

# Chapter 13

## Neurosurgery Education Around the World: Africa



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### Introduction

It is gratifying to note that the issues related to global health have shown a significant progress over the last decades. This resulted in important improvements of human health in many countries. However, a lot of ground to cover still remains, including within the framework of the Sustainable Development Goals (SDGs), a series of global health goals set for 2030, proposed by the General Assembly of the United Nations in 2015 [15]. Some of the major global health issues involve neurosurgery, from noncommunicable diseases like injuries, cancers, hypertension, and its neurological consequences, to communicable diseases when it comes to infectious diseases and congenital malformations. Global surgery as a formal area of universal health-care coverage (UHC) continues gaining international interest since 2015 when the Lancet commission on Global Surgery Report was released and the

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adoption of the World Health Assembly (WHA) resolution WHA68.15 “*Strengthening emergency and essential surgical care and anaesthesia as a component of universal health coverage*” [15, 16].

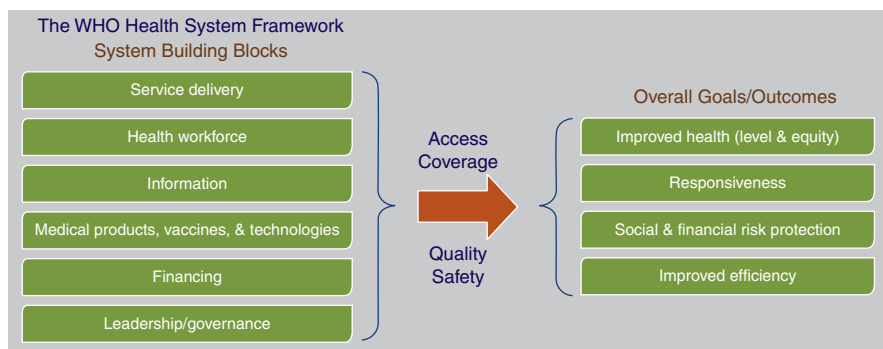
The philosophers Norman Daniels and Mark Jessen have argued that some basic goods in life are essential, and health is one of them. To secure equal opportunities in life, providing health care and education is an ethical requirement of humanity. The World Health Organization (WHO) defines a health system as “*all the activities whose primary purpose is to promote, restore and/or maintain health. Or it’s the people, institutions, and resources arranged together in accordance with established policies, to improve the health of the population they serve.*” Hence, one of the main services provided by a health system is a comprehensive emergency care. As described within WHO health system framework (Fig. 13.1), one of the pillars of a well-functioning health system is the health workforce, and one that is in the right place at the right time with the right training, ready to deliver proper care [2].

Global health consists of population-based public health strategies that are implemented in cost-effective ways to serve the most vulnerable members of our population. When this principle is applied to Africa, since the majority of the countries are low-income countries, it is clear that there is a desperate need to implement population-based public health strategies to advance the training of health-care professionals and the availability of material and human resources. While pursuing these goals, it is important to draw from the experience of other countries to ensure that we invest as wisely as possible particularly in the training of the African neurosurgical workforce.

## Historical Background

### *The African Legacy*

Africa is known as the cradle of humanity and the home of many civilizations. Each participated in the building of human history and cultural capital. Several anthropologists have stated that the greatest evolution in human prehistory has taken place in



**Fig. 13.1** World Health Organization’s (WHO) health system framework [3]

Africa, and that the first civilization in humankind took root around the Nile valley. In the papyrus documents of Pharaonic Egypt, descriptions are made of the way head trauma was treated, endonasal brain aspiration (before mummification), and trephination that pharaohs underwent just before death in order to allow their souls to find their way to paradise. Among the tribes in Africa whose healers have practiced and taught the basic rules of trephination for centuries, we can mention Chaouia and Kabyle tribes (respectively in Morocco and Algeria), the Gouache in the South of Morocco, and the Tuareg in Sub-Saharan Africa and Libya. From Abulqassim Al Zahrawi (Abulcasis) in the tenth century to the current ages, education in African neurosurgery has known many peaks and troughs. Abulcasis is considered to be the pioneer of neurosurgery and wrote a book composed of 30 treatises “*Kitab Al Tasrif Liman Ajaza an Al Talif*” [4] which was later translated into many languages and served as the basis for teaching both medicine and surgery in various schools in Europe during the Renaissance. The Arab-Islamic medicine has greatly contributed to the development of medicine during the Middle Ages as it flourished in North Africa and later allowed for medicine to develop in Europe in the thirteenth century: Hussein Ibn Sina (Avicenna), Abubakr Ar-Razi (Rhazes), Ibn El Haytham, Ibn Tofail, Ibn Zohr (Avenzoar), Ibn Rochd (Averroes), Ibn Maymon (Maimonide), and many others have all marked the Golden Age of Arab-Islamic medicine. The knowledge and practice of those Hakims, meaning “wise man,” as doctors were called, have later spread around the Mediterranean, and have been taught in medicine schools (School of Cordoba, Spain; Karaouiyyine University in Fez, Morocco; Schola Medica Salernitana in Italy [7]; Ecole de Montpellier in France). Further to this spread of knowledge, the first care facilities were built (also called Maristan, Arabic word meaning “hospital” in that period) [1].

Unfortunately, this historical asset did not necessarily work in favor of the African continent when it came to the scientific advances in the world. From the eleventh to the eighteenth centuries, Africa was marginalized from the important cultural, technological, and economic advances until the beginning of the twentieth century. It woke up to find itself weak and colonized by European powers and to witness a world that had moved forward at high speed without its active participation. Concerning the medical development in Africa in the second half of the twentieth century, the focus was on the setting up of vaccination plans against infectious diseases, such as plague, cholera, tuberculosis, malaria, and HIV/AIDS. The lack of medical professionals and the endless needs in basic health care urged African states to deliver only primary health care to their citizens, therefore marginalizing neurosurgery among all the other surgical specialties, wrongly considered as a “luxury specialty” [1].

### ***The Dawn of African Neurosurgery***

The birth of neurosurgery in Africa, as an independent specialty, just about 60 years ago, was an arduous process. It started in North African countries and South Africa and was introduced in the majority of countries by European neurosurgeons, brought to the continent by citizens of the colonizing countries. When Africa emancipated

from the occupational state, there were no native African neurosurgeons, and the number of native physicians did not exceed five [1]. When Africa gained back its independence, it was deemed to fall into a worrying health-care situation. The continent was bound to keep European physicians and even request more assistance to provide much-needed health care for the local population until some pioneers of African neurosurgery took over (Table 13.1).

**Table 13.1** Some of the first neurosurgical departments in Africa by European physicians and native pioneers [1]

	First departments by European physicians	Some of the first native neurosurgeons
<b>North Africa</b>	The first units of neurosurgery were set up in Algiers, Algeria, in 1942; and in Casablanca, Morocco, in the 1940's respectively by Doctors P. Goignard and R. Acqua viva [14]	The first local neurosurgeons in north Africa would take over between 1960 and 1975: those are Doctors H. El Kerdoudi, D. Bouchareb. A. El Ouarzari and A. El Khamlichi in Morocco; M. Abada, A. Abdelmoumen, A. Bousalah and Boutmene in Algeria; and M. Betteyeb in Tunisia. The latter set up the first operational department of neurosurgery in Tunisia in 1964. In Egypt, the first neurosurgeons to set up neurosurgery between 1950 and 1960 were Drs. A Abu Zikri, O. Sorour, I. Higazi, A. Benhaway and S. El Guindi in Cairo, and S. Boctor and G. Azab in Alexandria.
<b>West Africa</b>	The first neurosurgery unit has been set up in Dakar, Senegal, in 1967, by French neurosurgeon B. Courson.	The first Senegalese resident joined up, Dr. M. Gueye, in 1977, and became the first Senegalese Professor and Neurosurgery Department Chairman. The first Ivorian neurosurgeon, Dr. K. Kanga, had already started practicing neurosurgery in 1974. In Ghana, the first Ghanaian neurosurgeon, Dr. J.F. Osman Mustaffah, set up the first neurosurgery department in 1969. In Nigeria, neurosurgery was introduced in the country by local neurosurgeons. The first department was set up in Ibadan in 1962 by Dr. E.L. Odeku.
<b>East Africa</b>	Neurosurgery was set up by English-speaking neurosurgeons from Europe first in Kenya where it was introduced by Dr. P. Clifford, an ENT surgeon who operated on encephaloceles and hydrocephalus, before an Italian neurosurgeon, Dr. Renato Ruberti pioneered neurosurgery in 1967.	In 1971, Dr. J. Kiryabwire, the first Ugandan neurosurgeon would join come back to Uganda, after training in London
<b>Southern Africa</b>	In South Africa, things were different, the practice of neurosurgery began with Doctors R.A. Krynauw in Johannesburg in 1940, and H.L. de Villiers Hammann in Cape Town in 1946 both born in South Africa and trained respectively in Oxford (United Kingdom) and Munich (Germany).	

In Morocco, European neurosurgeons started passing on their knowledge to local trainees around in 1962. Local professors gradually replaced them, and over a 20-year span, Moroccan teachers were more than 80% of the teaching workforce within neurosurgery training programs. This encouraged the government to open more Moroccan schools, develop local training, and promote clinical research. Efforts then focused on evenly distributing neurosurgeons all over the country. The aim was to integrate neurosurgery as an important part of the health and academic system. Neurosurgery trainees still went to foreign countries for a limited time for additional training. It rapidly became obvious that a full training in a foreign country was costly and above did not teach the trainees how to adapt their learning to the local conditions. This self-improving system allowed Morocco to go from zero native Moroccan neurosurgeons in 1956, after gaining back its political independence, to 80 neurosurgeons, a number that increased exponentially over the years [1]. In Sub-Saharan Africa (SSA), the training system did not follow the same template over the years, despite neurosurgery being set up as a specialty in most countries by 1960s and the opening of many medical schools after each country's political independence. Instead, most SSA chose to send their trainees to Europe and North America. However, many neurosurgeons who trained abroad continued to practice where they trained. Therefore, the SSA demand of neurosurgeons was not met. In 1998, the neurosurgeon/inhabitant ratio in SSA was 1/7–ten million [1].

## **The Neurosurgical Workforce Distribution in Africa: Past and Present**

The discrepancy of the regional distribution of neurosurgeons is palpable. In 1998, the neurosurgeon/inhabitant ratio was 1/230,000 in the world, whereas in Africa it averaged at 1/1,238,000. Moreover, most African neurosurgeons (86%) were condensed in the North African countries and in South Africa. This resulted in providing the rest of the African continent, which accounts for 74% of the entire Africa population, with 14% of the neurosurgery workforce and neurosurgeon/inhabitant ratio of 1/6,368,000. Additionally, these countries also suffer a lack of basic neurosurgical equipment and appropriate facilities.

A survey was conducted by A. El Khamlichi in 1998 to establish a comprehensive guide to assessing the status of neurosurgery in Africa. It was published and presented in the different international meetings to inform the neurosurgical community worldwide about the distressing ratio of neurosurgeons in Sub-Saharan Africa. Two years later, a more elaborate version of the survey was conducted to carry out a follow-up in order to have more detailed information regarding already-existing training systems, and the biomedical equipment available, the pathology spectrum but mostly to appraise the kind of help African neurosurgeons needed. The results of the survey in the tables below (Table 13.2) were presented to the WFNS Administrative Council (AC) on February 20, 1999 [5]. The request made by African neurosurgeons was clear: to be supported by the WFNS for the acquisition of basic equipment and to have access to basic training in neurosurgery. Regarding

**Table 13.2** Evolution of African neurosurgery

	Population (in millions)	Neurosurgeons	Ratio (adjusted)
A. Results of the survey conducted by A. El Khamlichi in 1998 [1]			
Africa	800	565	1/1066666
South Africa	45	86	1/ 405,405
North Africa	140	400	1/ 380,658
Sub-Saharan Africa	615	79	1/ 7,784,810
World	5.479	23.940	1/ 230.000
<b>WHO recommended ratio</b>			<b>1/100.000</b>
B. Results of the survey conducted by A. El Khamlichi in 2016 [1]			
Africa	1.120 (+75)	1.727	1/ 654,000(1/691000)
South Africa	55	171	1/ 420,000
North Africa	181	1.187	1/ 131,000
Sub-Saharan Africa	884	369	1/2395663
<b>WHO recommended ratio</b>			<b>1/100000</b>

the first issue, the WFNS president, Pr. M. Samii, was already able to secure equipment as he already secured two companies to manufacture basic instrument sets for craniotomy and laminectomy at a reduced price.

Regarding the support to training, the WFNS AC members committed to encourage the organization of training courses in Africa and accepted the project presented by A. El Khamlichi to set up a regional training center in Rabat to train African neurosurgeons in their continent. The training in regional centers was an aim for African neurosurgeons and had many advantages. First, it could avoid the “brain drain.” The young who trained in Europe or North America rarely went back to their African home countries. Second, the young neurosurgeons could receive their training in an environment more similar to their home countries. Third, the training cost would be a fraction of the cost of training in Europe or North America.

Thanks to the efforts of the new national and regional centers, an exponential growth of the number of neurosurgeons and trainees was witnessed. In the latest inquiry presented in the WFNS Webinar on June 13, 2020, J. Ntalaja showed that in 4 years (2016–2020) the number of neurosurgeons went from 1727 (Table 13.2B) to 2044 in 2020; in addition, there are 1036 residents currently in training. The success witnessed in the development of neurosurgical training supports the original strategy, proposed by Professor A. El Khamlichi, and that supported by the WFNS was a winning proposition.

### **Minimizing the Paucity of Neurosurgeons in Africa: From the WFNS Residency Training Center (RTC) to a Widespread African Effort**

Born from the cooperation between the WFNS and the Mohammed V University in Rabat in 2002, the WFNS Rabat Training Center (WFNS RTC) aims at ensuring basic training in neurosurgery for postgraduates from Sub-Saharan African

countries. The financial support provided by the WFNS RTC aims at two goals. First, it provides the required resources (human and logistics) to achieve the neurosurgery training. Second, it provides financial aid grants to candidates in order to allow them to live decently and focus on their training. The Moroccan authorities shoulder the first part, which accounts for 90% of the total expenses accrued. African doctors benefit from free enrolment at the university, which allows them to complete internships at the hospital. The only cost the trainees need to bear is that of medical insurance, which often does not exceed 1.800 MAD (less than 200 USD) per annum [1].

During these 18 years, 64 young African doctors have enrolled at the WFNS-RTC: 54 to complete the 5-year training and 7 enrolled for a limited complimentary training (6 months to 3 years) since they were already enrolled in a training program in their home countries. All these young neurosurgeons are well-integrated into the national health system in their country and all are able to acquire the required basic equipment that allows them to operate on patients [18]. They also successfully promote and lobby for neurosurgery in their countries and by doing so manage to work with local authorities to launch a local training program. Currently, 64 young African neurosurgeons have been trained or are training in the WFNS-RTC. Neurosurgeons trained at the WFNS RTC upon graduation and reentry in their country of origin are also eligible for receiving a neurosurgical set of instruments by the WFNS Foundation.

Following the footsteps of the first francophone reference training center in Rabat, the Consortium of Collaborative Neurosurgical Sites of Training of the East, Central and Southern African region (C-CNS-ECSAR) was established in 2006 as the second WFNS reference center in Africa, and the first Anglophone. The center incorporates neurosurgical training at major hospitals in the East African region of Sub-Saharan Africa. The initiative was led by Dr. Mahmood Qureshi of Kenya, Prof Paul H. Young of the Foundation for International Education in Neurosurgery (FIENS), and Dr. Benjamin Warf who was working in Mbale, Uganda, at the time [6, 11].

In 2014, Pr. M. Samii's started a program called "Africa 100" aimed at increasing the training of young African neurosurgeons. The program committed to managing the full basic training of 100 young African doctors in neurosurgery by providing them with scholarships and enrolling them in training departments in Africa or elsewhere. In January 2014, the first six trainees of the "Africa 100" program enrolled in the WFNS-RTC, all of whom were sponsored by Pr M. Samii. Since then, four neurosurgery centers are able to train and accept "African 100" trainees. They are located in Dakar (Senegal), Algiers (Algeria), Nairobi (Kenya), and Cairo, Egypt. In 4 years (2014–2018), 15 trainees were enrolled in the "Africa 100" program, all of whom are currently under training. Eight of these have completed their training at the WFNS-RTC. In 2018, the Africa 100 committee accepted the applications of 31 students from the following countries: Somalia, Nigeria, Zimbabwe, Chad, Tanzania, Gambia, Swaziland, Niger, Mauritania, Zanzibar, Cameroon, Guinea Conakry, Benin, Malawi, and the DRC (Fig. 13.2).



**Fig. 13.2** African map representing countries of applicants accepted in the program by Africa 100



## The Impact of Local Training on the Growth of African Neurosurgery

The two examples to follow are provided to highlight the importance of local neurosurgery training on the growth of our field in Africa.

***The Nigerian Experience*** Dr. Nasirou was trained in the WFNS RTC from 2002 to 2004. In 2004, after he came back to his home country, and with the help of Pr. Shehou, the Regional Neurosurgical Centre was established in Sokoto. It was commissioned in 2007 and received the WFNS neurosurgical set and a microscope. In the following 10 years, the center trained 14 young neurosurgeons and aimed for 50 more in the years to come. In the same time, the Nigerian Academy of Neurological Surgeons was formed in 2007 with 58 active members. The success of this project was possible because of the commitment and team-building abilities but also local training for human resources and local financial and administrative support.

***The Democratic Republic of Congo (DRC) Experience*** In Congo, where the practice of neurosurgery started in 1976. The DRC has a surface area of 2,345,409 km<sup>2</sup>, 75,000,000 inhabitants, and only 4 neurosurgeons dispatched in two provinces out of 26 in 2019. Neurotraumatology was the main neurosurgical activity. Before the World Federation of Neurosurgical Societies Rabat Reference Training Center (WFNS RTC) sent its first wave of newly trained neurosurgeons, there was the fol-



lowing equipment in the DRC: one MRI device 0.35 Tesla, four CT scan devices, and one image intensifier. Late Mudjir Balanda M.D. was the first to be trained at the WFNS RTC, who returned to his country, but unfortunately died a year later. Jeff Ntalaja, as soon as he came back home after training at the WFNS RTC in December 2013, witnessed the will to trigger the development of neurosurgery in the country, namely in improving patients' management and equipment purchase. An appeal was written to the political and administrative authorities for the purchase of tools to improve working and patients' management conditions. The permission was given to purchase new equipment: image intensifiers; several CT scan devices, with three including 64 slices; five MRI devices, with two 1.5 Tesla; one digital angiography device; one basic operating microscope; two Medtronic Quadrant systems; etc. Help also came from the neurosurgeons who were practicing outside the country. The diaspora (neurosurgeons outside the country), Professor Kazadi Kalango, Professor Kalala from the University of Gand, Dr Orphee Makiese, a neurosurgeon at Clinique Floreal in France, Dr Hugues Matondo, an interventional radiologist practicing in Belgium, to mention a few, are important partners toward the development of neurosurgery in the DRC, namely by strengthening competence and sharing practical experience in neurosurgery. A Congolese Society of Neurosurgery was established as well as an online information exchange platform with an information website linked to the Congolese Society of Neurosurgery. In March 2018, we set up a National Neurosurgery Excellence Pole whose coordination has been carried out by Jeff Ntalaja M.D. A pole is a unit including neurosurgeons who practice neurosurgery, ranging from minimally invasive surgery to the surgery of malformations, tumors, traumatology, and degenerative surgery. It is a collaboration platform gathering neurosurgeons (three from outside the country), but also specialists from neighboring fields (anesthetists, radiologists, etc.). Currently, the number of neurosurgeons is up to 9 [8].

## **The African Neurosurgery Training Curriculum**

The WFNS RTC's vision revolves around training African neurosurgeons within their native continent to create a self-sufficient and sustainable system aiming to provide a well-trained neurosurgical workforce. Its main goal is to teach them to work with affordable and low-maintenance technology and expand efforts to improve quality of neurosurgical care throughout the continent. As a result, neurosurgeons' availability increased during the last two decades in Africa due to the joined efforts of senior African senior neurosurgeons and the WFNS [19]. The WFNS RTC welcomes 4–5 Moroccan residents and 1–2 other African residents per hospital per year. One resident stays in Rabat while five others are sent to the hospitals in Casablanca, Fes, Marrakech, and Oujda. Currently, other teaching hospitals are opening their doors to welcome more African residents in Rabat, Casablanca, Agadir, and Tangier, increasing the capacity to welcome more African residents. Other international doctors can become neurosurgical residents by taking the same

competitive exam as Moroccan graduates. The neurosurgical curriculum in the WFNS RTC encompasses 5 years of training, including rotations in the five neurosurgical departments of Rabat and 6 months in a neurology department. The residents undergo the exact same curriculum regardless of their nationality. The 5–6-year-long training is predominant in Africa except in Egypt, where it is 6–8 years long, depending on the city, for example.

## **The Current Challenges of Neurosurgical Training in Africa**

Despite the enormous efforts of the WFNS Foundation, the lack of material resources and equipment remains a major obstacle to the practice and teaching of neurosurgery. The WFNS Foundation has been instrumental in providing basic neurosurgical sets and microscopes. Other international institutions have donated or sold at a reduced rate surgical instruments sets and/or microscopes. These programs are to commend and propagate. However, to avoid the main drawback, which is that the continuous assistance may result in a lack of incentive by the local health authorities from acquiring the equipment, a regular audit of the facilities seeking help is strongly recommended to establish the needs. Ideally, this should be a joint effort of the WFNS Foundation and CAANS [13, 14].

Cost-effectiveness and a fair and smart distribution of available resources are two sound principles when developing neurosurgery strategies for the African continent. However, ethically speaking, these two concepts might appear to be contradictory. An educated health-care team can help orient the authorities to a more cost-effective management of the health systems.

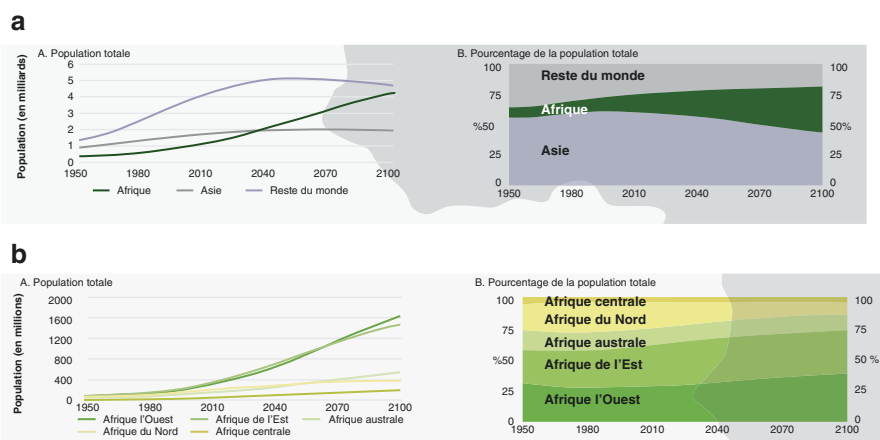
On-site education after completion of the neurosurgery training program is very important. Prior to the recent COVID-19 pandemic, this required traveling abroad. The registration fee and travel expenses oftentimes were prohibitive to the majority of young neurosurgeons. During the unprecedented global health crisis experienced by the world during 2020 following the COVID-19 outbreak, many questions were raised about the essentials of global health and the management of the health systems all over the planet. At the same time, new opportunities were discovered. Education has shifted to the use of videoconferencing platforms to alleviate the cancelling of all courses formerly requiring attendance. Lectures and conferences as well as case discussions and meetings covering various neurosurgery topics were all held electronically. E-learning appeared to be an attractive, easy, comfortable, cheap solution to replace educational social gatherings, but it has also shown some downsides. Resistance, financial issues, infrastructures, and dedicated IT (Information Technology) personnel in addition to the need for official legalization are a prerequisite. Nevertheless, the rapid increase in the speed of travel and communication, as well as the economic interdependency of all nations, has led to a new level and speed of globalization that can be a driving force.

## Future Opportunities and Unmet Needs

Africa is currently undergoing a demographic transition, at different stages depending on the region, but most of the African population is still young. By 2025, the African population is expected to reach 1.4 billion people with 1.1 billion in Sub-Saharan Africa. Fertility is at its highest but so is mortality. Both these facts have a direct impact on the increase of the already existing need for neurosurgeons. It is also worth mentioning that pediatric neurosurgery here since 45% of the African population will be under 15 years old. Also, more than half of the African population in 2025 will live in cities. This has the potential to increase the number of traffic road accidents and urban violence. The goal is to reach a critical mass of neurosurgeons to speed up the process of increasing the neurosurgical care capacity in Sub-Saharan Africa. Furthermore, the progress and technological advances witnessed recently in neurosurgery have required significant financial, material, and human resources, to grant patients safe and efficient treatment.

As shown in Fig. 13.3, the African population will double between 2015 and 2050 up to 2.4 billion inhabitants. By 2100, the African population will represent more than 25% of the population and Asia will reach almost 50% of the world population. The rest of the world, including Europe, North, Central and South America, will account for less than 25% of the population. In addition, most of the African population itself will be concentrated in East and West Africa accounting for almost 75% of the population.

It is also worth noting that with the epidemiological transition from a majority of communicable diseases, and a fair amount of injuries, to the predominance of non-communicable diseases, but just as many injuries, a change in the neurosurgical pathology spectrum is predicted. Currently, most of the African neurosurgical pathologies are CNS traumas, infections, hydrocephalus, and congenital diseases.



**Fig. 13.3 (a, b)** Estimated evolution of the African population by global neurosurgery during the 2017 conference [10]

The predicted shift in Africa's epidemiological profile includes a lower number of infections and an increase in life expectancy. This in turn could result in a higher incidence in tumors, cerebrovascular diseases, and urban violence. This will itself trigger changes when it comes to choose a subspecialty, which can only be possible if the number of neurosurgeons is sufficient to cover enough ground. In addition, some environmental changes such as climate change and unhealthy eating habits can cause an increased incidence of cancers, which in turn can reveal themselves only when they metastasize to the brain.

There are several important WHA resolutions targeting advancements in surgical care and further providing a mandate to allow LMICs and resource-poor settings to prioritize assessment, development, and restructuring of health-care systems aimed at caring for acutely injured patients at the time of the event and for those whose illness requires urgent care. For example, neurosurgeons continue to be fundamental in international advocacy of patients suffering from traumatic brain injury (TBI) and spinal cord injury (SCI), which represent significant contributors to global morbidity and mortality. TBI and SCI correspond to approximately 55 million (estimated range 53–58 million) and 27 million (estimated range 25–30 million) prevalent cases, respectively [17], and remain a priority in achieving UHC and context-specific priority areas in global neurosurgery, which relies heavily on advocacy by neurosurgeons [15].

Another important consideration are the social and cultural changes around the world, including Africa. With an increase of the levels of literacy, most likely there will be a rise of patients and their families' awareness regarding their medical management. This will likely result in higher societal expectations regarding the quality of care. Another important aspect is that with more trained neurosurgeons in Africa there will be more competition for the best opportunities. Due to limited resources, it is possible that not all neurosurgery trainees will have access to achieve competency in standard neurosurgery, microsurgical, and operative techniques.

The North and South African countries are on the right track to work as a driving force for the rest of the continent through the developing network of training centers. The African neurosurgery is now a fully integrated member in the international neurosurgical community through WFNS and other institutions and has its own regional organizations like the CAANS and the national neurosurgical societies working hand in hand to build a better future for the continent by promoting and developing neurosurgery locally and in Africa. More importantly, when we add up all these parameters, Africa is a young continent, full of potential waiting to be harnessed. It is highly attractive for investment in medical care.

The training program has to be reviewed to meet the future needs of neurosurgeons starting with a reinforcement of education and training in standard neurosurgical techniques, then developing training in subspecialties mainly pediatric neurosurgery (20–30% of neurosurgical activities), neuro-oncology, neuroendoscopy, spine surgery, and functional neurosurgery. Minimally invasive techniques, as opposed to the classical surgical techniques, should be developed within the availability of appropriate equipment. Simulation centers are highly encouraged, even if costly, to avoid the medical error.

Also, the research gates are yet to be developed in African countries. Research projects are known to be beneficial not only for scientific purposes within themselves, but also for the individual growth of young trainees. Research teaches them to think critically and gain independence. Young trainees are full of energy and driven to change the situation for better, an ambition Africa can only benefit from.

The role of CAANS and national neurosurgical societies is capital as they are the main actors in the advancing and promoting of neurosurgery in the wide variety of socioeconomic and scientific aspects. These include but are not limited to setting up new active neurosurgical societies, institutionalizing inter-African cooperation and exchange (south–south cooperation), exchanging with other continental and international institutions (training, research, organization), and collaborating with an established training program in Africa to exchange faculty and harmonize training standards.

## Conclusion

Sustainability of actions and collaborative partnerships are essential factors to continue improving neurosurgical health care in Africa. Although the neurosurgical workforce in Sub-Saharan countries is increasing, its sustainability is still at risk. The economic reality of an expanding population with limited resources is a complex scenario with challenges and opportunities. Local solutions will be more successful when integrated with the support of the international neurosurgical community. Additional WFNS regional training centers are poised at cost-effectively increasing the neurosurgical capacity with long-term tenable plans. International efforts to organize and secure equipment will continue to be important and needed. However, even if global health is based on the idea of the underserved regions of the world being helped by wealthier countries, a two-way flow is necessary to address the global health challenges that the world faces. A more nuanced and contemporary perception can only allow the striving of global health as a whole [9]. Yet, the neurosurgical community's interfacing with global health governance, policymakers, donors, and other stakeholders lacks a unified, formalized framework for participation in neurosurgical global health advocacy, policy, and research [15].

Additional forces influencing the success of improving neurosurgical care in Africa include providing strategies to address the brain drain, resulting in a dearth of health staff at multiple levels. Additional cultural barriers, such as a high percentage of personnel absenteeism, need to be addressed to improve the shortage of properly trained staff. A culture promoting value-based professional growth of well-trained most likely will result in improved desire to work harder. Such cultural change will also need to rest on the availability of resources to ensure that the neurosurgical workforce can effectively deliver good health care to its own people [2].

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