Neurocritical Care in Developing Countries

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Abstract Neurocritical illness heavily burdens the developing world. In spite of a lack of resources for population-based health in most developing countries, there is an increasing demand for resource-intense strategies for acute neurological care. Factors including rising individual incomes in emerging economies, need for neurointensive care in humanitarian emergencies, growth of private hospitals, the rising burden of noncommunicable disease, and the practice of neurocritical care by specialists outside of neurology are discussed. Possible steps to improve the global practice of neurocritical care include: (1) emphasis on prevention of neurocritical illness through traffic safety and adequate outpatient treatment; (2) standardization of training requirements and skill sets; (3) guidelines on cost-effective measures including medications, equipment, and devices; (4) strengthening of surveillance systems and registries for both noncommunicable and communicable neurological diseases; (5) expanded use of teleneurology; (6) educational exchanges of neurointensive health care workers; and (7) monitoring of neurological intensive care unit death rates due to nosocomial infections, neurological disease, and other causes. A summary of reported mortality rates among neurocritically ill patients in African countries in recent years is provided as an illustrative example.

Keywords Stroke · Trauma · Neurology · Intensive care · Neurologist · Developing countries

Neurocritical illness burdens the developing world, at times heavily and without the necessary resources, training, and facilities to provide the care that is very much needed. Infectious diseases are a major cause of neurocritical illness in developing countries, including meningitis, encephalitis, and cerebral malaria. Beyond infectious disease, there is now an even greater need to combat and address acute presentations of chronic disease. Ischemic and hemorrhagic stroke, severe head injury, and epilepsy are major unaddressed causes of morbidity and mortality in most developing countries. In addition to these highly prevalent disorders, neurological manifestations of rabies, tuberculosis, tetanus, organophosphate poisoning, and eclampsia remain smaller but important burdens of disease.

What then is the role of neurocritical care in the developing world? From one perspective, there is a lack of resources for population-based health in most developing countries. Yet, simultaneously, there is an increasing demand for resource-intense strategies for acute neurological care in these same settings. What can be learned from existent neurocritical care practices in developing countries to date? Why should neurocritical care be practiced worldwide?

First, rising incomes are experienced globally and asymmetrically, creating new upper and middle classes in some of the world's rapidly developing regions. For example, the absolute number of people considered "middle class" is greater in China than in the United States of America. This rising middle class has attributes and lifestyle-related habits that may put them at higher risk for neurocritical illness, including longer life span,

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hypertension, tobacco abuse, and increased transportation use. They may also be able to afford and access care that has not traditionally been prioritized in the health systems of some countries.

Second, a low gross national income at a country level does not equate to an absence of intensive care units (ICUs) (Fig. 1). Although ICUs are expensive and severely under-resourced in many locations, they treat a high number of patients, particularly in urban centers. In some countries, including least developed countries, governments fund hospitals that necessarily include ICUs. Humanitarian assistance groups and military hospitals may also include some form of management of acute head injury, meningitis, and seizures, even in fragile states and least developed countries. This means that neurocritical care may still be practiced and life-saving in extremely resource-poor locations. Neurointensivists may serve some of the most vulnerable patient populations and in times of extreme need.

Third, other specialties are recognized as having an acute or intensive care component to them, including surgery and cardiology, while neurology is often ignored in this regard. This suggests that neurocritical care is practiced but may not be formalized into a subspecialty. Just as neurology in general is usually not practiced by neurologists (instead being practiced by psychiatrists, general practitioners, and internists), neurocritical care is often practiced by neurosurgeons, general surgeons, and cardiologists. Medical ICUs may be filled with neurological patients but the recognition that a neurologist should be consulted, trained, or helpful in such circumstances often needs concerted promotional efforts. Neurocritical care may even be common but is overlooked and not quantified.

In a trend that is likely growing, private hospitals exist as islands of high resource care in some of the poorest regions of the world. These hospitals may employ greater numbers of health care workers per patient than a typical ICU in a high income country. The wages provided by private hospitals can drain physicians from the public sector in that region, leading to a relatively high number of neurologists in private clinics and hospitals where neurocritical care may be more likely to be practiced. Hiring of neurologists into the private sector can develop neurocritical care practices in countries where more limited government investment would have not considered or prioritized this need.

The establishment of neurocritical care in the United States is rooted in the poliomyelitis outbreaks of the early twentieth century [1]. Although the iron lung was replaced by newer techniques for ventilatory support and polio outbreaks ceased, the role of the intensivist continued to evolve to responsibility for other neurological diseases and presentations. In the 21st century, the development of

Fig. 1 A patient recovering from acute ischemic stroke in the intensive care unit of Mittaphab Hospital, Vientiane, Lao People's Democratic Republic

neurocritical care must be motivated by the growing burden of chronic noncommunicable diseases. Although not directly comparable, a summary of causes of acute care for neurological illness reported in medical journals from African countries in recent years (whether the patients were admitted to a formal ICU or not) demonstrates that mortality is high and much work is needed to improve the current situation, including in children [2–18] (Table 1). Whether these deaths are primarily due to the severity of neurological injury, late presentations to hospital, inadequate resources for intensive care needs, nosocomial infections, or other factors remains unclear. The mortality rates of patients in neurocritical settings deserve special attention. Existence of hospitals who accept acute neurological patients is insufficient. Significant coordination is required to finance, support, and sustain the work of practitioners of neurocritical care.

Solutions are possible and important. Neurocritical care everywhere can benefit from the growing organizational efforts of neurointensivists in high income countries who are standardizing skill sets and certification as well as fostering research opportunities. Private–public partnerships between health care facilities, local businesses, and drug and technology companies can also promote the way forwards. This includes commitment to drug delivery outside of urban settings and strengthening capacity for drug manufacturing in countries that can distribute within the developing world. Although tissue plasminogen activator is a standard of care for acute ischemic stroke in higher income settings, developing countries struggle with poor drug availability, poor medical facility organization, and poor community awareness of disease beyond the more clear indicators of absolute poverty. As such, snake venom, urokinase, and even unproven forms of acute stroke treatment may be employed when real treatments exist.

Table 1 Summary of selected studies of mortality outcomes involving neurocritical disease in Africa

Study	Year	Country	Description	Design (study & duration)	Diseases	No. of Patients/Subjects	Mortality findings
Sinclair et al. [2]	1989	Zambia	All admitted patients with non-traumatic coma	16-month study of inpatient non-traumatic coma	Eclamptic coma, cerebral malaria, organophosphorus poisoning	170	Cerebral malaria 23%, eclamptic coma 36%, organophosphorus poisoning 30%
Brewster et al. [3]	1990	Gambia	Children with <i>falciparum</i> malaria admitted to a single hospital	3-month prospective study of a 75-bed pediatric wing in a large provincial hospital	Comatose and febrile with seizure and a diagnosis of cerebral malaria	308	14%
Carne et al. [4]	1993	Congo	Children admitted to university hospital for cerebral malaria	18-month prospective study	Cerebral malaria	170	15%
Oyelami et al. [5]	1994	Nigeria	All patients presenting to a hospital with symptoms from 17D yellow fever vaccine	1-month observation period	Post-vaccination reaction to yellow fever vaccine	25	20% experience fatal coma
Shokunbi and Solagberu [6]	1995	Nigeria	All casualty department admissions among children aged ≤ 15	1-year retrospective study in a university hospital	Childhood head injury	160	13% compared to 1% for all patients in this same age group
Muyembe and Suleman [7]	1999	Kenya	Patients with any type of head injury admitted to surgery, ICU, or dead upon arrival	18-month mixed retrospective-prospective study in a provincial general hospital	Head injuries mostly due to road traffic accidents	361	28% brought in dead; 3% died in hospital
Mwangi et al. [8]	2002	Kenya	Children admitted with acute bacterial meningitis	7-year retrospective review in a district hospital	Acute bacterial meningitis, mostly due to <i>Streptococci</i> , <i>Enterobacteriaceae</i> , and <i>H. influenza</i>	390	30%
Beye et al. [9]	2003	Senegal	All admitted patients with eclampsia	2-year retrospective university hospital study	Severe eclampsia with coma	28	Maternal mortality 35%, child mortality 43%
Odebo and Abubakhar [10]	2004	Nigeria	All children aged ≤ 16 admitted for head injury	10-year retrospective study of admitted children managed non-operatively	Head injury, mostly due to road traffic accidents and falls	267	14%
Agùmon et al. [11]	2005	Benin	Severe head injury admissions	5-year retrospective study in a teaching hospital	Severe head injury, mostly due to road traffic accidents	236	70%

Table 1 continued

Study	Year	Country	Description	Design (study & duration)	Diseases	No. of Patients/Subjects	Mortality findings
Bartkovjak et al. [12]	2007	South Sudan	Children admitted and treated including 80% comatose patients and 26% with convulsions	8-year study at 3 separate clinics	Cerebral malaria	261	< 10% of children
Sène Diouf et al. [13]	2008	Senegal	All admitted stroke patients with a confirmatory head CT and a GCS ≤ 8	16-month prospective study in a teaching hospital neurology ICU	Acute ischemic stroke	105	83% mortality overall; 3-month survival of 10%
Sadarangani et al. [14]	2008	Kenya	All children admitted with coma and recent history of seizures, convulsions on arrival, or requirement for phenobarbital or phenytoin	2-year retrospective study in a rural district hospital	Convulsive status epilepticus	388 episodes of convulsive status epilepticus	15% in-hospital + 21% when including long-term follow up
Dehayem et al. [15]	2008	Cameroon	Patients admitted with diabetic coma	3-year retrospective study	Diabetic coma	52	21% in diabetic coma, more than half due to infection
Bahloul et al. [16]	2009	Tunisia	Children with GCS ≤ 8 admitted for severe head injury	8-year retrospective study at a university teaching hospital	Severe head injury, mostly due to road traffic accidents	222	24%
Wahab et al. [17]	2008	Nigeria	Consecutive admissions for first-ever acute ischemic stroke admitted within 72 h of onset	16-month cross-sectional observational study in tertiary care university hospital	Ischemic stroke	100	28% at 30 days
Louriz et al. [18]	2009	Morocco	Consecutive admissions to a medical ICU	16-year retrospective study of inpatient admissions to a teaching hospital	Acute aluminum phosphate poisoning	49	49%

Similarly, magnesium for eclampsia is still not universally available, not because it is too expensive but because the demand for magnesium is unquantified and the profitability unclear to companies. More recently, the prospects of solar-powered blood pressure cuffs [19] and fluoxetine for motor recovery in stroke [20] have the potential for scale-up. These interventions may help meet the growing need to improve long term outcomes.

Convincing ethical arguments exist to bring neurocritical care to whole populations in developing countries and not just those who can pay. Many aspects of neurocritical care can be practiced in most developing countries in reliable, affordable, and pragmatic ways; however, care without attention to neurological recovery post-admission and standard hygiene practices is an ignoble goal. Where intensive care is practiced, in low income settings as well as wealthier ones, it must have a clear endpoint and realizable goal. Most importantly, responsible neurocritical care must be incorporated into the ideally seamless continuum between prevention, intervention, recovery, and rehabilitation. Although it may be simpler to say that there are no resources for neurological intensive care for the poorest poor, the human face of the growing burden of neurological injury worldwide obliges policy makers, medical practitioners, and ministries of health to find a more nuanced and workable approach. Developing countries deserve possibilities for neurocritical care that respond to the changing needs of populations in poverty.

What can be done to improve the situation for patients with neurocritical illness in resource-poor regions?

- (1) Prevention: Helmets, seatbelts, speed bumps on roads, provision of aspirin, blood pressure monitoring, smoking cessation measures, epilepsy treatment. Primary care reduces the need for neurocritical care.
- (2) Standardization of training requirements and skill sets for the practice of neurology and neurocritical care.
- (3) Guidelines for the use of certain treatments, practices, and procedures in the care of neurocritical patients in all settings. This may include recommendations for such simple things as sequential compression devices or compression stockings, bedside swallowing tests, antibiotic prophylaxis, or daily aspirin use. Ideally, this should include the care of both children and adults. It may also identify a list of unproven, experimental, and unclear treatments for further study.
- (4) Strengthening of surveillance systems and registries for chronic neurological disease and neurocritical illness. A knowledge of the burden of disease that exists will help set priorities for funding and raise the profile for neurocritical care on the international health agenda.
- (5) Global neurocritical care educational exchanges which include training opportunities for physicians on both short and long term bases.
- (6) Teleneurology: The potential to diagnose and exchange information in a timely way around the world is now realizable and potentially cost-effective, making use of limited expertise for different challenging situations.
- (7) Monitoring of ICU death rates and nosocomial infections in neurocritical illness. An accurate assessment of the ability to prevent complications in neurocritical care patients is an important foundational step for evaluating the successes and failures of work to date. At best, a record of non-neurological threats to neurological patients in low resource settings can lead to simple and widespread measures to improve patient outcomes.

As in all places, the neurointensivist in the developing world faces challenges. These challenges are compelling and worthy of greater attention.

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