



Review of Neurosurgery in the Democratic Republic of Congo: Historical Approach of a Local Context

Tshibambe N. Tshimbombu¹, Antoine Beltchika Kalubye², Caitlin Hoffman³, John H. Kanter⁴, Gail Rosseau⁵, Daniel Safari Nteranya⁶, Arsene Daniel Nyalundja⁷, Jean-Pierre Kalala Okito⁸

Key words

- Democratic Republic of the Congo
- Health care resources
- International community
- Key actors
- Neurosurgery
- Workforce neurosurgeons

Abbreviations and Acronyms

DRC: The Democratic Republic of Congo

KUC: Kinshasa University Clinic

LMICs: Low-and-middle income countries

NPPC: Neuro-psycho pathology center

SSA: Sub-Saharan Africa

WFNS: The World Federation of Neurosurgical Societies

From the ¹Dartmouth Geisel School of Medicine, Hanover, New Hampshire, USA; ²Clinique Universitaire, Université de Kinshasa, Faculté de Médecine, Democratic Republic of Congo; ³Department of Neurological Surgery, New York-Presbyterian Hospital, Weill Cornell Medical College, New York, New York; ⁴Section of Neurosurgery, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire; ⁵George Washington University School of Medicine and Health Sciences, Washington, DC, USA; ⁶Surgery Department, Official University of Bukavu, University Clinics of Bukavu, Democratic Republic of Congo; ⁷Center for Tropical Diseases and Global Health, Faculty of Medicine, Université Catholique de Bukavu, Democratic Republic of Congo; and ⁸Department of Neurosurgery, Ghent University Hospital, Ghent, Belgium

To whom correspondence should be addressed:

Tshibambe N. Tshimbombu, B.A.

[E-mail: tnt.med@dartmouth.edu; John.h.kanter@hitchcock.org]

Citation: *World Neurosurg.* (2022) 167:81-88.

<https://doi.org/10.1016/j.wneu.2022.07.113>

Journal homepage: www.journals.elsevier.com/world-neurosurgery

Available online: www.sciencedirect.com

1878-8750/\$ - see front matter © 2022 Elsevier Inc. All rights reserved.

INTRODUCTION

Nearly 93% of the population in Sub-Saharan Africa (SSA) does not have access to safe, effective, timely, and basic surgical care.¹ Access to specialty surgical services, such as neurosurgery, is particularly limited.^{2,3} Due to a complex array of historical, political, social, and economic factors, the Democratic

Neurosurgical practice in the Democratic Republic of Congo (DRC) is challenged by limited resources and infrastructure. The DRC has 16 local residing neurosurgeons for 95 million inhabitants, a ratio of 1 neurosurgeon per 5.9 million Congolese citizens. This is attributable to decades of political unrest and a loosely regulated health care system. Understanding the role of neurosurgery in a historical context is necessary to appreciate and overcome current challenges in the delivery of neurosurgical care. We describe past and present political, social, and economic challenges surrounding the development of neurosurgical practice and training. Highlights of early innovators, current challenges, and a suggested framework to guide future advances in neurosurgical practice are provided. Interviews with Dr. Antoine Beltchika Kalubye, the oldest living neurosurgeon in the DRC, and Dr. Jean-Pierre Kalala Okito, current president of the Congolese Society of Neurosurgery, provide a detailed account of events. Firsthand narrative was supplemented via literature review and collaboration with registrars in the DRC to review current neurosurgery programs. Our discussions revealed that decades of political unrest and inconsistent management of health care resources are responsible for the current state of healthcare, including the dearth of local neurosurgeons. The neurosurgery workforce deficit in the DRC remains substantial. It is essential to understand local neurosurgical history, in its present state and breadth of challenges, to inform future development of neurosurgical care and to secure equitable partnerships between local stakeholders and the international community.

Republic of Congo (DRC), one of the countries in SSA, serves as an excellent example of the challenges faced in addressing the local burden of neurosurgical disease, evaluating pertinent needs, and establishing initiatives to augment neurosurgical capacity and strengthen health systems.^{4,5}

Global neurosurgery is an emerging field that seeks to address global health care disparities in low- and middle-income countries (LMICs) by applying strategies from public health to increase capacity for neurosurgical care.^{2,6,7} This article seeks to characterize the state of neurosurgery in the DRC while highlighting past and current challenges. First, we present the history from colonial times to the present day of the DRC, a country whose health care delivery system experiences challenges that are unique to this nation, yet

thematically like those in other LMICs within SSA. We provide accounts of the early challenges experienced by 4 physicians instrumental in the development of neurosurgery in the DRC. Our report concludes with a characterization of the current state of neurosurgery in the DRC and presents possible opportunities for future advancement of global neurosurgical initiatives.

BACKGROUND

The DRC is the second-largest African country situated in the African Great Lakes region of Sub-Saharan Africa, with just more than 95 million inhabitants from 250 ethnic groups. The DRC is rich in natural resources, with deposits of raw minerals estimated to be worth more than \$24 trillion.⁸ Despite these assets, the country

has been a theater of political unrest and home to the world's poorest people.

In 1885, the DRC was recognized as the Congo Free State, the private land of King Leopold II of Belgium. He transferred control to the Belgian parliament in 1908 and the colony was renamed the Belgian Congo. Throughout the colonial era, endemic infections such as malaria and dysentery were problematic, as no knowledge existed of pathogenesis nor transmission. Belgian leadership sought to create a health care system and to train medical personnel to combat infections. In 1920, the Medical Foundation of the University of Leuven in Congo was built with the goal of providing informal apprenticeships to Congolese citizens as medical assistants and nurses (Figures 1 and 2).⁹⁻¹¹ Formal medical training was introduced in 1954 with the first Belgian Congo university, called Lovanium (Figure 3), and its associated teaching hospital, Kinshasa University Clinic (KUC).^{11,12} Initially, only Belgian citizens were admitted into the medical degree program. These events led to the introduction of new health care practices, including modern biomedical surgery, which replaced *African surgery*, “a cutting ritual for purification which involved making small incisions on patients for the ritual removal of offending objects which ranged from stones or dried spiders to live worms.”¹³



Figure 1. School of Medical Assistants founded by the Medical Foundation of the University of Leuven to train Congolese Citizens as medical assistants and nurses.

Events in 1960, known as “the year of Africa,” were transformational, as 17 African countries, including the Belgian Congo, became independent.¹⁴ The Belgian Congo was renamed the DRC. These newly independent countries lacked adequate preparation to assume control of their lands. An agreement was reached for a progressive withdrawal of Belgians to ensure basic medical training for Congolese. Several violent insurrections forced Belgians, including doctors, to depart prematurely, stripping medical clinics of human, material, and financial resources. The Congolese government allowed the previously trained Congolese medical assistants and nurses to complete a 3- to 5-year medical degree curriculum at Lovanium under the guidance of the remaining Belgian doctors.¹⁰ This process proved slow and extremely challenging, as the Belgian physicians lost their incentive to preserve their previous level of commitment.

From 1965 to the present, the DRC has endured years of internal battle for leadership, resulting in several changes of the head of state, economic instability, and political unrest. In the process, the country's name changed twice. It became Zaire in 1971 and the University of Lovanium became the University of Zaire. Then, in 2001, the DRC was reinstated, and the University of Zaire became the University of Kinshasa.

Postcolonial political unrest, combined with severe unpreparedness and internal conflicts created substantial challenges for the healthcare system. The previously high-quality health care system established by Belgians declined rapidly, leading to the withdrawal of investors. The result was the collapse of the DRC's health care system and the creation of a humanitarian disaster.

Common Neurosurgical Ailments

The epidemiologic incidence and prevalence of neurosurgical cases in the DRC was first reported in 1977, by Dr. Shako Djunga, the first Congolese neurosurgeon, who trained in Belgium. Cranial cases were more common (60%), and the most frequently encountered pathologies reported were head trauma (34.5%), congenital disorders (13.4%), and spinal infection (12.7%).^{15,16} Current neurosurgical pathologies are not well reported, and data come from the experience of practicing neurosurgeons through personal communications with Dr. Beltchika Kalubye between April and July 2022. Pathologies are primarily spinal and less commonly cranial. The decrease in the rate of cranial cases has been due to lack of adequate surgical materials needed for cranial operations and the shortage of intensive care units.

Among spine surgeries, the most common indication for surgical management involves herniated intervertebral disc and spinal trauma. Other indications include repair of myelomeningocele, resection of spinal tumors, and cervical spondylosis. The common cranial operations include repair of skull fractures and evacuations of hematomas in traumatic brain injury. Other cranial diagnoses include cerebral malformations and intracranial infections. The most common primary brain neoplasms are glioblastoma, meningioma, and pituitary adenoma. Also, vascular pathologies, including aneurysms, are frequent, but the diagnosis continues to be a challenge due to lack of experience with vascular diagnostic studies and pathology.

Neurosurgical Equipment

Neuroimaging has a significant role in the diagnosis and management of neurosurgical and neurologic diseases. Although there has been an increase in the number



Figure 2. Training of Congolese Citizens as medical assistants and nurses at the School of Medical Assistants.

of Congolese neurosurgeons, there is still a need to establish adequate infrastructure, including sustainable access to neuroimaging nationwide. Unfortunately, there is an uneven distribution of imaging resources, with the northern zones, in particular, lacking access (Table 1). Specialized neurosurgical operating equipment, such as microinstruments and operating microscopes, as well other equipment, including head clamps and endoscopes, are currently only available in the western zone. This presents a serious challenge to public health because not all patients with emergent neurosurgical injuries requiring

immediate surgery can survive while waiting for transportation to the nearest equipped neurosurgical zone. Thus, there is a need for imaging and neurosurgical equipment in all zones to increase access to care and ultimately lower the preventable mortality rate from treatable neurosurgical disease.

Health Care and Key Actors

From the postcolonial era to now, the DRC's public health sector remains loosely regulated. Elements that have contributed to this dysfunction include recurrent wars stemming from an unstable political system, the inefficient and

disproportionate management of humanitarian aid, and the duplication and waste in the allocation of resources.¹⁷ Health financing is almost totally dependent on a fee-for-service system and on humanitarian assistance. In addition to a few private sectors and nongovernmental organizations, active participants include the United States, the European Union, the Global Fund to Fight AIDS, Tuberculosis and Malaria, and United Nations Agencies, including the Central Emergency Response Fund, United Nations Population Fund, United Nations Sustainable Development Group, United Nations Development Program, United Nations Children's Fund, World Health Organization, and the United States Agency for International Development.¹⁷ In addition, the DRC has access to loans from the World Bank, the International Monetary Fund, Global Financing Facility, and the African Development Bank.¹⁷

Despite access to funding, there is significant mismanagement, due to multiple local and international steering committees/organizations. Many committees directly fund health care projects designed by local agencies, which are duplicated by other local agencies, and funded, nonetheless. This redundancy has generated high management costs and imbalanced distribution of resources.¹⁷ Projects receiving funding primarily focus on infectious diseases, women, and children; surgical capacity building is disproportionately underfunded.¹⁷ As a result, surgical care in the DRC lacks proper infrastructure, equipment, and personnel to deliver the desired level of care. There have been efforts to increase the number of Congolese surgeons trained, but efforts to ensure adequate infrastructure and equipment are lacking. Thus, solutions are needed to help improve the DRC's health care system.

Early Neurosurgical Workforce and Facilities

Neurosurgery in the DRC survived its early years, with general credit attributed to the efforts, brilliance, determination, and dedication of 4 doctors, specifically Richard Werth, Shako Djunga, Guy DeChef, and Beltchika Kalubye. They were forced to be self-reliant and develop



Figure 3. Earliest picture of Lovanium, pre-independence.

Table 1. Current Available Imaging in All Four Zones in the DRC

Imaging	North Zone (Kisangani)	South Zone (Lubumbashi)	East Zone (Bukavu)	West Zone (Kinshasa)
CT	0	6	3	16
MRI	0	0	2	6
Conventional Angiography	0	0	0	1

DRC, Democratic Republic of Congo; CT, computed tomography; MRI, magnetic resonance imaging.

creative responses to demands while working with limited resources.

Catholic University of Leuven: Dr. Richard Werth. Dr. Werth was a Belgian physician who obtained his medical degree at the Catholic University of Leuven in Belgium and completed specialty training in otolaryngology. After the DRC's independence, he became dean of Lovanium School of Medicine from 1964 to 1971. His goals included training Congolese medical assistants, improving the quality of teaching and medical care, and integrating teaching with biomedical research.¹⁵

In 1969, after consultation with the senior members of the department of surgery, Dr. Werth made known his strong desire to introduce neurosurgery to the DRC.¹⁵ Objections were raised, including that the subspecialty was a luxury for a developing country without adequate resources required to ensure delivery of quality care. He insisted that neurosurgical cases were to be expected, as they were initially handled by Belgian general surgeons. Dr. Werth was committed to promoting the curiosity and potential of Congolese as future physicians.¹⁵ Although much of Dr. Werth's personal and academic life remains unknown to the current medical community, the first Congolese neurosurgeon, Dr. Djunga, reported that "the development of neurosurgery in the DRC lies on the foundations laid by Dr. Werth's perceptive."¹⁵ Such perspective entailed training local physicians in neurosurgery to build a boots-on-the-ground workforce and mentorship structure.

Lovanium School of Medicine: Dr. Antoine Shako Hiango Omokanda Djunga. Dr. Djunga earned his medical degree from

the Free University of Brussels in 1967 and trained at KUC in Lovanium as an assistant surgeon. He became interested in neurosurgery when Dr. Werth expressed the need to introduce the field in the DRC. He benefited from Dr. Werth's mentorship and connections to obtain a grant to train in neurosurgery at the Free University of Brussels. The training in Brussels provided an additional opportunity for a fellowship in the United States at New York University, Bellevue Medical Center. After completing his training in 1971, he returned to Zaire as the first Zairian neurosurgeon.^{15,16}

Upon his return, Dr. Djunga reported being frequently frustrated by the lack of appropriate equipment.¹⁵ He relied on his contacts from Brussels and New York to acquire even the consumables needed to carry out surgeries such as craniotomies.¹⁵ At the end of 1973, he advocated for the construction of surgical suites at KUC capable of accommodating both general and neurosurgical procedures.^{15,16} Although this was a great accomplishment, he began to advocate for the construction of an independent neurosurgery hospital. Such a goal remained only a blueprint due to financial constraints.¹⁵

Despite limitations, he remained an avid mentor and advocate. To ensure sustainability, he helped his mentee, Dr. Beltchika Kalubye, to obtain a grant to train in Neurosurgery in Toulouse, France. Moreover, he continued his advocacy by supporting a project led by his colleague, Guy Dechef, for the construction of an independent neuro-psycho-pathology center (NPPC). However, his work ended prematurely in March of 1986. He died while preparing a thesis in Belgium, leaving a void in neurosurgery in Zaire and

the continent of Africa.¹⁶ His mentorship, leadership, and collaboration have laid the foundation of neurosurgery on which his mentee built and sustained.

Catholic University of Leuven: Dr. Guy Dechef. Dr. Dechef obtained his medical and psychology degrees from 1953 to 1958 at the Catholic University of Leuven.¹⁸ After graduation, he specialized in neuropsychiatry at both Lovanium and Leuven from 1959 to 1964. He worked at KUC as the section chief of neuropsychiatry.¹⁸

Dr. Dechef, although not a neurosurgeon, was as strong of an advocate for the specialty as Dr. Djunga. They were both eager to bring change in their respective fields. The neuropsychiatry unit at KUC was underequipped and lacked an inpatient unit. Admitted patients were housed in Mount Stanley Psychiatric Institute, an underequipped psychiatric facility near the residence of President Mobutu. In 1967, President Mobutu relocated patients to the hospital in Kinkole, another ill-equipped facility located 20 km from Kinshasa, to build a facility to host the Organization of African Unity summit.¹⁹ This event led Dr. Guy Dechef to facilitate successful negotiations and funding to build the first NPPC. Dechef's plan was inspired by his visit to the Henri Collomb hospital in Dakar, Senegal, and the Neuropsychiatry Institute of the Clairiere at Betrix in Belgium.¹⁹

In 1973, the NPPC was built and achieved centralization of neurologic, neuropsychiatric, psychiatric, and neurosurgical care.^{15,18} NPPC was well equipped with diagnostic equipment, including electroencephalography, ultrasound, and a medical laboratory.¹⁵ In addition, this centralization helped better integrate radiology, pathology, and neurosurgery facilitating the proper diagnosis. Medical tests that could not be performed at NPPC, such as tests for neuro-ophthalmology, neuro-otology, or radioisotope scanning, were done at KUC.^{15,18} With the creation of NPPC, KUC remained a diagnostic and surgical site since it housed neurosurgical operating rooms. NPPC was the primary neuropsychiatric inpatient center, registering an average of 320 admissions per year.¹⁵

Besides advocating for progress from 1964 to 1985, Dr. Dechef trained 20 neuropsychiatrists, including 18 Congolese and 2 Belgians.^{18,19} His work, particularly advocating and proposing a plan for the construction of NPPC, made Dr. Dechef an important contributor to the development of neurosurgery in the DRC. The end of bilateral cooperation between Zaire and Belgium in 1990 forced him to return to Belgium. Afterward, he became a consultant in other African countries, including Rwanda, where he taught neuropsychiatry from 1992 to 1994 at the psychiatric hospital of Ndera in Kigali. He left Rwanda due to the genocide of 1994 and returned to Belgium. There, he worked at the Beau Vallon Hospital in Saint Servais at Namur and died in Charleroi on April 4, 2006.¹⁸

Lovanium School of Medicine: Dr. Antoine Beltchika Kalubye. Dr. Kalubye earned his medical degree at Lovanium in 1971. He was assigned to Dr. Djunga as an assistant surgeon and there he developed a passion for neurosurgery. He benefited from Dr. Djunga's connections to pursue neurosurgery training at the University of Paul Sabatier of Toulouse under Dr. Yves Lazorthes Fils, former Professor of Neurosurgery and Emeritus Dean of the Faculty of Medicine at the University of Toulouse. A year before returning to the DRC, Dr. Djunga died unexpectedly. After his death, neurosurgical cases were performed by a team of young Congolese general surgeons with special interest and training in neurosurgery. These surgeons, Dr. Pierre Mfumu, Dr. Mukuna, and Dr. Evariste Likinda Bofonda, helped fill the neurosurgical gap before the return of Dr. Kalubye. In 1987, Dr. Kalubye returned to Zaire, becoming the only neurosurgeon in the country, and took over Dr. Djunga's position as Chief of the Section of Neurosurgery at KUC and NPPC.

Despite facing many challenges early in his career, he sustained the field from 1987 to 1992, with occasional help from his contacts. He too faced financial and logistic constraints, but he requested help from the University of Toulouse to safely perform certain procedures. One of the major steps during his era was the introduction of computed tomography scan.

Current Neurosurgical Workforce and International Contribution

Since 1992, there has been a notable increase in the number of neurosurgeons in the DRC, yet the burden of neurosurgical conditions is far from being adequately addressed due to a low neurosurgeon-to-population ratio.⁵ Today, the DRC counts 27 surgeons practicing neurosurgery. These include 16 neurosurgeons residing in the DRC full time, 6 neurosurgeons who trained and practice outside of the DRC, referred to as neurosurgeons from the diaspora, and 5 general surgeons with additional neurosurgical training and expertise (Table 2). The current increase in workforce density is due to international and local contributions. International support was provided by the World Federation of Neurosurgical Societies (WFNS) in Rabat, Morocco, with Professors Abdeslam El Khamlichi and Abdessamad El Ouhabi, and the University of Dakar, Senegal with Dr. Seydou Boubakar Badiane. Both

programs allowed Congolese to receive full training in neurosurgery following international standards.

Locally, to build neurosurgical training, cooperation with the Belgium government helped establish the second neurosurgical training center at the Ngaliema Clinic in the capital city of Kinshasa. Previously known as Clinique Reine Elisabeth, Ngaliema Clinic was originally built to train young Congolese doctors in nonsurgical specialties. Dr. Jean-Pierre Kalala Okito, who trained in Ghent, Belgium from 1986 to 1992, led neurosurgical training. He mentored Congolese interested in neurosurgery including Dr. Didier Mudjir Balanda. Dr. Kalala secured additional support and neurosurgery training for Congolese doctors with Dr. Abdeslam El Kamlichi, who established the WFNS Rabat, Morocco Training Center. In 1999, Dr. Kalala left Ngaliema Clinic returning to Belgium. After Dr. Mudjir completed his training, he assumed leadership of the neurosurgical practice. Unfortunately, Dr.

Table 2. The Current Neurosurgical Workforce in the DRC

Local Neurosurgeons (n = 16)	Neurosurgeons from the Diaspora* (n = 6)	Local General Surgeons† (n = 5)
Dr. Antoine Beltchika Kalubye	Dr. Kazadi Kalangu (ZW)	Dr. Pierre Mfumu
Dr. Jeff Ntalaja	Dr. Jean-Pierre Kalala (BE)	Dr. Evariste Likinda Bofonda
Dr. Tresor Ngamasata	Dr. Orphée Makiese (FRA)	Dr. Simon Kotoluka
Dr. Glennie Ntsambi	Dr. Alphonse Lubansu (BE)	Dr. Teddy Ketani Mayindou
Dr. Safari Mudekereza Paterne	Dr. Nyunyi Wambuyi Katumba (SA)	Dr. Cherubin Tshiuza Mpoji
Dr. Charles Katchungunu	Dr. Muke Mayoyo (SA)	
Dr. Denis Ndeni Makenzi		
Dr. Dieu-Merci Kabulo		
Dr. Sarah Mutomb		
Dr. Adalvaire Shweka		
Dr. Feruzi Kitembo		
Dr. Rosi Yogolelo		
Dr. Niveron Yenga Yenga		
Dr. Max Malangu		
Dr. Christophe Zirumana		
Dr. Guelord Mtamdua Metre		

DRC, Democratic Republic of Congo; ZW, Zimbabwe; BE, Belgium; FRA, France; SA, South Africa.
 Current list of all *Congolese neurosurgeons who work and live in the country they reside and †local Congolese general surgeons with additional training and neurosurgical privileges.

Mudjir died on September 27, 2012. Subsequently, Dr. Jeff Ntalaja became the second Congolese to train at the WFNS site in Morocco and he is currently the chief of the section of neurosurgery in Ngaliema Clinic.²⁰

Additional local efforts are ongoing with the active support of Dr. Kazadi Kalangu, a Congolese neurosurgeon from the diaspora. Dr. Kalangu established a neurosurgical practice in the southern region of the DRC, Lubumbashi in 2015. The practice has been described as “active and efficient” by Dr. Kalala and it is reinforced by young colleagues from Dakar and Harare. Also, in the eastern region of DRC, another group of surgeons, led by Drs. Paterne Safari and Charles Kachungunu, established a neurosurgery practice serving the cities of Bukavu and Goma. This practice has been receiving support from Rwandan and Ugandan colleagues, due to the proximity of those regions to the 2 countries. These significant collaborative efforts have had tangible, positive impacts on the DRC’s neurosurgery. Reform on current health care policies is needed to gauge and sustain current efforts, and most importantly to continue embracing additional opportunities through intra- and extracontinental collaboration.

Addressing Neurosurgical Access and Local Education

The DRC counts 25 provinces, including the capital city, Kinshasa, which is administratively equivalent to a province. Before 2015, all local Congolese neurosurgeons practiced and resided in Kinshasa because it was the best equipped of all the zones (Table 1). The surgeons traveled to the 24 other provinces as needed. In 2015, the Congolese Society of Neurosurgery was created to unite all Congolese neurosurgeons and address such a concern. Chaired by Dr. Kalala, the Congolese Society of Neurosurgery divided the country into zones and allocated neurosurgeons to facilitate access to basic neurosurgical services nationwide (Table 3). This decentralization was important to fix the disproportionate distribution of resources, allowing neurosurgeons to train general surgeons in minor and emergent neurosurgical procedures and thus address all neurosurgical cases. Except for the northern region, other zones currently have one or more permanent neurosurgeons (Table 3), yet the neurosurgeon: population ratio of 1:5.9 million still far exceeds the minimum ratio of 1 neurosurgeon per 200,000 people recommended by The

WFNS Global Neurosurgery Committee.²¹ Also, the lack of infrastructure and surgical equipment in most zones further complicates neurosurgeons’ tasks. Dr. Ntalaja, the second vice president of the Francophone Section of the Continental Association of African Neurosurgery Societies in Nigeria, is currently working on collaborative efforts to address these limitations. He works through continental and international collaborations to solicit funding that helps with the acquisition of state-of-the-art equipment. His efforts are already demonstrating progress. The DRC recently acquired equipment for micro-neurosurgery, pituitary surgery, fluoroscopy, stereotactic surgery, and neuronavigation, all located in Ngaliema Clinic in Kinshasa. Likewise, Congolese neurosurgeons from the diaspora have been of tremendous help in providing much-needed surgical equipment for specialized cases.

Neurosurgeons from the diaspora and visiting doctors from the WFNS also support local education by introducing to the neurosurgical armamentarium procedures that were not previously done in the DRC, such as clipping aneurysms, skull-base surgery, endoscopic surgery, and instrumented spinal fusion. In August of 2018, Professor Adyl Melhaoui, a visiting neurosurgeon from Morocco, assisted 2 young Congolese neurosurgeons, Dr. Ntalaja and Dr. Tresor Ngamasata, in a surgical case that involved clipping of an anterior communicating artery aneurysm and resecting a convexity meningioma. The procedure took place in Ngaliema Clinic, and the outcome was a success. Such procedures used to be a challenge in the DRC due to the lack of adequate equipment and experience. However, intercontinental educational collaboration has been valuable in sharing knowledge to improve local Congolese neurosurgeons’ experience and helping with instruments needed to perform safe surgical procedures.

DISCUSSION

In June of 2022, the DRC will celebrate 62 years of independence, yet the country has more to do on the path to progress in its health care system. The DRC’s current state can be understood in the context of

Table 3. Neurosurgical Zones in the Democratic Republic of Congo and Current Local Neurosurgeons in Each Zone

Zones	Center Location	Population	% Population	Local Neurosurgeons
North	Kisangani	17,599,000	18.51%	None
South	Lubumbashi	27,022,000	28.48%	Dr. Dieu-Merci Kabulo Dr. Sarah Mutomb Dr. Shweka Adalvaire Dr. Feruzi Kitembo Dr. Rosi Yogolelo Dr. Niveron Yenga Yenga Dr. Max Malangu
East	Bukavu	14,760,000	15.53%	Dr. Safari Mudekereza Paterne Dr. Katchungunu Charles Dr. Ndeni Makenzi Denis
West	Kinshasa (KUC)	35,682,171	37.54%	Dr. Antoine Beltchika Kalubye Dr. Ntsambi Dr. Jeff Ntalaja Dr. Tresor Ngamasata Dr. Christophe Zirumana Dr. Guelord Mtamdua Metre
Total	Country	95,063,171	100%	16

years of political instability and mismanagement of resources. Some of DRC's systemic problems are still prevalent today. These chronic humanitarian crises have made it difficult for the DRC to escape this growth delay in the progress of modern medical care. Hence, the DRC continues to lag in all fields, including its health care system. In the areas of surgery, particularly neurosurgery, there are substantial critically unmet needs. Our recommendations for improvement are listed to follow.

Health Care Reform and Infrastructure

There is a need to strengthen governance and leadership in the health sector by establishing a national steering committee. The current system has multiple independent steering committees that work directly with the office of the Minister of Health. Those committees benefit from international aid either directly or through government intermediaries. In addition, they also receive funding from the country's internal revenue. Yet, the lack of collaboration between those committees has led to redundancy.

Consolidating efforts by means of a national steering committee and eliminating redundancy will conserve much-needed resources to build neurosurgery facilities with state-of-the-art medical equipment and personnel and allow for adequate funding of more efforts within the DRC. Such reform should not be solely limited to neurosurgery but should be extended to other fields, especially those that complement neurosurgery such as neuroscience nursing, neuroradiology, neuroanesthesiology, and neurocritical care. These fields operate in tandem, and all are needed to ensure adequate short- and long-term care for patients.²²

Establishing Local Training Programs

A ratio of one Congolese neurosurgeon to approximately 5.9 million Congolese people indicates a pressing need for training, advocacy, and partnerships. The presence of a neurosurgical hospital can facilitate local training opportunities. Dewan et al.²³ argued that students from LMICs, when trained abroad, fail to return to their respective countries for a variety of reasons, including social, economic, and political. Thus, it is critical to establish partnerships with the global neurosurgery

community to ensure local collaborations. Such collaborations can facilitate sustainable local educational benefits, and the development of initiatives that will complement local existing efforts, ultimately supporting the growth and future autonomy of local neurosurgery.

Uganda, a country in Eastern Africa and one of the close neighbors of the DRC, presents a unique example of a successful partnership. One of the members of the global neurosurgery community, Duke University in Durham, North Carolina, has been working in Uganda for the past 15 years. In 2007, Uganda had 1 neurosurgeon for 6 million people, a 1500-bed neurosurgery hospital, 1 ventilator, 2 neurosurgery units in Mulago and CURE Children's Hospital, and no neurosurgery training program. To mitigate this deficit, Uganda established a collaboration with Duke University's Global Surgery Program to build more neurosurgical facilities and train 50 neurosurgeons by 2030, so they can become self-sufficient. To date, the country counts 12 fully trained neurosurgeons, with others currently in training; four neurosurgical facilities that provide training, and each is adequately equipped for most neurosurgical cases. This clearly demonstrates the benefit of engaging global neurosurgery communities. Their expertise and commitment foster training, mentorship, and most importantly establish a goal-oriented agenda to make host LMICs self-reliant.²³

CONCLUSIONS

Neurosurgery in the DRC had a challenging beginning, primarily due to the country's political instability. Early efforts have provided a solid foundation to sustain the field. To date, the proportion of Congolese neurosurgeons to neurosurgical cases remains unacceptably low, despite the increase in the number of neurosurgeons. With adequate national health care leadership, international aid, and internal infrastructure the current system can be bolstered as a foundation to build sustainable partnerships and ensure adequate neurosurgical training and care within the DRC for the future. The development of training institutions and access to care in concert with complimentary subspecialties in radiology, anesthesiology, and critical care is crucial to fulfilling this unmet need.

REFERENCES

1. Brima N, Davies J, Leather AJ. Improving quality of surgical and anaesthesia care at hospital level in sub-Saharan Africa: a systematic review protocol of health system strengthening interventions. *BMJ Open*. 2020;10:e036615.
2. Park KB, Johnson WD, Dempsey RJ. Global neurosurgery: the unmet need. *World Neurosurg*. 2016;88:32-35.
3. Ellegala DB, Simpson L, Mayegga E, et al. Neurosurgical capacity building in the developing world through focused training: clinical article. *J Neurosurg*. 2014;121:1526-1532.
4. Rosseau G, Kim EE, Barthélemy EJ, et al. The current state of neurosurgery in Somaliland. *World Neurosurg*. 2021;153:44-51.
5. Kanmounye US, Lartigue JW, Sadler S, et al. Emerging trends in the neurosurgical workforce of low- and middle-income countries: a cross-sectional study. *World Neurosurg*. 2020;142:e420-e433.
6. Dempsey RJ, Buckley NA. Education-based solutions to the global burden of neurosurgical disease. *World Neurosurg*. 2020;140:e1-e6.
7. Niquen-Jimenez M, Wishart D, Garcia RM, et al. A bibliographic analysis of the most cited articles in global neurosurgery. *World Neurosurg*. 2020;144:e195-e203.
8. Democratic Republic of the Congo: Economy. Available at: <https://globaledege.msu.edu/countries/democratic-republic-of-the-congo/economy>. Accessed May 3, 2022.
9. Monekosso GL. A Brief History of Medical Education in Sub-Saharan Africa. *Acad Med*. 2014;89(suppl):S11-S15.
10. Vincent J, Borghgraef R. The teaching of medicine at Lovanium University. *J Med Educ*. 1959;34:690-693.
11. Hennebert PN. Aux cliniques universitaires à Kinshasa. Available at: <https://docplayer.fr/15598373-Aux-cliniques-universitaires-a-kinshasa.html>. Accessed August 21, 2021.
12. Roger B. Reportage Photos - Université Lovanium De Léopoldville. *Afrique Rédaction*; 2010. Available at: <http://afriqueredaction.over-blog.com/article-cree-le-18-02-10-a-21h22-afrique-redaction-conflit-arme-rdc-mis-a-jour-le-jeudi-18-02-10-a-21h25-par-45225754.html>; 2010. Accessed August 21, 2021.
13. Au S. Cutting the flesh: surgery, autopsy and cannibalism in the Belgian Congo. *Med Hist*. 2017;61:295-312.
14. Everett K, Hardick E, Johnson D. The Year of Africa; January 2021. Available at: <https://origins.osu.edu/article/year-of-africa-1960-rumba-pan-africanism-Kariba>; January 2021. Accessed August 21, 2021.
15. Djhnga S. Perspectives in international neurosurgery: neurosurgery in Zaire. *Neurosurgery*. 1983;13:95-97.

16. Tshimbombu TN, Song SH, Kanter JH. Dr. Djunga: first Congolese neurosurgeon. *World Neurosurg.* 2022;160:68-70.
17. Ntembwa HK, Lerberghe WV. Democratic Republic of the Congo: Improving Aid Coordination in the Health Sector. Geneva: World Health Organization; 2015. Available at: https://apps.who.int/iris/bitstream/handle/10665/186673/WHO_HIS_HGF_CaseStudy_15.4_eng.pdf?sequence=1&isAllowed=y. Accessed September 8, 2020.
18. Wéry. Promouvoir les connaissances scientifiques dans les régions d'outre-mer. Available at: https://www.kaowarsom.be/fr/notices_dechef_guy. Accessed May 3, 2022.
19. Tshimbombu TN, Song SH, Rojas-Soto DM, Daniel OLEA. Historical overview of the only neuro-psycho-pathology center in the Democratic Republic of Congo. *World Neurosurg.* 2022;161:72-74.
20. Karekezi C, El Khamlichi A. Takeoff of African neurosurgery and the World Federation of Neurosurgical Societies Rabat Training Center alumni. *World Neurosurg.* 2019;126:576-580.
21. Sichimba D, Bandyopadhyay S, Ciuculete AC, et al. Neurosurgical equipment donations: a qualitative study. *Front Surg.* 2022;8:690910.
22. Meara JG, Leather AJM, Hagander L, et al. Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. *Lancet.* 2015;386:569-624.
23. Dewan MC, Rattani A, Fieggen G, et al. Global neurosurgery: the current capacity and deficit in the provision of essential neurosurgical care. Executive Summary of the Global Neurosurgery Initiative at

the Program in Global Surgery and Social Change [e-pub ahead of print]. *J Neurosurg* <https://doi.org/10.3171/2017.11.JNS171500>, accessed July 21, 2021.

Conflict of interest statement: The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received 21 May 2022; accepted 25 July 2022

Citation: *World Neurosurg.* (2022) 167:81-88.
<https://doi.org/10.1016/j.wneu.2022.07.113>

Journal homepage: www.journals.elsevier.com/world-neurosurgery

Available online: www.sciencedirect.com

1878-8750/\$ - see front matter © 2022 Elsevier Inc. All rights reserved.