



Building neurosurgical capacity in low and middle income countries



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ABSTRACT

Neurosurgery capacity in low- and middle-income countries is far from adequate; yet burden of neurological diseases, especially neuro-trauma, is projected to increase exponentially. Previous efforts to build neurosurgical capacity have typically been individual projects and short-term missions. Recognizing the dual needs of addressing disease burden and building sustainable, long-term neurosurgical care capacity, we describe in this paper an ongoing collaboration between the Mulago Hospital Department of Neurosurgery (Kampala, Uganda) and Duke University Medical Center (Durham, NC, USA) as a replicable model to meet the dual needs. The collaboration employs a threefold approach to building capacity: technology, twinning, and training performed together in a top-down approach. Also described are lessons learned to date by Duke Global Neurosurgery and Neurosciences (DGNN) and applicability beyond Kampala.

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1. Introduction

Building capacity in low- and middle-income countries (LMIC) has proven difficult [1], especially in the more complex subspecialties, such as neurosurgery [2,3]. In Africa, there are approximately 565 neurosurgeons for the entire continent (Fig. 1). The ratio of neurosurgeons to population is complex with a bimodal distribution. The majority of the neurosurgeons are concentrated in just several countries with the remaining neurosurgeons spread out for the majority of the entire continent [4,5]. Of the 565 neurosurgeons in Africa in 2007, 485 were in northern Africa (Egypt, Morocco, Algeria, and Tunisia) and South Africa, which results in a neurosurgeon: inhabitant ratio of 1:358,000. However, in East Africa only 27 neurosurgeons were available to treat 270 million people, a 1:10 million ratio of neurosurgeon to inhabitants. Many countries do not even have one neurosurgeon.

A closer look at two countries of similar size, Uganda and Morocco demonstrates the real dilemma. Morocco with 32 million people has 171 neurosurgeons, a ratio of 1:187,000, which is not vastly different than the United States ratio of approximately 1:65,580 [6]. In Uganda, there are only 6 neurosurgeons for 33 million people, a ratio of 1:5,500,000. This is inadequate to cover the much needed emergency procedures, let alone the necessary elective surgeries to relieve the suffering of the pediatric and adult patients with neurological disorders amenable to surgery. As of 2009 Uganda had no training centers

compared with Morocco that had 6 training programs [7]. The real question then centers on how a LMIC with lack of significant resources and a significant health care workforce shortage for routine medical can even attempt to develop more complex surgical capacity. The increases in population, trauma and road traffic accidents in nearly all LMICs [1,5,8, 9] leave people in need without any chance of meaningful treatment unless neurosurgical capacity can be increased.

2. Potential solution to building capacity

Over the last eight years, the Duke Neurosurgery Program has taken a threefold approach to developing neurosurgical capacity in Uganda. The approach includes technology, twinning, and training. The technology component is focused on building the technological capabilities to properly perform neurosurgery, provide safe anesthesia, and then recovery room, intensive care unit and general ward care that will allow patients to recover to the best of their ability after their neurosurgical procedure and the biomedical expertise to service and repair the equipment. The twinning relies on developing a collaborative effort between a developed academic medical center, Duke University Health System, and the LMIC Neurosurgery Department at Uganda's national referral hospital, Mulago Hospital [10]. The Training component moves beyond surgical camps to a residency-training program. Training of all health care professionals through surgical camps is inadequate to meet the burden of disease. The shortage can only be met by developing a neurosurgery-training program that trains Ugandan surgeons in the neurosurgical subspecialty. Finally, the overarching theme and backdrop of this threefold approach is the concept of "Together and Top

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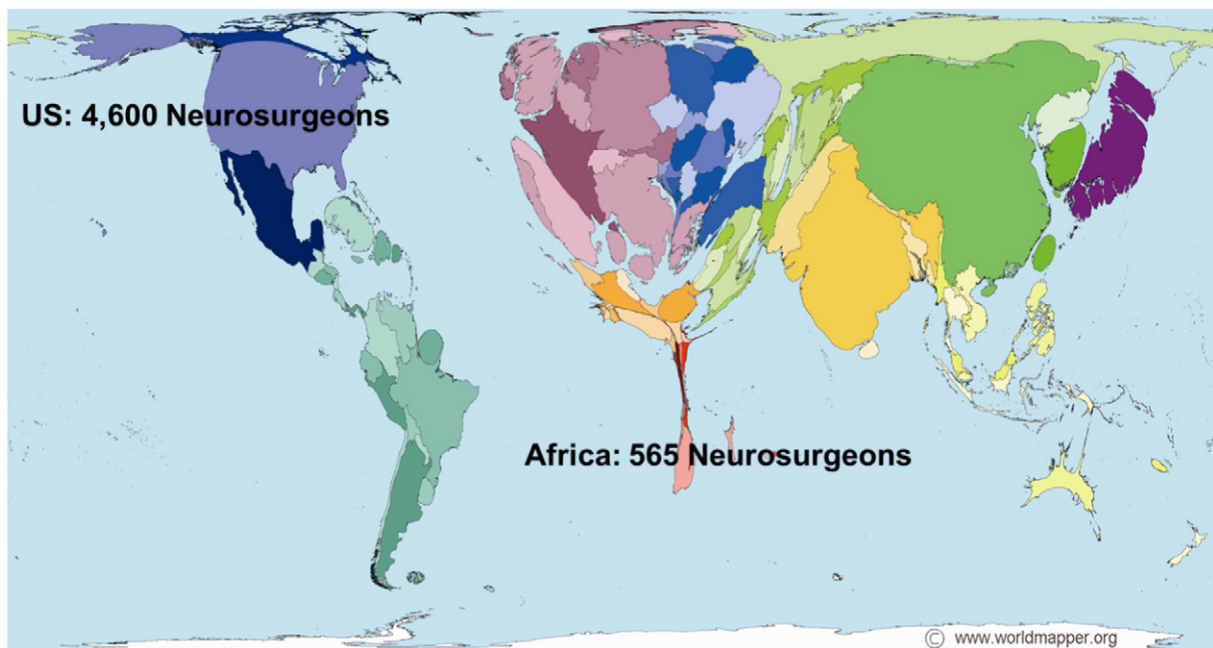


Fig. 1. Global distribution of physicians. [Sourced from World Mapper] Note the significant deficiency in central and eastern Africa, which is reflected in the lack of neurosurgeons in Africa compared to North America.

Down”: neurosurgery can be one of the first subspecialties developed not the last and the proof of concept will be that if complex neurosurgical operations can be performed safely then all the other surgical specialties will benefit.

2.1. Technology

Technology available for surgery at most LMIC hospitals, including the larger national referral hospitals, is less than ideal. Other investigators have used just the presence of a pulse oximeter as a proxy measure that the basic needs of an adequate operating room have been met [11, 12,13]. Many LMIC hospitals lack fundamental needs like electricity and water, but this was not the case at Mulago Hospital in Kampala [14]. However, Mulago Hospital had serious technology deficits with zero ventilators and no monitoring equipment in their operating rooms. Of their five operating rooms, several were still using ether in 2007. The Duke University Health System developed a program called Duke Global Health PLUS (Placement of Life-giving Useable Surplus). The Duke Global Health PLUS program stopped the previous system of new equipment being depreciated by Duke University and then sent to a surplus warehouse where liquidators would buy the sometimes two- and three-year-old equipment for pennies on the dollar. The liquidators would then typically increase the price dramatically and sell to United States veterinary clinics or to LMIC hospitals. The new program allowed the equipment to be evaluated by biomedical engineers for their worthiness to withstand the rigors of LMIC environments and then the equipment was set aside for Duke faculty projects in LMICs.

In the first year, 2007, the Duke Global Health Program delivered to Mulago Hospital 1400 pieces of equipment worth over 1,200,000 USD. This equipment refurbished the five Mulago operating rooms, a six-bed recovery room, and eight intensive care unit beds. The operating rooms were completely transformed with microscopes, anesthesia machines, monitoring equipment, drills, bipolar cautery, and plating systems for affixing bone flaps to the skull. The recovery room was converted from five trolleys with essentially no medical equipment to a room with proper beds, monitoring equipment and proper transport monitors. The Intensive Care Unit gained proper monitoring equipment, intravenous pumps, and intracranial pressure monitors. Over the last eight years the Duke Global Health PLUS program has now delivered

more than 61 t of equipment worth over 8,000,000 USD. However, all the equipment and technology are doomed to failure without proper biomedical maintenance and repair.

From 2007 to 2015, several biomedical engineers have been sent to training courses in Africa and now Mulago’s Neurosurgery Department has their own dedicated biomedical engineer. The Duke bioengineers who are critical members of the “twinning” program have worked with the LMIC biomedical engineers to train them in equipment maintenance, repair, and diagnostic problem solving. The relationship between the biomedical engineers from Duke and Uganda allows for constant interaction to keep the equipment maintained and in proper working order to allow the neurosurgeons and anesthesiology teams to work together to build capacity.

2.2. Twinning

Two common approaches to twinning have included a single surgeon visiting a facility and teaching and working with local surgeons or a surgical camp being performed but not providing in-depth training to be left for the local surgeons to perform once the developed country surgeons leave [15]. Single surgeon visit can have great benefit at times [16]. Surgical camps with multidisciplinary teams on the other hand can benefit those receiving the critical care at the camp; however, capacity building is limited and there is an increased dependence of the LMIC to wait for the surgical team to return [15,17]. The twinning concept emphasizes training not only the surgeons but also everyone in the health care delivery and maintenance of the technology. Twinning applies to working with the LMIC neurosurgeons, anesthesiologists, nurse anesthetists, operating room, recovery room, intensive care unit and general ward nurses, and biomedical engineers during the week long surgical camps. The goal is to work side by side throughout the week, “Together,” with educational and training courses at the beginning of the camp and gradual transition of care during the surgeries and pre- and post-operative care from the developed country health care workers to the LMIC surgeons, nurses, and biomedical engineers.

During a two-year period before the Duke Program was initiated the Uganda neurosurgeons performed 125 cases (57 cases in FY06 and 68 cases in FY07). After the program was instituted the Ugandan neurosurgeons accomplished 392 procedures in two years (187 cases in FY08

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