

Challenges to the Provision of Emergency Services and Critical Care in Resource-Constrained Settings

Renae E. Stafford^{*,†,‡}, Catherine A. Morrison^{*,†,‡}, Godwin Godfrey^{*}, William Mahalu^{*}

Mwanza and Sengerema, Tanzania

ABSTRACT

The practice of intensive care unit (ICU) care in Sub-Saharan Africa is challenging and can have a significant impact on the lives of people in the region. Sub-Saharan Africa bears a disproportionate global burden of disease compared with the rest of the world. Inadequate emergency care services and transportation infrastructure; long lead times to hospital admission, evaluation, treatment and transfer to ICU; inadequate ICU and hospital infrastructure and, unreliable consumable and medical equipment supply chains all present significant challenges to the provision of ICU care in Sub-Saharan Africa. These challenges, coupled with an inadequate supply of trained healthcare workers and biomedical technicians and a lack of formal ICU-related research in Sub-Saharan Africa, would seem to be insurmountable. However, ICU care is being provided in district and regional hospitals throughout the region. We describe some of the challenges to the provision of emergency services and critical care in Tanzania.

Sub-Saharan Africa accounts for a disproportionate global burden of disease related to maternal and child mortality, human immunodeficiency virus/acquired immunodeficiency syndrome, malaria, and tuberculosis with communicable, maternal, neonatal, and nutritional disorders accounting for 76% of premature mortality in Sub-Saharan Africa [1]. As the region continues to struggle with control of these long-standing global health concerns, the growth in gross domestic product and increasing life expectancies have led to an increase in prevalence of noncommunicable diseases such as hypertension, cardiovascular disease, and diabetes with the proportion of deaths due to noncommunicable disease projected to rise from 59% in 2002 to 69% in 2030 [1,2]. Complications from these diseases and those associated with communicable diseases and sepsis [3,4], maternal health and care of the surgical patient [5,6], and those with traumatic injury [5–7] contribute to the need for appropriate emergency and critical care services.

Whereas the burden of these diseases and the subsequent need for emergency and critical care services is great, the available infrastructure, human resources, diagnostic and treatment capabilities, and financial resources devoted to provision of emergency and critical care services is not [8,9]. Despite these challenges, patients with illnesses and injury are being provided emergency and critical care services at the district and regional hospital levels [10] and in remote rural areas [6]. These hospitals are at the front line of care in Tanzania.

Resources are scarce at all levels of treatment and care. For example, the general lack of transportation infrastructure leads to patients in need often arriving to the hospital hours after injury or days after the development of

critical illness. The lack of an integrated approach to triage, resuscitation, and stabilization of acutely ill patients adds to the delay in treatment [11]. This coupled with lack of critical care resources in the hospital itself such as trained staff, drugs, basic diagnostic and medical equipment, and guidelines [10], as well as the limited ability to transfer a patient to higher levels of care contribute to the high mortality seen in these patients versus those in more resource-rich settings [8].

BACKGROUND

We describe a case that illustrates some of the challenges and resource limitations to providing emergency and critical care services in Tanzania.

Mr. Y is an elderly man brought to the casualty room at a 300-bed district hospital in rural Tanzania by private vehicle. A hippopotamus that had been rampaging a local village attacked him; that village was >30 km away from the hospital. On arrival to the hospital, he was hypotensive and tachycardic with altered mental status. Examination revealed large abdominal wall and pelvis wounds that were contaminated with mud and plant material and eviscerated abdominal contents with active hemorrhage. In addition, he had large buttocks and leg wounds and an open elbow fracture. An intravenous port was inserted and the patient was given normal saline and transferred to the operating theater. There was no blood available in the hospital.

The patient arrived in the operating theater and was attended by a nurse anesthetist while the surgeon finished another operative case. His blood pressure dropped with induction of halothane anesthesia and he received intravenous crystalloid resuscitation until blood was available well

The authors report no relationships that could be construed as a conflict of interest.

From the *Catholic University of Health and Allied Sciences, Wurzburg Road, Mwanza, Tanzania; †Sengerema Designated District Hospital, Sengerema, Tanzania; and the ‡Touch Foundation, Mwanza, Tanzania. Correspondence: R. E. Stafford (staffordrenae@gmail.com).

GLOBAL HEART
© 2014 World Heart Federation (Geneva).
Published by Elsevier Ltd.
All rights reserved.
VOL. 9, NO. 3, 2014
ISSN 2211-8160/\$36.00.
<http://dx.doi.org/10.1016/j.ghheart.2014.08.005>

after the operation had started. He required multiple small bowel resections, irrigation of the abdominal cavity, debridement and reconstruction of the abdominal wall and perineum, irrigation of multiple open wounds, and splinting of an open elbow fracture. He was extubated and transferred to the intensive care unit (ICU) with a systolic blood pressure of 100 mm Hg. Mr. Y remained in the ICU for 2 days until he was stable enough to transfer to a referral hospital.

Tanzania, a country in East Africa, has a population of nearly 45 million that has increased by 30% in the decade between 2002 and 2012 [12]. Great strides have been made in reducing infant and maternal mortality, diagnosis and treatment of malaria and human immunodeficiency virus, and in increasing the number of health workers and access to health care; yet, Tanzania still struggles with inadequate healthcare delivery and resource limitations. The majority of the population (70%) lives in rural areas and is involved in subsistence farming, except in areas bordering large lakes such as Lake Victoria where fishing is also a means of employment [12]. Road infrastructure, except in major towns, is primarily composed of dirt roads.

Basic health care is provided in villages at dispensaries staffed by a clinical assistant. The next level of care is at a health center staffed by a clinical officer (CO), with 3 years of training after secondary school, and a nurse [13]. Health centers may also have an assistant medical officer (AMO), who has 2 years of additional training after CO school, and a nurse midwife. AMOs have been trained to perform operations including caesarian sections, and some health centers have emergency caesarian section theaters. The next level of care is provided at the district hospital level with usually 1 designated hospital for each district. In general, they provide a full range of basic services including laboratories, radiology machines, and operating theaters. They are staffed by general medical doctors, AMO, CO, nurse, and attendants and may or may not have specialists. Patients needing a higher level of care are referred to a regional or referral hospital.

EMERGENCY PRE-HOSPITAL CARE, TRANSPORTATION, AND REFERRAL SYSTEMS

The district hospital that served as the first point of contact with the healthcare system for Mr. Y is located in a rural Tanzania in a geographic area that encompasses 3,335 km² and borders on Lake Victoria. Its catchment area has a population of 501,915, and the hospital is 60 km from the nearest major referral hospital [14]. Sending a patient to the referral hospital for a higher level of care requires a minimum of 1.5 h and a 25-min ferry ride across Lake Victoria. There is no coordinated community-based pre-hospital care for the severely injured or ill.

Community-based care is a first step in the care of critically ill and injured patients. The lack of coordinated acute care referral systems that include pre-hospital care and transportation at the community level is the first bottleneck in the care of the acutely ill and injured in

Tanzania [15] and is critical to improving the delivery of care for these patients by leading to shorter pre-hospital times and quicker time to treatment [16]. The lack of pre-hospital care means that severely injured or ill patients often die prior to reaching the hospital or deteriorate en route. The Bellagio Essential Surgery Group, a group committed to raising international awareness to increase access to surgical services in resource-constrained settings in Sub-Saharan Africa, recommends improvements of systems for the delivery of trauma and acute care [17] as 1 of 4 key recommendations. They recommend improvement in pre-hospital care as the first step in this process, in addition to strengthening patient management, referral systems, and care at clinics and hospitals, as well as the removal of financial barriers to care. Improvements in pre-hospital care by training lay persons in the community in basic first aid for trauma can be achieved in developing countries [16,18]. These interventions have been shown to be efficacious and can be done in a cost-effective manner—approximately US\$3 per life-year saved [19].

As in the case of Mr. Y, a private vehicle is the most common method of emergency transportation of a critically ill or injured patient. These vehicles may be automobiles, trucks, police vehicles, minibuses, motorbikes known as “piki” or “boda,” or nonmotorized vehicles such as bicycle and carts. Ambulances are pre-positioned at several health centers in the district and at the district hospital. Ambulance transportation from the outlying health centers and dispensaries to the hospital is used for the transport of pregnant women in labor or other critically ill patients and is arranged via telephone with the district medical officer or their representative. Ambulances do not routinely go to the scene of a traumatic event or to the home of an ill person. Whereas ambulance services may be better suited to densely populated urban areas, they can still be cost effective and do save lives by performing pre-hospital care and hastening the time of arrival to definitive care [19]. However, their wider use in Tanzania is limited by their number, working order of the vehicles, and funds for maintenance and repair, in addition to the lack of a coordinated system for dispatch.

Cell phone service, even in rural areas, is ubiquitous throughout most of Tanzania, allowing for ease of communication. Although there are multiple M-health initiatives that use cell phones for health education, community health worker training, telemedicine [20], referral systems primarily for pregnant women [21], and community-based care [22], their use in the pre-health care facility environment for referral from the field has yet to be fully developed and is a potential avenue for intervention [23].

HUMAN RESOURCES

Mr. Y was evaluated in a casualty department staffed by a nurse and a CO and cared for in an ICU that was staffed by 2 nurses. The hospital, despite performing over 5,000 major operative cases a year with nearly 10,000 deliveries,

has no permanent surgical or medical specialist, no anesthesiologist, and no healthcare workers with formal specialty training in emergency or critical care. The hospital is understaffed by approximately 40% according to Ministry of Health and Social Welfare guidelines.

Lack of adequate human resources and their management—matching the number of qualified, trained personnel with appropriate skill sets to healthcare facility need, in-service training, professional development, and supervision in health facilities to provide critical care—is a challenge throughout Sub-Saharan Africa and Tanzania [17,19,24,25]. The World Health Organization states that healthcare workforce should be available, accessible, acceptable, and be of high quality [26]. However, deficiencies in 1 or all of these attributes contribute to the inadequacy of acute and critical care services provided in Tanzania [27]. The majority of countries in Sub-Saharan Africa fall below the minimum acceptable density set by the World Health Organization at 59.4 healthcare workers per 10,000. Tanzania and other countries have designed strategies to increase the number of healthcare workers across all cadres [28–30], but they have not kept up with the increase in population growth [27].

Tanzania, despite a concerted effort to increase the number of healthcare workers and specialists [28,29], has a significant deficit in human resources for health needed to provide critical care with only 0.26 and 0.079 medical doctors and medical specialists and 2.0 nurses/nurse midwives per 10,000 population, respectively [30]. In addition to the severe shortage of healthcare workers, there is a distribution problem whereby only 55% of all healthcare workers are located in rural areas, such as that where Mr. Y received his care, yet the rural population accounts for over 70% of the population [31].

In a study of emergency and critical care services in 10 hospitals in Tanzania, none of the hospitals had all of the staff who are involved in these services trained in triage, emergency, or critical care [10]. In-service training is also lacking [24]. In the Tanzania study, there were no anesthesiologists in any of the district or regional hospitals, and the average number of specialists in the district and regional hospitals was 5 [10]. A similar study found only 0.04 physician anesthesia providers per 100,000 population and only 0.15 anesthesia providers of any type per 100,000 populations in Tanzania [32].

The inadequate supply of healthcare workers across all cadres are the result of inadequate production numbers [33], inadequate educational infrastructure, and not enough experienced tutors to adequately train the numbers of healthcare workers required to meet demand [34]. There is also an outflow problem, as many healthcare professionals may leave the practice of medicine to seek higher paying jobs within their own country (internal brain drain) or may move to another country for similar reasons (external brain drain) [35]. The lack of trained healthcare professionals leads to inadequate staffing for casualty, theater, and ICU that results in high patient-to-nurse/

healthcare worker ratios [36]. This, in combination with lack of formal emergency and critical care training for nurses and other healthcare professionals that provide the bulk of care in district hospitals such as COs, AMOs, and anesthesiologists [6,10], contributes to the difficulty in provision of critical care services.

SUPPORT SERVICES

Mr. Y's example of resuscitation with crystalloid only despite severe traumatic injuries demonstrates the critical lack of essential support services available at the hospital that treated him. He was brought to theater with crystalloid resuscitation only due to the lack of blood in the blood bank. The hospital had the ability to type and cross-match blood and real-time donation from friends and family was required. This delayed his receiving blood until the operative case was well underway. The lack of blood in this setting led to larger volume resuscitation and the potential for respiratory complications and organ dysfunction. His renal function post-operatively was poor with low urine output and a creatinine level of 4.8 at the time of transfer to a referral hospital. Even though basic lab tests such as hemoglobin level, white blood cell count, and creatinine level and basic radiology were available, other tests that are useful in managing critically ill patients such as partial pressure of oxygen, lactate, and clotting studies were not available. This made assessment of resuscitation status difficult.

Support services such as medicine and equipment, labs, diagnostic radiology, blood banking, and nonmedical support staff are often lacking in hospitals in Sub-Saharan Africa [6–10]. Whereas the Tanzania Ministry of Health and Social Welfare has blood transfusion service policy guidelines, there are many challenges to its implementation including extremely limited availability and utilization of blood components, hospital-based donations, and reliance on family-based donations, as well as varying standards, increased demand due to burden of disease such as malaria and maternal disorders [37]. Medication stock outs and limited availability of functioning diagnostic radiology and other basic medical equipment is common in Tanzania and at this district hospital where recently one could not even obtain a hemoglobin level [38].

Ventilators and other equipment in the operating theater and ICU at the hospital, when available, are often older, outdated, or have been donated and no longer work due to inability to obtain parts, inappropriate design for an environment with erratic power supplies, and lack of biomedical engineering training and maintenance [6,8,9,39,40]. Oxygen supply is variable and challenging and is provided by oxygen concentrators that are expensive but easy to maintain [6,8,36]. Mr. Y underwent halothane anesthesia as this and ether are the only inhaled anesthetic agents available at the district hospital. Muscle relaxants are rarely available and the most common agent available for sedation is valium. He was extubated prior to transfer to

the ICU due to lack of availability of ventilators and trained staff to manage them.

Basic equipment such as pulse oximeters are available in only 57% of district and regional hospitals surveyed in Tanzania, and oral airways were available in only 43% [10]. Whereas most hospitals, such as this hospital, have basic diagnostic x-ray and ultrasonography, transfer of a critically ill patient for these investigations may be required when machines are broken or there are stock outs of associated supplies [9,35].

Support services are particularly important when it comes to implementation of care for sepsis [3,4,9]. In a self-reported survey about the availability of critical care resources to treat patients with severe sepsis or septic shock, only 23% of respondents from African countries said that invasive blood pressure monitoring was always available, 33.9% always had central venous pressure monitoring, 25.7% were always able to measure lactate, and <40% always had peritoneal dialysis [9]. Given Mr. Y's hypotension on presentation and delay in resuscitation as well as his bowel injuries and grossly contaminated wounds, sepsis would be common sequelae in this scenario. His clinical picture of inadequate urine output and blood pressure that was inappropriately low despite volume resuscitation as well as a rising creatinine level were all suggestive of sepsis. However, no invasive blood pressure or central venous pressure monitoring or lactate levels were available to guide resuscitation. Thus careful attention was made to pulse oximetry measurements, routine vital signs, and clinical assessment. He was treated empirically with antibiotics for sepsis.

INFRASTRUCTURE

Lack of a reliable, 24-h supply of electricity and water are among of the major challenges to providing critical care services in Africa [6,24,28]. Only 34% of hospitals in Sub-Saharan Africa that are electrified have a reliable electricity source [40], and only 22% of hospitals in Tanzania have been shown to have the basic infrastructure necessary to provide emergency and surgical care [24]. The lack of a reliable electricity supply is even more urgent when oxygen concentrators are in use and power surges can damage monitoring equipment and ventilators. The district hospital has backup solar power and a generator, which are often in use due to inadequate electrical supplies. The backup power supplies only the lab, operating theater, and ICU in order to maintain functioning of ventilators and monitoring and laboratory equipment.

The hospital does not have an improved water source and is often without an adequate supply of water in the dry season. Water is needed for sanitation and sterilization, and the lack of water or a clean water supply can lead to infection control problems [41]. There are no current statistics on post-operative wound infections or healthcare-associated infections at the hospital, and microbiologic testing is unavailable.

SUMMARY

After 2 days, Mr. Y was transferred to the referral hospital where he underwent a second-look laparotomy with resection of further compromised intestine. He continued to deteriorate clinically with worsening renal function, hypotension, and apparent sepsis and died on the third referral hospital day.

This case exemplifies the challenges of providing emergency and critical care services in a rural, resource-challenged setting in Tanzania. Transportation to the hospital was provided by untrained community members. Therefore, the patient had no pre-hospital care. The lack of a coordinated transportation system led to a delay in presentation and resuscitation. Upon arrival, his first point of care was a triage casualty room with minimal resources and medical personnel with no formal training in emergency care. No blood was available, and it had to be obtained from a community member, further delaying appropriate resuscitation. Upon arrival in the operating theater, care was provided by an anesthetist as no anesthesiologist was available at the hospital and the surgeon was involved in another case. Intraoperative hypotension was managed by using the lowest levels of anesthetic possible due to the lack of pressor agents and colloid for resuscitation. He was extubated at the end of the case due to lack of ability to care for ventilated patients in the ICU. ICU management was limited to fluid resuscitation as no pressors were available, and no invasive monitoring was available. Transport to a higher level of care was delayed due to the geography of the area, instability of the patient, and the need for transport from a remote hospital that would require a long trip involving a ferry ride across a lake.

Despite these challenges, he received the best care available given the resources. Basic lab and radiology services, pulse oximetry, urine output monitoring intravenous antibiotics, pain medications, and fluids were all available. Two nurses were on staff in the 8- to 10-bed ICU 24 h a day, and 24-h surgical specialist care with multiple ICU rounds per day were available during this time. Good communication occurred between practitioners at the referring hospital and the referral hospital and the patient was able to be transferred to the referral hospital 2 days later.

The use of guidelines for triage, resuscitation, and management of critically ill patients has been shown to be severely lacking in hospitals in Tanzania [10]. However, there is an important role for implementing such guidelines. Even though Mr. Y. ultimately succumbed to his injuries, his case illustrates that the application of basic principles of resuscitation and surgical and critical care management can be applied in a limited resource setting, and it underscores the need for basic emergency and critical care training, improved resources, and continued quality improvement to enhance care.

REFERENCES

- Lozano R, Naghavi M, Foreman K, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012;380:2095–128.
- Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Med* 2006;3:e442.
- Jacob ST, Lim M, Banura P, et al. Integrating sepsis management recommendations into clinical care guidelines for district hospitals in resource-limited settings: the necessity to augment new guidelines with future research. *BMC Med* 2013;12:1107.
- Dunser MW, Festics E, Dondorp A, et al., for the Global Intensive Care Working Group of European Society of Intensive Care Med. Recommendations for sepsis management in resource-limited settings. *Intensive Care Med* 2012;38:557–74.
- Tomlinson J, Haac B, Kadyaudzu, et al. The burden of surgical diseases on care services at a tertiary hospital in sub-Saharan Africa. *Trop Doct* 2013;43:27–9.
- Towey RM, Ojara S. Intensive care in the developing world. *Anaesthesia* 2007;62(Suppl 1):32–7.
- Towey RM, Ojara S. Practice of intensive care in rural Africa: an assessment of data from Northern Uganda. *Afr Health Sci* 2008;8:61–4.
- Fowler RA, Adhikari NK, Bhagwanjee S. Clinical review: critical care in the global context—disparities in burden of illness, access, and economics. *Crit Care* 2008;12:225.
- Baelani I, Jochberger S, Laimer T, et al. Availability of critical care resources to treat patients with severe sepsis or septic shock in Africa: a self-reported, continent-wide survey of anaesthesia providers. *Crit Care* 2011;15:R10.
- Baker T, Lugazia E, Eriksen J, et al. Emergency and critical care services in Tanzania: a survey of ten hospitals. *BMC Health Serv Res* 2013;13:140.
- Reynolds TA, Mfinanga JA, Sawe HR, Runyon MS, Mwafongo V. Emergency care capacity in Africa: a clinical and educational initiative in Tanzania. *J Public Health Policy* 2012;33(Suppl 1):S126–37.
- Tanzania National Bureau of Statistics. Tanzania in Figures 2012. Available at: www.nbs.go.tz/nbs/takwimu/references/Tanzania_in_figures2012.pdf. Accessed August 1, 2014.
- National Bureau of Statistics, Ministry of Finance. Statistical Abstract 2012. June 2013. Available at: <http://www.nbs.go.tz/Stastical%20Abstract/Statistical%20Abstract%20Report%202012.pdf>. Accessed August 1, 2014.
- Msekela JA. Socioeconomic Profile of Mwanza Region. May 30, 2008. Available at: http://www.mwanza.go.tz/kurasa/habari_mpya/SOCIO%20ECONOMIC%20PROFILE%20OF%20MWANZA%20REGION.pdf. Accessed August 1, 2014.
- Chalya PL, Dass RM, Mchembe MD, et al. Citywide trauma experience in Mwanza, Tanzania: a need for urgent intervention. *J Trauma Manag Outcomes* 2013;7:9.
- Mock CN, Tiska M, Adu-Ampofo M, Boakye G. Improvements in prehospital trauma care in an African country with no formal emergency medicine services. *J Trauma* 2002;53:90–7.
- Luboga S, Macfarlane SB, von Schreeb J, et al., for the Bellagio Essential Surgery Group. Increasing access to surgical services in Sub-Saharan Africa: priorities for national and international agencies recommended by the Bellagio Essential Surgery Group. *PLoS Med* 2009;6:e1000200.
- Tiska MA, Adu-Ampofo M, Boakye G, Tuuli L, Mock CN. A model of prehospital trauma training for lay persons devised in Africa. *Emerg Med J* 2004;21:237–9.
- Kobusingye OC, Hyder AA, Bishai D, et al. Emergency medical services. In: Jamison DT, editor. *Disease Control Priorities in Developing Countries*. Washington, DC: World Bank; 2006. p. 1261–79.
- Shout-Africa. Tanzania: Cell Phones Saving Lives in Tanzania. May 5, 2011. Available at: <http://www.shout-africa.com/health-lifestyle/tanzania-cell-phones-saving-lives-in-tanzania/>. Accessed August 1, 2014.
- United Nations Population Fund. Tanzania's Global First in Using Mobile Phones in National Health System. May 11, 2012. Available at: <http://africa.unfpa.org/public/news/pid/10714>. Accessed August 1, 2014.
- Pathfinder International: mHealth in Tanzania: Improving Delivery and Quality of Community Home-Based Care. Available at: <http://www.pathfinder.org/our-work/projects/mhealth-in-tanzania.html>. Accessed August 1, 2014.
- United Republic of Tanzania Ministry of Health and Social Welfare. Tanzania National eHealth Strategy 2012–2018. May 21, 2013. Available at: http://www.who.int/goe/policies/countries/tza_ehealth.pdf. Accessed August 1, 2014.
- Hsia RY, Mbembati NA, Macfarlane S, Kruk ME. Access to emergency and surgical care in sub-Saharan Africa: the infrastructure gap. *Health Policy Plan* 2012;27:234–44.
- Calvello E, Reynolds T, Hirshon JM, et al. Emergency care in sub-Saharan Africa: results of a consensus conference. *Afr J Emerg Med* 2013;3:42–8.
- Global Health Workforce Alliance, World Health Organization. A Universal Truth: No Health Without a Workforce. November 2013. Available at: <http://www.who.int/workforcealliance/knowledge/resources/hrhreport2013/en/>. Accessed August 1, 2014.
- Manzi F, Schellenburg JA, Hutton G, et al. Human resources for healthcare delivery in Tanzania: a multifaceted problem. *Hum Resour Health* 2012;10:3.
- Tanzania Ministry of Health and Social Welfare. Human Resources for Health Strategic Plan 2008–2013: Health Worker Initiative. Available at: [http://www.ih.eprints.org/798/1/MoHSW.pdf_\(23\).pdf](http://www.ih.eprints.org/798/1/MoHSW.pdf_(23).pdf). Accessed October 13, 2014.
- United Republic of Tanzania. United Republic of Tanzania Health Sector Strategic Plan III: Partnerships for delivering the MDG's. July 2009–June 2015. Available at: <http://www.mamaye.org/en/evidence/tanzania-health-sector-strategic-plan-iii-july-2009-%E2%80%93june-2015>. Accessed October 13, 2014.
- HRH Consortium. Human Resources for Health Program Rwanda. Available at: www.hrhconsortium.moh.gov.rw/. Accessed August 1, 2014.
- United Republic of Tanzania Ministry of Health and Social Welfare. Human Resource for Health Country Profile 2012/2013. July 2013. Available at: http://www.tzdp.org.tz/fileadmin/documents/dpg_internal/dpg_working_groups_clusters/cluster_2/health/Key_Sector_Documents/HRH_Documents/Final_Country_Profile_2013.pdf. Accessed August 1, 2014.
- Dubowitz G, Detlefs S, McQueen KA. Global anesthesia workforce crisis: a preliminary survey revealing shortages contributing to undesirable outcomes and unsafe practices. *World J Surg* 2010;34:438–44.
- McPake B, Maedo A, Araujo EC, Lemiere C, el Maghraby A, Cometto G. Why do health market forces matter? *Bull World Health Organ* 2013;91:841–6.
- World Health Organization. Policy Brief on Faculty Development: Transforming and Scaling Up Health Professional Education and Training. Geneva, Switzerland: World Health Organization; 2013.
- Siyam A, Zurn P, Ro OC, et al. Monitoring the implementation of the WHO Global Code of Practice on the International Recruitment of Health Personnel. *Bull World Health Organ* 2013;91:816–23.
- Dunser MW, Baelani I, Ganbold L. A review and analysis of intensive care medicine in the least developed countries. *Crit Care Med* 2006;34:1234–42.
- United Republic of Tanzania Ministry of Health and Social Welfare. Tanzania National Transfusion Service Policy Guidelines. November 12, 2012. Available at: <http://ih.eprints.org/817/>. Accessed August 1, 2014.
- United Republic of Tanzania Ministry of Health and Social Welfare. Tanzania Service Availability Mapping 2005–2006. November 27, 2012. Available at: <http://ih.eprints.org/785/>. Accessed August 1, 2014.
- Okafor UV. Challenges in critical care services in Sub-Saharan Africa: perspectives from Nigeria. *Indian J Crit Care Med* 2009;13:25–7.
- Adair-Rohani H, Zukor K, Bonjour S, et al. Limited electricity access in health facilities in sub-Saharan Africa: a systematic review of data on electricity access, sources and reliability. *Glob Health Sci Pract* 2013;1:249–61. Available at: <http://www.ghspjournal.org/content/1/2/249.full.pdf+html>. Accessed October 13, 2014.
- Basnet S, Adhikari N, Koirala J. Challenges in setting up a pediatric and neonatal intensive care units in a resource-limited country. *Pediatrics* 2011;128:e986–92.