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Pediatric neurosurgery in Africa – present and future

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Abstract There is no doubt that the development of neurosurgery in general and paediatric neurosurgery in particular has lagged behind in many African countries, and in some unfortunate areas there is not even one single neurosurgeon. In contrast to this alarming situation, there are some excellent neurosurgical centres in northern and southern Africa, which developed fairly rapidly in the 1960s. To date, there are still striking contrasts in Africa where, of the neurosurgeons who are present there at all, some work in extremely difficult conditions while others have better facilities comparable to those in some of the best centres in the world. There is a general strong desire for neurosurgery in Africa to be developed using first what is available locally, then what is available in Africa and only then to turn to the world at large, and there is also consensus that this is the way to proceed. This paper will analyse the current status of paediatric neurosurgery in Africa and the problems that are hampering its development, and suggestions will be made about its future development. It is obvious that Africa is a huge continent and it might sound rather presumptuous to pretend to speak for it in detail. Taking account of this limitation, I will speak mostly about what is accepted nowadays as fact and reality common to most African countries, and for illustrative purposes some details will be given from Zimbabwe, which is where I practice.

Keywords Paediatric neurosurgery · Progress · Africa · Zimbabwe

Current status of paediatric neurosurgery in Africa

Africa is the second largest continent, with 35 million square kilometres and 700 million people distributed in 52 different countries.

A recent survey conducted in the continent for WHO shows a striking paucity of neurosurgeons [4]. There are in fact only 565 neurosurgeons for the whole continent (ratio of 1 neurosurgeon for 1,352,000 people). For comparison purposes, the ratio for the whole world is 1 neurosurgeon for 230,000 people; that in Europe is 1:121,000 people, and in North America the corresponding ratio is 1:81,000 people.

Further analysis shows some major discrepancies among African countries, which we arbitrarily divided into four groups:

- Group 1 is made up of countries with more than 15 neurosurgeons, such as Egypt (with 165 neurosurgeons), Algeria (130), Morocco (80), and Tunisia (25) in North Africa, and South Africa (86) in southern Africa. The total number of neurosurgeons in this group is 436 for a population of 174 million people (ratio 1:400,000 people).
- Group 2 countries each have a minimum of 5 neurosurgeons and a maximum of 15; examples are Nigeria (13 neurosurgeons), Kenya (8), Senegal (8), Sudan (6), Cameroon (6), Zimbabwe (6) and Libya (5). The total number of neurosurgeons in this group is 52 for a population of 187,900,000 (ratio 1:3,600,000 people).
- Group 3 embraces countries with fewer than 5 neurosurgeons, such as Ivory Coast (4 neurosurgeons), Uganda (3), Tanzania (3), Democratic Republic of Congo (2),

Table 1 Distribution of neurosurgeons in African countries

Egypt	165	Somalia	2
Algeria	130	Ethiopia	1
South Africa	86	Mauritius	1
Morocco	80	Namibia	1
Tunisia	25	Botswana	1
Nigeria	13	Guinea	1
Kenya	8	Ghana	1
Senegal	8	Burkina Faso	1
Sudan	6	Congo Brazzaville	1
Cameroon	6	Gabon	1
Zimbabwe	6	Malawi	1
Libya	5	Mozambique	1
Ivory Coast	4	Togo	1
Uganda	3		
Tanzania	3		
Democratic Republic of Congo	2		
Total	565 neurosurgeons		

Somalia (2), Ethiopia (1), Mauritius (1), Namibia (1), Botswana (1), Guinea (1), Ghana (1), Burkina Faso (1), Congo Brazzaville (1), Gabon (1), Malawi (1), Mozambique (1) and Togo (1). The total number of neurosurgeons in this group is 27 for a population of 250,236,000 people (ratio 1:9,268,000) (Table 1).

- Group 4 comprises countries with no neurosurgeon at all, namely Niger, Mali, Mauritania, Equatorial Guinea, Guinea Bissau, Lesotho, Swaziland, Rwanda, Madagascar, Comoro Islands and Burundi. In this particular category there are no neurosurgeons at all for a population of 46,662,600 people (Table 2).

Table 2 African countries with no neurosurgeon

Niger	
Mali	
Mauritania	
Equatorial Guinea	
Guinea Bissau	
Lesotho	
Swaziland	
Rwanda	
Madagascar	
Comoro Islands	
Burundi	
Total	11 countries

Equally, the number of departments of neurosurgery and the number of hospitals with modern neuroradiological equipment follow the same trend. Countries in the first group each have at least five departments of neurosurgery; those in group 2 have between two and four; there is one department per country in the third group, and finally none at all in the fourth group.

The numbers of CT scans and MRI machines also vary from country to country; 18 countries have no modern imaging apparatus, 13 each have one single CT scanner, and 13 each have a minimum of two. Most of these sophisticated neuroimaging apparatuses are concentrated in northern and southern African countries (Table 3).

Table 3 Numbers of neurosurgery departments, CT scanners, and MRI systems in some African countries

Country	Departments of neurosurgery	CT	MRI
South Africa	7	50	16
Algeria	11	12	1
Tunisia	5	25	2
Morocco	11	35	6
Zimbabwe	3	9	3
Total	37	131	28

It is interesting to note that even though these apparatuses are available in some countries, they may nonetheless be out of reach for many people, who cannot afford the cost of a CT scan or MRI.

Another fact that must me acknowledged is that the African population is young, with 50% of the population below the age of 18 years. Inevitably, African neurosurgeons do practice paediatric neurosurgery on a daily basis, even though established paediatric neurosurgical departments are few and far between in the continent.

In Zimbabwe, for instance, approximately 30% of the population are under the age of 15 years, and the country has a total population of 11 million people. The central or teaching hospitals are located in the two major cities, Harare Central Hospital (total beds 1,340) and Parirenyatwa Hospital (total beds 1,083) in Harare and Mpilo Central Hospital (total beds 719) in Bulawayo. These hospitals are government supported, and each of them has a department of neurosurgery. There is a total of 150 neurosurgical beds in the country. Recently, two paediatric hospitals were built inside the premises of Harare Central Hospital in Harare and Mpilo Central Hospital in Bulawayo. This has increased the total number of neuropaediatric beds from 35 to 60 for the whole country [5].

On average, 80 patients are seen and examined weekly in Harare at the neurosurgical outpatient clinics, and

about 25–30 of them are children. Allied specialties such as radiotherapy and oncology are available at Parirenyatwa Hospital. There is no department of paediatric neurology as such; general paediatricians refer patients to us.

There are also three rehabilitation institutes for brain- and spinal cord-injured adults and children: two are located in Harare and one in Bulawayo. A specialised unit for rehabilitation of children with "cerebral palsy" is active at Harare Central Hospital and it has lately extended its services to children with hydrocephalus, meningomyelocele and encephalocele.

Organisation of medical services in Zimbabwe

Until 1980, health services were available only in major cities; ironically they were almost absent in the rural areas, where most of the African population lived. Equity in health and improvement of quality of life became one of the priorities soon after independence: hence the policy of construction of health facilities within a radius of 10 km.

The health system was reorganised in four levels:

1. Primary or rural village level: the goal is prevention of communicable disease through development of primary health care (hygiene, nutrition, safe water supply, sanitation, immunisation, and family planning). Community workers, who may be qualified nurses, environmental health workers, or people from the local community with some particular relevant training, perform the tasks involved.

2. Secondary or district level (district hospital): primary curative services are offered, and primary health care efforts are monitored, co-ordinated, and supported at this level; the district hospital functions as the first-line centralised centre for treatment or referral.

3. Tertiary or provincial level (provincial hospital): basic specialist services that are not available at district level (e.g. general surgery, internal medicine, paediatrics, gynaecology, and ophthalmology) are provided at the provincial hospitals.

4. Quaternary level (central hospital or teaching hospital): more sophisticated treatments (e.g. neurosurgery, open heart surgery, plastic surgery, paediatric surgery, haemodialysis, laparoscopic surgery) are possible here; training of health care personnel of all categories, and research and development in health care planning, implementation, and organisation also take place in the teaching hospitals.

This strategy has significantly decreased the infant mortality, maternal mortality, and the incidence of some diseases, such as tuberculosis and diarrhoea. The same cannot be said for the majority of African countries, where such a health care pyramid either does not exist at all or exists but is nonfunctional because of wars, and/or political and economic instability.

Pathologies seen in Africa in general and in Zimbabwe in particular

All paediatric neurosurgical pathologies encountered in Europe and North America are seen in Africa with some variations. The characteristics common to most patients seeking health care are:

1. Most of them live in rural areas and need to travel long distances at great expense to reach the nearest neurosurgical centre.

2. Misdiagnosis of neurosurgical conditions is still common.

3. Even when the correct diagnosis is made, the decision to refer the patient is not taken within a neurosurgically acceptable time frame, either because of unawareness or because traditional healers have to be consulted over a long period of time.

As a consequence, benign pathologies are allowed to become gross and incurable. Sellar and parasellar lesions may progress to blindness, benign spinal cord compression may progress to irreversible paraplegia, posterior fossa tumours might not be diagnosed until the child affected has already developed optic nerve atrophy, and hydrocephalus is first seen when the head has reached a huge size with the cortex less than1 mm in thickness [5, 8]. This applies particularly in the case of the rural population.

In Zimbabwe, the commonest neurological pathology is hydrocephalus; the epidemiology is not well known, and this aspect is common to all pathologies in Zimbabwe in particular and the continent in general.

The causes are multiple: congenital stenosis of aqueduct of Sylvius, blockage of the outlet foramina of the IV ventricle (Luschka and Magendie) secondary to severe meningitis, posterior fossa tumours, brain tumours (craniopharyngioma, intraventricular tumours), post-haemorrhagic condition in the premature newborn, association with meningomyelocele, etc.

The second commonest pathology is that of head and spinal injuries, mostly secondary to road traffic accidents owing to the recent sharp increase in the number of cars and to the inadequacy of roads. Another factor highly peculiar to this continent is that children in African countries tend to play in the streets without any supervision even when there is heavy traffic. Moreover, some of the vehicles in use are in poor mechanical condition and often overloaded, thus defying any type of security measures.

Intracranial sepsis, particularly epidural abscess and subdural empyema secondary to poorly treated or untreated sinusitis, otitis media, trauma or meningitis, are the next most frequent pathologies.

The incidence of tuberculosis of the brain and spine, intracerebral abscesses, encephalitis, AIDS and related neurosurgical complications is increasing rapidly.

Congenital abnormalities include mostly meningomyelocele and encephalocele affecting the cranial vault and the fronto-ethmoidal bone.

Brain tumours, which used to be considered less common in African children, are now seen more frequently because of the availability of specialists, CT scanners and MRI, and in Zimbabwe because the number of African children seen at the teaching hospitals has more than quadrupled in the last 19 years. The tumours seen are hemispheric gliomas, craniopharyngiomas, pineal region tumours, posterior fossa tumours and brain stem gliomas.

Spinal extradural neoplasms, spinal intradural extramedullary neoplasms and intramedullary neoplasms are also seen in our practice. Intracerebral aneurysms and vascular malformations are extremely rare. There is a consensus among African neurosurgeons that the diagnosis is frequently missed because of lack of expertise and lack of adequate equipment.

Parasitic infestations (e.g. cysticercosis, bilharzia) reflect unhygienic living conditions.

In Zimbabwe, modern investigations are available such as CT scanning (seven scanners in Harare and two in Bulawayo) and MRI (three in Harare). Two CT scanners and one MRI system are owned by the teaching hospitals, allowing easier access to these investigations than before for all children. Other apparatus belongs to private institutions, which means that only people who are covered by an insurance policy or can pay cash are able to benefit from these facilities.

Cerebral digital angiography can be performed at the teaching hospital with newly acquired modern instruments. Other investigations available are myelogram, EEG, EMG, evoked potentials, isotope scan, SPECT scan, ultrasound scan and Doppler ultrasonography.

The operating theatre is equipped with adequate and modern instruments, including microsurgical sets and operating microscopes or magnifying lenses. More sophisticated machines, such as CUSA and laser, are not yet available.

The operating schedule is limited to 3 days per week, but emergencies can be handled on a daily basis at any given time. Strict sterile techniques are observed in the operating rooms.

A dedicated operating theatre for neurosurgery is available only at Parirenyatwa hospital. In other hospitals theatres are shared with other specialists.

Well-trained and fully qualified specialist anaesthetists, three of whom have a subspecialty qualification in paediatric neuroanaesthesia, anaesthetise the children. In 1998, 220 neuropaediatric operations were performed in Zimbabwe.

There are still no specialised resident nurses working permanently in paediatric neurosurgery. The nursing system is such that nurses rotate regularly through the various departments of the hospitals in order to be "polyvalent". As a result, the nursing level tends to fluctuate with time. Neurosurgeons therefore have to be vigilant at all times (by checking the nursing level regularly, by keeping children in the ICU or in a specialised high-dependency care unit for a little longer than might otherwise have been necessary after surgery).

Future of paediatric neurosurgery in Africa

The future and the development of paediatric neurosurgery in Africa depend upon the way our problems, some of which are common to several African countries while others are specific to particular countries, are addressed. It is also true that the environment determines the type of practice, while the quality of practice depends almost entirely on the individual neurosurgeon [8]. Our problems could be summarised under five headings: Manpower, Equipment, Choice of technology and surgical techniques, Delay in referral of patients and grossness of pathologies, and Research.

Manpower

Training of more neurosurgeons for countries in need should be a priority. This has been successfully achieved in some African countries, and in a relatively short period of time [3]. Solidarity among African neurosurgeons should prevail over and go beyond political ideology. If all established African schools could train one neurosurgeon every 5 years, the shortage we are now observing could be corrected rapidly. Besides the internationally accepted curricula, African candidates should also be taught to perform arteriography, ventriculography, and myelography and have a reasonable background in general surgery to prepare them for the fact that they might later practice in isolation in a location where neurodiagnostic facilities are in short supply and where a lone neurosurgeon will have to deal with conditions that in a more sophisticated environment would be shared between hyperspecialists.

This does not mean hankering after things that have gone, but it does mean applying what was good in the past to benefit those in underprivileged environments [8]. A period of training in a sophisticated centre will be required in addition. Each candidate will be introduced to laboratory research and will personally be in contact with progress and advances for this period, which will provide new comprehension of a wider neurosurgical world.

For the time being, several African countries will have to maximise the minimal manpower resources available. In fact, hundreds of miles from academic cen-

tres, competent general surgeons usually deal with head injuries, hydrocephalus, closure of meningomyelocele, subdural empyemas, etc. Therefore, the training of a general surgeon is already wide in our environment, as ours become more truly general surgeons than do their first-world peers. I am not advocating the training of "second-class" neurosurgeons, but of more competent general and orthopaedic surgeons to supply a real need in areas where there are no neurosurgeons [8]. The idea of visiting neurosurgeons should be encouraged in order to assist some young colleagues who are isolated in other African countries and who need to learn specific techniques, to update their knowledge or just to have the opportunity of discussing some difficult cases with a colleague on the spot for a short period of time. These trips could be financed by such organisations as WHO, pharmaceutical companies, WFNS, governments, the local business community, etc.

Lack of equipment

This is a major problem in many African countries. In the allocation of what meagre resources are available priority is given to other sectors of the health care system, such as primary health care, so that little is given to neurosurgery. I do, however, also believe that a number of procedures in paediatric neurosurgery can be carried out with basic sets of instruments and magnifying glasses. The concept of manufacturing basic sets of instruments at a low cost must be pursued and developed in third-world countries in collaboration with more advanced nations. A locally designed valve (Harare shunt) that has saved the life of several children and the economically affordable Maurice world-wide shunt are examples of this approach. Regional co-operation could also help in providing facilities for neurodiagnosis, neurology and neurosurgical functions.

Books and journals, which are also pillars of improvements in the treatment of patients and in the learning process, are not available most of the time. It is important to take advantage of the electronic mail to get the information needed or to identify colleagues who are willing to help out with journals and books. (I have found that it is easier to exchange a book or/and photocopies of interesting papers for attractive sculptures or other excellent objets from Africa).

Organisations such as WHO may offer good facilities in this line, and publishers could help by producing low-cost books, for instance books with soft covers, which are more affordable.

Choice of technology and technique

The choice of technology and techniques utilised must be appropriate to the environment in which they are to be applied and must really help the patient [2]. Utilisation of something that is not perfect, but is more than adequate, can be much more than "second best". In this line we have helped several children by operating on intramedullary spinal cord tumours in two stages, in the absence of CUSA and CO_2 laser [4]. The stress caused by the number of operations (two) patients have to undergo is more than offset by the good results. Endoscopic III ventriculostomy could also obviate the need of using shunts to treat hydrocephalus in selected patients.

In order to avoid complications and to increase the success rate of this procedure, MRI is required to define the nature of aqueductal blockage and to determine the position of the basilar artery beneath the III ventricle [1]. Where MRI is not available, a surgeon with sound knowledge of the endoscopic anatomy must rely on this knowledge.

Lastly, it is important to emphasise that a well-informed mother, irrespective of her level of education, can be the best nurse for her child. A study conducted in Harare on "the analysis of factors influencing the mortality in children following insertion of a shunt" clearly demonstrated that information was the most important factor. This explains the dramatic drop in mortality observed in the past [6]. It is important to note that children of mothers who were educated women but had not been given appropriate information did not do well. This is an important factor to keep in mind, as a skilled and technically good neurosurgeon may obtain poor results if the little time required is not taken to explain the child's condition and the possible complications linked with poor nursing to his or her mother.

Delay in referral of patients and grossness of pathologies

It is important to use the health care pyramid present in each country to introduce mechanisms for the improvement of neurosurgical treatment. The best way is to make regular visits to outlying hospitals. Such contacts stimulate interest, improve standards of practice, and get patients in need of expert care to specialists earlier. It is also a good practice to send clear instructions about the type of patients to be referred and the referral timeframe that is acceptable in paediatric neurosurgery. This message should be passed on to medical students, as they will be the future doctors working in the peripheral hospitals and therefore responsible for referring patients to specialists. This factor has made a large contribution to the identification of more pathologies and in much earlier referral of more patients for treatment in Zimbabwe.

Research

Most of the research done in Africa is clinically oriented. Laboratory research is generally seen as a luxury limited to sophisticated centres in the world.

I would like to differ with this view, as I believe that some research could be done at minimal cost. For instance, in Harare we have an excellent animal laboratory (with baboons, dogs, etc.) where experiments can be conducted with all due consideration for the international laws on the protection of animals. Specimens requiring sophisticated analysis could be sent to a colleague who has an interest in the research and who works in a more sophisticated centre. In this way, Africa could make some contribution to the chapters of neuroprotection, spinal and head injury etc.

Clinically oriented research can also be very interesting if conducted efficiently. It may identify better ways of preventing diseases by tailoring better health education programmes. Africa is still rich in terms of the number of patients seen with some pathologies that are currently rare in some developed countries. Indeed, there are still various aspects to be elucidated in the chapter of congenital abnormalities, spinal tuberculosis, hydrocephalus, brain tumours, brain infections, etc. The epidemiology of most of these pathologies is still unknown in Africa.

Conclusions

I sincerely believe that Africa as a whole will catch up and reach the international level some day. For the time being, it is important to keep on going with whatever little is being done. It is from that "little" that major achievements will be developed if we persevere. African neurosurgeons should make every effort and use the power they have to take part in the design and introduction of health care systems that will bring patients to them, and should do all they can to make their services available and accessible to these patients. It is important to show an interest in disease prevention, health education, and rehabilitation if neurosurgeons want their specialty to be correctly oriented towards the needs of their environment [8]. The creation of a lobby for paediatric neurosurgery is an important priority and a good exercise, which can be expected to bear fruit.

The quality of paediatric neurosurgery must be equal to the best in the world, but with the accent on appropriate technology for the benefit of the patients.

Finally, the improvement of paediatric neurosurgery in Africa is not only a challenge for Africa, but also a challenge for the "world of paediatric neurosurgery".

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