

Cardiac Critical Care in Resource-Limited Environments

Lessons from Tanzania

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ABSTRACT

The concept of cardiac critical care is emerging as a tool in the management of cardiovascular diseases in many Sub-Saharan African countries. The region is undergoing significant epidemiological transition. There remains a significant burden of infectious and nutritional disease, but cardiovascular disease, notably hypertension and coronary artery disease, as well as other noncommunicable diseases (NCD) are emerging rapidly, placing a double burden on existing healthcare systems. Within this complex, heterogeneous, and changing epidemiologic setting, efforts to diagnose and treat cardiovascular diseases have increased. As more patients are diagnosed with acute cardiac conditions, the number requiring management in a cardiac critical care unit is also increasing. In this review, using the Tanzanian experience, we attempt to chronicle the appearance of cardiac critical care services and the many challenges to their implementation in a resource-limited environment.

The concept of cardiac critical care has become integral to the management of patients with cardiac disease throughout the developed world. These specialized units permit rapid diagnosis and advanced management of life-threatening conditions that require close or constant attention by a group of specially trained health professionals. The first dedicated cardiac critical care facilities were coronary care units. In the 1950s, mortality from myocardial infarction was alarmingly high. Coronary care units were established early in the 1960s to rapidly identify and terminate arrhythmias associated with myocardial infarction [1]. The advent of coronary care units was associated with a substantial decrease in in-hospital mortality after myocardial infarction [2]. Subsequent advances in technology, coupled with survival of more complicated cases of coronary artery disease, produced changes in the clinical characteristics of patients admitted to coronary care units. Patients with complex, multisystem organ involvement became more numerous [3].

These changes called for more comprehensive cardiac critical care services, including a proposal by the American Heart Association to increase the availability of clinicians with general critical care skills [4]. The evolved cardiac critical care unit is an intensive care unit for complex patients with cardiovascular disease who become critically ill and who are more prone to major systemic complications. Three cardiac critical care levels have been proposed.

Level 1 is identified with large tertiary medical centers and is capable of managing all cardiovascular conditions and associated multisystem complications. All forms of invasive and noninvasive monitoring capabilities and advanced technologies to support the cardiovascular system are available. Patients are managed by full-time cardiac intensivists, or general intensivists working in collaboration

with a cardiologist, who are available at all times and may be continuously on-site. The nurse-to-patient ratio is 1:1 or 1:2. Multidisciplinary teams comprising pharmacists, nutritionists, and respiratory physicians are present. Access to interventional cardiology and cardiac surgery is usual at this level.

A level 2 critical care unit is capable of providing initial evaluation and treatment of most acute cardiovascular conditions and medical comorbidities. All invasive and noninvasive monitoring is available. The unit is staffed by cardiologists with intensivists available for consultation or comanagement of complex patients. The nurse-to-patient ratio is 1:1 to 1:3.

Level 3 units are capable of managing respiratory failure, administering inotropic therapy, and providing immediate resuscitation of cardiac arrest. They focus on patients with suspected acute coronary syndrome, heart failure without shock, and hemodynamically stable arrhythmias. Noninvasive monitoring and echocardiography are readily available at this level. Cardiology service admission or consultation is available for management of patients admitted to these units with primary cardiac conditions. The nurse-to-patient ratio is 1:2 to 1:3.

These functional designations for cardiac critical care units are driven by numerous assumptions regarding the prevalence of various cardiac disorders, availability of supporting technologies, therapeutic modalities, and infrastructure. They provide a useful structure for understanding and planning critical care services. As in many other countries, cardiac critical care is in its infancy in Tanzania. Its trajectory of evolution may be quite different from the path followed in currently developed countries. Patterns of disease prevalence, the healthcare delivery system and workforce, medical education, and available

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resources will all have their effects. In the sections to follow, we will attempt to briefly review these important variables that will determine the evolution of cardiac critical care services in Tanzania and other resource-limited nations.

PATTERN OF CARDIAC DISEASES IN TANZANIA

The spectrum of cardiac conditions in a Sub-Saharan African country such as Tanzania is quite different from that observed in the developed world. These differences must be understood and taken into account in any discussion of cardiac critical care in evolving healthcare systems. Evidence now shows that Sub-Saharan Africa is at a period of epidemiological transition, with cardiac diseases associated with lifestyle and urbanization becoming more prevalent [5–7]. What is unique and different from transitions that occurred in Western European countries about a century ago is that the epidemiologic transition in Sub-Saharan Africa is occurring at a time when the cardiac diseases associated with poverty and infections still persist. This has created a double burden in which new cardiac diseases are imposed on the already stressed health systems and brings challenges to clinicians in terms of prioritization and management of the large number of patients requiring attention. In a typical tertiary healthcare facility in Sub-Saharan Africa, the spectrum of cardiac disease is that of mixed “old” and “new” diseases [5,7].

Hypertension, which was rare until the 1970s [8], has become the most important cause of cardiac outpatient clinic visits [9], and hypertensive heart disease is a major cause of heart failure [7] and hospital admissions [10] among adults in Tanzania. Nonischemic dilated cardiomyopathy is frequent, being the second most common cause of heart failure in many parts of Sub-Saharan Africa [11], including Tanzania [7]. Three forms of nonischemic dilated cardiomyopathy are recognized in our setting: peripartum cardiomyopathy, which occurs a few weeks before or after delivery; human immunodeficiency virus (HIV)-associated dilated cardiomyopathy; and idiopathic dilated cardiomyopathy. Whereas chronic rheumatic heart disease has become rare in the developed world, it is still a common cause of cardiac disease in Sub-Saharan Africa, especially among children and young adults [7,12]. Ischemic heart disease is becoming more prevalent in the region, although hypertension remains the most important cause of heart disease in many parts of Sub-Saharan Africa [13]. There is, however, an alarming increase in the prevalence of precursors of ischemic heart disease, especially in the urban populations [14], and it is reasonable to expect that with time the disorder will become an important cause of cardiac disease. In Sub-Saharan Africa, acute myocardial infarction typically occurs in individuals in middle and high socioeconomic classes [13].

Although patients with HIV infection have been found to be at increased risk for coronary atherosclerosis [15], acute coronary syndromes are still uncommon in this

group. However, aneurismal dilation of major blood vessels is not uncommon among patients with HIV infection [16]. These patients may present with acute aortic dissection requiring care in acute cardiac units. Pulmonary hypertension and cor pulmonale related to frequent respiratory tract infections including tuberculosis are common among HIV-infected patients in our population [16]. Massive pericardial effusion with tamponade is another important cause of acute admission requiring critical care management in our setting and is primarily due to tuberculous pericarditis [17]. As a sequela of tuberculous pericardial effusion, constrictive pericarditis is common, producing significant disability and often resulting in long hospital stays ultimately requiring surgical management, if available. Endomyocardial fibrosis is an important and surprisingly prevalent form of restrictive cardiomyopathy in this part of the world, which typically produces right heart failure and ascites [18]. With this form of restrictive myocardial disease, there is an association with low socioeconomic status. Uncorrected congenital heart diseases are frequently encountered, often presenting challenges to surgical teams as most of these late comers present with complications such as heart failure or severe pulmonary arterial hypertension.

In the developed countries, cardiac critical care systems emerged primarily in response to coronary artery disease and myocardial infarction. In resource-limited regions of the world, the decidedly different burden, distribution, and nature of the prevalent cardiac diseases will move the evolution of cardiac critical care along a different trajectory. This scale-up will also have to take place within the healthcare system existing in these areas, using infrastructure already in place and adapting to current patterns of patient management and referral. An understanding of healthcare delivery systems already in place is essential to predicting the ways in which cardiac critical care will likely emerge in resource-limited countries.

THE TANZANIAN HEALTH CARE SYSTEM AND CURRENT PROVISION OF CARDIAC CRITICAL CARE

The Tanzanian health system is a multitiered decentralized system designed to move patients from a local point of first contact through increasingly centralized and specialized facilities [19]. There are 6 tiers of care starting at the village level where most primary care is delivered (Fig. 1). Hospital care begins at the district level. It includes outpatient and basic inpatient services including surgical services, emergency obstetric care, and laboratory and basic diagnostic x-ray services. Designated critical care or intensive care services, however, are generally not available at the district level (Table 1).

Intensive care is more readily available starting at the regional level. These hospitals have a larger staff of medical doctors including general surgeons, general medical physicians, pediatricians, specialized nurses, and midwives. The level of critical care provided in these intensive

care units varies from ventilator management of respiratory failure and defibrillation capability to a simple increase in the nurse-to-patient ratio and more frequent patient observations [20]. There are currently no coronary care or cardiac critical care units in any of the regional hospitals.

Tanzania has 4 referral hospitals that serve different geopolitical zones made up of regional groups. Two of the 4 referral hospitals were originally built and operated by faith-based organizations. These now partner with the Tanzanian government, which provides subsidies for them to function within the national healthcare system. These centers offer more advanced specialized care and are staffed by medical doctors, most of whom are specialized or subspecialized. Laboratory, x-ray, and other imaging services are larger and more sophisticated in these institutions. All the referral hospitals with their more specialized staff are able to offer general intensive care services. They are also engaged in medical education and with their associated medical schools offer doctor of medicine degrees as well as postgraduate training in internal medicine, pediatrics, obstetrics and gynecology, and general surgery. The nursing schools associated with referral hospitals offer a bachelor of nursing degree. The referral hospital in Dar es Salaam, Muhimbili National Hospital, is the country's largest and has been designated the national referral hospital. In association with Muhimbili University of Health and Allied Sciences, medical and surgical subspecialty training is available and includes, among others, programs in cardiology, anesthesiology, and pulmonary medicine. The nursing school at Muhimbili University of Health and Allied Sciences offers the nation's only master of science degree program in critical care nursing.

The national referral hospital has just inaugurated a designated cardiac critical care unit, the nation's first. This is an open 6-bed ward that is designed to function as a level 3 unit. Each bed is equipped with a physiologic monitoring system that includes electrocardiography (ECG), pulse-oximetry, and noninvasive blood pressures. There is no central ECG monitoring capability, nor is there automated arrhythmia detection. The system will accept modules for pressure transduction, thermal-dilution cardiac output, and end-expired carbon dioxide, although these are not currently available, so central or direct peripheral arterial pressure monitoring cannot be performed. The unit has access to 3 volume ventilators. ECG, portable chest x-ray, and bedside echocardiography are available in the unit at all times.

Laboratory support for the unit is minimal. Basic studies such as complete blood count, electrolytes, glucose, urea nitrogen, creatinine, and liver function studies are generally available during the day. Biomarkers such as troponin and creatine phosphokinase can be obtained on weekdays but have turnaround times of 24 h. Natriuretic peptide is not available. Arterial blood gas analysis is available, but samples must be carried across campus to the emergency department. Coagulation studies, while available, have long turnaround times and have suffered from persistent quality control issues. Although thrombolytic

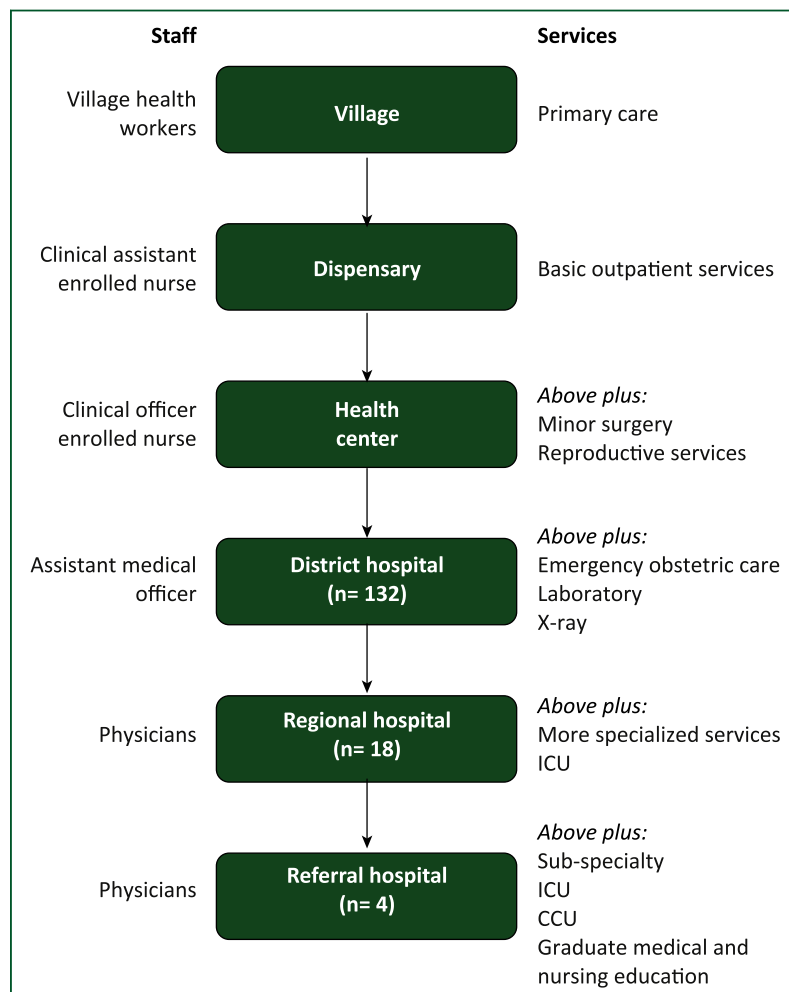


FIGURE 1. Health system structure in Tanzania with services and staffing provided. CCU, cardiac care unit; ICU, intensive care unit.

therapy for ST-segment elevation myocardial infarction has been administered sporadically at the referral hospitals, no organized regional or national program of public education, rapid transport, and early thrombolysis exists.

TABLE 1. Cardiac services offered in selected hospitals

	District Hospitals (n = 40)	Regional Hospitals (n = 12)	Referral Hospitals (n = 4)	Private Hospitals (n = 6)
ICU	1	10	4	6
CCU	0	0	1	1
Telemetry	0	0	0	0
Thrombolysis	0	0	1	2
Cardiac catheterization	0	0	1	0

Parenthetical values indicate the number interviewed.
CCU, cardiac care unit; ICU, intensive care unit.

The recently opened cardiac critical care unit at the national referral hospital is supported by a newly installed cardiac catheterization laboratory and an open heart surgery service. To date, the catheterization laboratory has performed only right heart studies. Except for Muhimbili National Hospital, no other hospital in the country offers cardiac catheterization services. Limited off-pump cardiac surgery is offered by 2 other referral hospitals (Bugando Medical Centre and Kilimanjaro Christian Medical Centre).

Private sector hospitals are becoming more common, especially in the population centers of Dar es Salaam, Kilimanjaro, and Mwanza. The services they offer are varied, depending on size, but generally they are equivalent to public system regional or referral hospitals. The larger private hospitals provide general intensive care. As of this writing, only 1 provides designated cardiac critical care services; none offer cardiac catheterization or open heart surgery.

CHALLENGES TO THE IMPLEMENTATION OF CARDIAC CRITICAL CARE SERVICES IN LOW-RESOURCE SETTINGS

The management of cardiovascular disease in Sub-Saharan Africa is in a period of transition. Though analogous to the conceptual and practical changes that began in the middle of the last century in developed countries, there are important differences that may significantly delay full implementation of the concept of cardiac critical care here. The dilemma faced by many African countries is the commitment of significant financial and educational resources to the widespread deployment of cardiac critical care at a time when there remains an enormous burden due to infectious and nutritional disease. Cardiac critical care will need tailored adaptation if it is to be successfully introduced. In the following sections, we explore the unique challenges faced by medical communities in resource-limited environments, as the concept of cardiac critical care emerges. We have grouped these challenges under 3 major headings: resource availability; healthcare workforce; and medical education.

Resource availability

Restricted financial resources constitute the major limiting factor in the deployment and maintenance of any level of cardiac critical care service in Sub-Saharan Africa. For example, in Tanzania, the national budget allocates approximately US \$2 per person per year for health care [21]. Uncovered costs must be made up by individuals or by combinations of international and private aid programs. Private health insurance is available but not widely used in Tanzania.

In Tanzania, the initial costs to acquire designated space and install required equipment are often deemed prohibitive. However, governmental or private aid programs can often be solicited to cover these “one-time” costs to establish critical care units and supply basic equipment

and essential furnishings. The true costs are ongoing and are often not initially considered before, and only become apparent after, installation. Difficulties are often attributable to supportive infrastructure, maintenance, and supply chain. For example, to ensure dependable supplies of clean water, construction or upgrade of water supply systems may be required. Electric power grids are often unreliable and unstable with frequent power outages, requiring the installation of expensive backup generation and voltage stabilization systems. A common stumbling block is the development of a dependable supply of medical gases. In our own coronary care unit, medical oxygen is piped into wall outlets from a central supply area. The central supply, however, consists of interconnected banks of cylinders that require frequent resupply to maintain adequate system pressure. Any delays in timely resupply can result in low system pressures and the potential for ventilator malfunction. Because only the largest hospitals have biomedical engineering departments, routine equipment maintenance is often neglected or delayed. Malfunctions and breakage tend to accumulate with resulting degradation of service and safety.

The public healthcare system in Tanzania uses a centralized system for the management of medical stores and equipment. Cost overruns in city hospitals can directly affect health care in the regions and vice versa as treatment facilities “compete” for available funds. As a result, essential intensive care items such as intravenous tubing, endotracheal tubes, central venous catheters, dressings, urinary catheters, ECG electrodes, intravenous fluids, and other consumables may sometimes not be available. When such shortages are encountered, often the only option is for family members, if they are able, to purchase equipment from local medical supply companies. In cases where families cannot afford to purchase needed supplies, the patient goes without. In critical care settings, these delays and shortages are lethal.

Provision of adequate laboratory services to support intensive care is often overlooked in the planning of critical care units. In general, only the referral hospitals can provide the types of laboratory investigations needed to support critical care service. Most laboratories only provide full service on week days. Night and weekend service is minimal. Turnaround times on most tests are ≥ 24 h. Laboratories must confront the same issues with stable electric power, water, and equipment maintenance as other hospital areas and suffer from the same shortages of consumables. Periods of a day or more may go by during which even basic studies become unavailable because of shortages of reagents or lack of collection tubes and equipment. In our institution, coagulation studies are especially prone to delays of a day or more and suffer from quality control problems. This single issue has proven very resistant to correction and is the major impediment (aside from drug cost) to the institution of a program of thrombolytic therapy.

Establishing cardiac critical care services is far more complex than just acquisition and installation of

infrastructure and equipment. The operational costs are usually much higher than anticipated by inexperienced healthcare systems and often exceed funds available. Without proper alignment of medical expertise, administration, funding sources, and acquisition and distribution of stores and pharmaceuticals, cardiac critical care systems may only provide high cost care with poor results.

Healthcare workforce

Staff trained in cardiac critical care are few. At baseline, the World Health Organization estimates there is a critical shortage of physicians and nurses in over 57 countries [22]. Tanzania is among those. In 1994, a public sector hiring freeze initiated a precipitous decline in numbers of healthcare workers in the country. In 1994, the Ministry of Health and Social Welfare reported 23 healthcare workers per 10,000 people [23]. By 2001, that number had fallen to 14 workers per 10,000, and in 2006, it was 6 per 10,000. In 2008, the Ministry of Health and Social Welfare reported 0.25 doctors and 3.7 nurses per 10,000 persons in the country [19]. By comparison, in South Africa the same year, there were 6.9 physicians and 38.8 nurses per 10,000, and in the United Kingdom, those numbers were 16.6 and 54 per 10,000 persons, respectively. The absence of jobs for healthcare workers in the public sector has been devastating. It has resulted in the migration of trained nursing, technical staff, and physicians to developed countries and has discouraged many from considering careers in health care. Additionally, HIV and tuberculosis pandemics have produced shifts in the distribution of healthcare workers from hospital-based positions to public health initiatives or to employment with the numerous governmental or nongovernmental organizations working within Tanzania.

The pool of nurses trained in cardiac critical care is exceedingly small not only in Tanzania but also in most resource-limited countries. Most of these nurses were trained and gained experience abroad, although one nursing school in Tanzania now offers graduate-level training in critical care. This means that new cardiac critical care units will be faced with the task of providing necessary training to nursing and technical staff before the units can become fully functional. Most of these potential staff members have significant deficits in the skills needed to work in a critical care environment.

The situation is most alarming within the physician workforce, as physicians are the primary drivers of cardiac critical care programs. According to the Tanzanian 2012 official census, there were 2,250 licensed physicians in Tanzania. In a survey just published by the Medical Association of Tanganyika [23] of physicians licensed in Tanzania, 2,246 of 2,250 total completed a questionnaire about their current practice status. Of those responding, 8.5% are currently employed outside of Tanzania. Of those remaining, 60.4% are practicing medicine and 39.6% report no clinical contact with patients. Only 43% of the

cadre who reported practicing are primarily employed by a hospital system (public or private) and thus involved in full-time patient care. Those not in the hospital system have found employment with nongovernmental organizations, health training, or research institutions or are pursuing further studies and thus are only involved in part-time patient care. Of the physicians who reported no patient contact, 16.1% have left the profession entirely. The remainder are pursuing careers in the pharmaceutical or medical equipment industries or have found employment in healthcare administration or government. The survey did not address specifically the reasons that so many physicians have migrated away from direct patient care. Other studies, however, have looked at demotivation of physicians in resource-limited environments, citing major drivers to be low salaries, lack of equipment and medications, lack of training opportunities, overwork, and the generally poor working environments in patient care areas [22,24–29].

Medical education

More problematic is the lack of educators qualified to provide instruction for new critical care staff. The public sector hiring freeze in Tanzania, which is only now being slowly lifted, resulted in the loss of an entire generation of nursing and medical school faculty. The paucity of faculty greatly limits the capacity of these institutions to increase the quantity and quality of new staff for cardiac critical care units.

In order to meet Millennium Development Goals, medical school enrollment will be increased by 50% over the next 3 years [19]; however, no plans for a corresponding increase in medical school faculty exist. In 2008, the Ministry of Health and Social Welfare in Tanzania reported 36 institutions that participated in the training of doctors, nurses, and clinical officers. At that time, these institutions were functioning with only about 40% of the required staff [30]. The underfunded medical schools have significant problems, working with low numbers of faculty and trying to combat problems with poor learning environments, low morale, and absenteeism. While these issues negatively affect undergraduate medical education, at the post-graduate level, these problems are magnified significantly. Burdened with undergraduate medical education, the teaching staff must resort to supervising a post-graduate curriculum based on seminars in which the students teach themselves. In our institution, faculty appear on the wards only twice weekly to participate in teaching rounds. During these rounds, groups of perhaps 10 to 15 undergraduate and post-graduate students pass through the wards as cases are presented to the instructors. These exercises tend to be short lectures and demonstrations at the bedside and, though informative, do not accomplish the task of teaching the intricacies of day-to-day patient management. Instruction in the critical care environment will require constant bedside experience and, equally, a more constant faculty presence. With

instructors in such short supply, these more effective teaching programs and intensive instruction in complex patient management simply will not be possible. The difficult learning environment is taking a toll on morale. A study published in 2010 by Leon and Kolstad [31] suggests that physician demotivation in Tanzania begins in the training years. They found that after 5 years of medical education, 66% of students reported being less motivated to pursue a career in clinical medicine than at the time they enrolled.

As a result of the significant problems facing medical education in the country today, there are few post-graduate education programs to produce the subspecialists who will develop and direct critical care units. At present, there are small subspecialty training programs in cardiology and pulmonary medicine. There are plans to begin post-graduate training in general critical care medicine at the national hospital and medical school in Dar es Salaam within the next year. Subspecialty training is impeded further by the lack of advanced treatment facilities and programs in-country. In our institution, it was hoped that the development of an advanced national cardiovascular disease program would enhance the training of subspecialists in-country and would obviate the need for existing training agreements with foreign programs. However, given delays encountered with the national program, it has been necessary to maintain arrangements for training outside the country. These training issues will not be solved easily. The reality is that quality cardiac critical care units will develop only slowly until the number of fully functional educational institutions can be increased, adequate numbers of faculty restored, and quality post-graduate education brought online.

THE FUTURE OF CARDIAC CRITICAL CARE IN TANZANIA

The complex cardiac critical care systems found in developed countries today evolved from simple concepts that appeared in response to a single disease. As these systems developed, they incorporated, in incremental fashion, an expanding knowledge base, advances in technology and materials science, and remarkable progress in therapeutics of all types. In more resource-rich countries in the world, there has been more than half a century for educational institutions to respond to workforce requirements, for expansion of infrastructure and information technology, for development of administrative systems to manage medical stores, and for government and third parties to figure out how to pay for everything. A fully evolved level 1 cardiac critical care system occupies the apex of an incredibly complicated pyramid.

Coronary artery disease and myocardial infarction, which triggered the development of cardiac critical care systems in the developed world, are not the predominant forms of heart disease in most resource-limited environments such as Tanzania. This means that critical care

systems that arise must treat a different, more heterogeneous, and more complex array of cardiac disorders than was the case 50 or 60 years ago in the developed world. If these new systems are to achieve outcome improvements comparable to those produced by simple arrhythmia management in the early coronary care units, they will require more experienced doctors and nurses, more surgical and interventional support, more pharmaceuticals, and expanded laboratory services.

One challenge to successful scale-up, however, is that physicians, hospital administrators, and politicians are often impatient to bring online the high level of critical care services available in more developed settings. The larger public and private hospital systems desire level 1 service immediately. Although the goal is appropriate, the challenge will lie in trying to compress the developed world's 60 years of experience into a far shorter period of time. Tanzania's national referral hospital, working in conjunction with the People's Republic of China, has just inaugurated a new cardiovascular center. The hospital has fledgling open heart surgery and cardiac catheterization programs. Installation of the cardiac catheterization laboratory was completed 8 months ago, yet it has performed only a few right heart catheterizations to date because funds for the purchase of consumables are not available. The operating rooms sit idle for weeks at a time for the same reason. A well-equipped cardiac critical care facility also exists. The hoped-for improvement in patient outcomes has not yet been seen because of low numbers of trained personnel, unreliable supply of drugs and consumables, and administrative inexperience. One risk is that unimproved patient outcomes in the face of rising costs may dampen the political will to completely develop and disseminate cardiac critical care services in the public system. It is certainly discouraging to already overworked personnel. Success of the cardiovascular program at the national hospital is doubly important because of its association with the country's health sciences university, which will train the doctors, nurses, and administrators needed for the delivery of critical care services.

In the Tanzanian public healthcare system, a slow scale-up of cardiac critical care initiatives will be most effective. One approach might be to develop level 3 units with expertise in fundamental heart failure management and basic coronary care with rapid identification and treatment of arrhythmias and thrombolysis. Such units could be managed with nurse-to-patient ratios of 1:2 or 1:3. The level of complexity of patients in these units would allow for on-the-job training of staff while medical and nursing schools ramp-up critical care training programs. Fundamental cardiac critical care of this type could be more easily and realistically exported from the referral hospitals to the regional hospitals. It would allow broader scale-up of specialized care, ensuring quality at the same time.

The development of cardiac critical care in Tanzania may lie with the designated referral hospitals. These large hospitals were originally established by faith-based

organizations and are operated not-for-profit. Subsidized by the Tanzanian government, these institutions see all patients regardless of ability to pay. A form of public-private partnership, they may have greater access to capital that can be used to build cardiac critical care services than the public system alone. These hospitals also maintain ties with European and American medical schools, nursing schools, and nongovernmental organizations and so have access to the medical and administrative expertise necessary to establish and operate critical care units. They are important providers of undergraduate and post-graduate medical and nursing education and so contribute directly to the pool of physicians and nurses trained to provide cardiac critical care.

A public-private model may also help scale-up care. One private hospital system in Dar es Salaam is building its own level 1 cardiovascular center and has contracted to bring an experienced cardiovascular team including surgeons and interventional cardiologists, nurses, technicians, and administrative staff to the hospital. Out-sourced, the program will allow the hospital to provide integrated and quality services quickly while it hopefully gains experience. Even though it will provide paying patients with important services, the majority of the populace will not benefit nor will these hospitals contribute significantly to the medical education effort. There is an opportunity for the center to contract education and training with the Ministry of Education where residents, nurses, and specialists can train at the center under the supervision of the experienced team. This approach will help enhance quality and scale-up care in the public system as well.

SUMMARY

The development of cardiac critical care in resource-limited countries, though necessary, will be challenging. Both public and private healthcare systems seem intent on rapidly establishing level 1 facilities without the important prerequisite of mastering more fundamental critical care programs. The risk is that the many challenges described will lead to higher costs with only marginal improvement in patient outcomes. Caution will be needed on the part of health ministries to ensure balance between public health and disease prevention programs with the needed introduction of more specialized care. Finally, the central importance of medical and nursing education will have to be recognized and prioritized in resource-limited countries. Well-trained health professionals will be central to any scale-up of services — public or private — by providing quality care, research, education, training, and strategy for programmed health system growth.

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