cancer medicine, the local providers offer insight into the practicalities of delivering healthcare in the challenging setting of limited resources. Relatively modest investment in the education and development of our pharmacy staff has facilitated the development of practical solutions to several of the issues faced in the development of the AOPS.

The pharmacy technicians who staff the AOPS graduated from a Kenyan polytechnic with a 3-year diploma in pharmacy technology. In Kenya, pharmacy technologists are trained and licensed to both maintain stores and dispense medications. However, their training in chemotherapeutics is generally limited or absent. Therefore, an early effort, coordinated with colleagues from University of North Carolina Hospitals, focused on increasing their comfort with the concepts and procedures related to chemotherapy reconstitution and dispensing. Competency training was provided to a number of pharmacy and nursing personnel, with pre- and post-training assessment. Core elements of this competency-based training are presented in Table 3. The pharmacy technologists are responsible for all AMPATH-Oncology chemotherapy reconstitution and dispensing, but frequently are called on to provide care in roles as diverse as drug administration (in the absence of nurses), patient counseling, and patient care coordination with other services.

Additionally, it is critical to understand the current staff policies for technicians in their practice environment – early in the creation of the AOPS it was determined that because of lack of sub-specialty training in any pharmacy area, a policy was in place that rotated pharmacy technologists through all areas of the hospital routinely. Therefore, coordination with hospital administration was necessary to maintain a trained cohort in the AOPS, and that rotations of technicians had to be coordinated with additional training, so that only certified technicians could operate in the AOPS.

Table 3. Core elements of pharmacy competency-based curriculum.

Chemotherapy Basics
- Mechanisms of cancer and chemotherapy
- Side effects of chemotherapy
- Risks of hazardous drug exposure

Appropriate and Safe Ordering of Chemotherapy
- Body surface area and dose calculation
- Dose adjustment for organ function
- Laboratory value evaluation

Personal Protective Equipment
- Required personal protective equipment for preparation, administration and disposal of hazardous drugs
- Chemotherapy preparation area (glove box, laminar flow hood, etc.)

Preparation and Administration of Chemotherapy
- Sterile preparation techniques
- Negative pressure reconstitution (versus venting vials)
- Use of chemotherapy compendium (diluent selection, fluid selection, infusion time/drip rate, expiration dating)
- Vein assessment and selection
- Administration of vesicants

Disposal of Chemotherapy
- Disposal of bulk hazardous waste, trace contaminated waste and sharps
- Chemotherapy spill clean up

Chemotherapy Supportive Care Measures
- Chemotherapy requiring pre- and/or post-hydration
- Antiemetic selection
- Management of allergic and anaphylactic reactions
- Management of extravasation

Certification to Handle Hazardous Drugs
- Completion of 2-day training course of the above topics
- Successful completion of chemotherapy competency exam

Cost containment

The initial reasons for the creation of the AOPS were noted above: supply-chain stability; increased patient safety; increased personnel safety; and environmental safety. In addition to making major improvements in these four areas, the AOPS has also allowed the creation of a living laboratory in which to explore the economics of chemotherapy delivery in a RCS. As indicated by the recent editorial by Kerr and Midgley, the paradigm set by HIV care in the developing world, a dollar a day (or $365.00 a year) is accepted as a set point for cost-constrained healthcare delivery.[4] Changes implemented within the AOPS allow AMPATH-Oncology to approach this point, and has laid the groundwork to explore further strategies to ensure affordable, sustainable cancer care in RCSs.

In order to constrain programmatic costs, AMPATH-Oncology has implemented several pharmacy-level changes. First, the use of centralized data collection and centralized purchasing and distribution has facilitated larger orders, with reduced costs per unit in the order. Throughout much of Kenya, chemotherapy is only stocked in limited quantities in private pharmacies. Because of the limited purchasing power, suppliers can charge a premium to the pharmacy, who then can charge a premium to patients. The AOPS negotiates large purchases (per the suppliers, the AOPS was the largest single purchaser of chemotherapy in Kenya in 2010) at discounts. Next, pharmacy was used to reinforce the rationing of cancer care to those diseases that were felt to be either curable or had high likelihood of clinically meaningful response to therapy. AMPATH-Oncology's expert-opinion based rank ordering of malignant diseases is presented in Table 4. Finally, the centralized preparation and dispensing of chemotherapy allowed the implementation of several changes to improve the efficiency in using the available pharmaceutics. These changes included use of fixed doses with an estimated BSA of 1.5 meters squared, and rounding to the nearest vial size.[27,28] These efforts at cost-containment were made consciously, but with little science to guide them, given the relative dearth in the literature addressing the practical implementation of cancer care in RCSs.

While the decision to round to vial size was made on pragmatic grounds, it was not felt that this approach risked additional harm, as BSA-based dosing minimally impacts inter-individual variability in exposures to most the chemotherapeutics used in the AMPATH-Oncology program.[29,30] The choices made insofar as the development of present algorithms for disease selection, and regimens utilized to treat are open for further evaluation and refinement. The current regimens were largely developed through expert opinion. AOPS is presently undergoing a step-wise review of all regimens in order to select evidence-based regimens that can be viably employed with limited resources. The process we intend to employ has already been undertaken with regimens for ovarian cancer and non-Hodgkin's lymphoma.[31,32]

Finally, from the overall programmatic perspective, while these efforts have led to substantive cost-savings, and have allowed the implementation of a feasible model for limited-resource cancer care delivery, the long-term sustainability of the program needs to be further evaluated. The current model of chemotherapy supply has relied on donations, either as drug or as financial support for local purchase. This approach has been invaluable in establishing the services of AMPATH-Oncology and the AOPS, however, this is not sustainable in the long term. We have begun to engage collaborators to undertake a series of changes over the next several years to both increase the economic viability of regimens, as well as establish novel funding mechanisms to allow patients to afford the cost of care. Next steps in this process include comparisons

Table 4. Representative diseases by prioritization scheme of AMPATH-Oncology.

Adult			Pediatric
High priority	Medium priority	Low priority	High priority
• Early stage breast cancer • Neoadjuvant cervical cancer • Kaposi's sarcoma • Hodgkin's lymphoma • Non-Hodgkin's lymphoma • Early stage osteosarcoma • Testicular cancer • Gestational trophoblastic disease	• Late stage breast cancer • Palliative cervical cancer • Endometrial carcinosarcoma • Head and neck squamous cell • Chronic lymphocytic leukemia • Chronic myelogenous leukemia • Indolent NHL • Multiple myeloma • Ovarian cancer • Prostate cancer	All other diseases not noted in other priority categories	• Acute lymphocytic leukemia • Hodgkin's lymphoma • Non-Hodgkin's lymphoma • Early stage osteosarcoma • Testicular cancer • Retinoblastoma • Nephroblastoma • Soft tissue sarcoma • Neuroblastoma

Table 5. Recommendations for development of an oncology pharmacy in a resource-constrained setting.

Procurement	• Bulk purchasing to reduce costs • Identification of reputable suppliers, particularly in areas at high risk of counterfeit • Placement of personnel on the procurement boards of hospital
Storage	• Physical security of storage location • Establish policies and procedures to buttress physical security measures
Preparation and dispensing	• Fixed dosing rounded to vial size to reduce waste and minimize potential for error • Pre-printed order sheets • Defined treatment protocols • Physical infrastructure to limit exposures (i.e. use of PPE and Class II laminar flow hood)
Disposal	• Defined disposal protocols for chemotherapy waste • A functional incinerator capable of safely destroying chemotherapeutics or a plan for long-term storage
Personnel training	• Safe handling of chemotherapeutics • Safe disposal of chemotherapeutics • Emergency procedures for events such as chemotherapy spills • Safe administration of chemotherapeutics (Nursing) • Management of complications (e.g. extravasation)
Cost containment	• Bulk purchasing • Fixed dosing to minimize waste • Defined cost-effective treatment protocols • Disease guidelines and priorities

of available regimens for relative cost-effectiveness and pursuit of more formal pharmacoeconomic evaluations, strategies which have been utilized to both choose cost-effective regimens in developing world settings and determine appropriate fee structures in emerging markets.[33,34] Additionally, we are exploring potential costing models, gathering socioeconomic data on our patient population, and undertaking discussions with microfinance organizations in an attempt to determine a sustainable long-term model for the delivery of cancer care.

Table 6. AMPATH oncology pharmacy stocks.

Adriamycin	Methotrexate
Etoposide	Dexamethasone
Vincristine	Tamoxifen
Bleomycin	Vinblastine
Cytarabine	Dactinomycin
Chlorambucil	6-mercaptopurine
Cyclophosphamide	Busulfan
Metoclopramide	Morphine
Gemcitabine[a]	Ondansetron

[a]Donation from Eli Lilly and Co.

Recommendations

Broadly, our recommendations for developing an oncology pharmacy in a resource-constrained setting are presented in Table 5. However, it is important to highlight the need for early investment in personnel in many developing world settings, few, if any, health care professionals have had formal instruction on the safe handling and disposal of chemotherapeutics, and generally have had limited experience with these drugs. It is therefore critical in creating a cancer therapy service that will use these drugs to train personnel on these issues. AMPATH-Oncology has had success with a strategy of limiting the number of personnel with access to chemotherapeutics, investing in the training of those limited personnel to increase their awareness of the risks in handling chemotherapeutics, putting SOPs in place to limit risks, and investing in physical infrastructure to modify risks (i.e. use of a Class II laminar flow hood). Using 'train the trainer' approaches in instructing the core pharmacy personnel ensures both dissemination of this critical safety knowledge as well as sustainability of pharmacy services in the area. Utilization of a certification to demarcate those staff who could be assigned to chemotherapy pharmacy helps to create awareness in the healthcare setting that chemotherapy requires additional training and wariness on the part of healthcare personnel. Finally, we think it is critical that education be recognized as an ongoing process, as opposed to a one-time investment. The feedback between well-trained, up-to-date clinical pharmacy service in a resource-constrained setting and colleagues in resource-replete settings can lead to a

dialogue for the further refinement of policies, procedures, and indeed, clinical care protocols to improve local outcomes in ways that collaborators in resource-replete settings cannot imagine. Therefore, it is critical, once these services have been created, to maintain continuing education opportunities and communication between sites.

Conclusions

There is an impending health care crisis of cancer in the developing world, given voice with the London Declaration, and recently highlighted by several high-profile editorials in the medical press.[4,5,35,36] Emphasized in this discussion has been the cost of cancer care, and the imperative to get chemotherapeutics to patients who need them and cannot afford them. This is particularly true in settings like Kenya, where less than ten dollars per capita are spent on health care per year.[4] However, it is critical to learn from the lessons of the developed world in creating cancer care delivery services, and acknowledge that cancer care does require a multidisciplinary team of specialists.

The AMPATH-Oncology Pharmacy Service was formed to address immediate needs in supply-chain management, occupational risk reduction, patient safety, and cost-containment. In redressing the most immediate concerns, we learned important lessons in each of these areas and offer our recommendations to help programs establishing similar developing world cancer care services. We found that the use of centralized pharmacy services has benefited the clinical cancer care program in several key areas: in procurement, use and inventory data have facilitated larger, more standard orders, and smoothed out supply chain management; a core group of trained specialists in chemotherapy preparation and dispensing allows practice-level changes for efficient use of supplies and improved patient and practitioner safety; a centralized process for chemotherapy contaminated waste management and disposal limits the risks to the population and the environment. However, in addition to these lessons, use of centralized oncology pharmacy services has allowed unique insight into how reasonable cancer care can be delivered at reasonable cost.

Constraining costs of cancer care is critical to sustainable delivery of care in a RCS. The AOPS has helped substantially in these efforts by AMPATH-Oncology, through bulk ordering, careful supply chain management, and pharmacy controlled protocols for therapy. The latter point, in particular, should be emphasized. A limited formulary of cancer drugs, based on the WHO Essential Medicines list, can be used in evidence-based regimens to offer therapy to the majority of patients presenting with curable disease and disease with expected clinically meaningful responses (Table 6 presents the formulary of the AOPS). A cancer pharmacy service serves as another check and balance to ensure these cost-containing measures are applied uniformly. Further, formation of a centralized service handling the most expensive consumable in the delivery of cancer care in RCSs allows for a more comprehensive exploration of novel approaches to cost-containment.

The creation of oncology-specific pharmacy services, externally regulated occupational safety, and internally generated safety procedures were major innovations in the safe practice of oncology in North American and Europe. It should be noted, however, that this was and continues to be a process of monitoring, improvement, and re-implementation.[37–41] In fact, there are resource-replete settings without these services, which have recently recognized their value and are adopting them in recent years, most notably in Japan.[42,43] The present push to deliver chemotherapy in resource-limited settings should not lead to the abandonment of the lessons learned regarding oncology pharmacies, and the role they serve in supply chain management, practitioner safety, patient safety, and cost-containment.

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