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A global perspective on Pediatric Neurology: A tale of different worlds

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Abstract

The paper is a compendium of the talks delivered in the symposium on 'Global Neurology: Pediatric Neurology - A Global Perspective' in the 'Joint 16th International Child Neurology Society and 49th Child Neurology Society meeting' held in October 2020. Neurological disorders are an important cause of disability and death. Neurological disorders in children significantly contribute to the global burden of disease, but they have received very little attention. Pediatric neurological disorders in resource-limited and high resource regions are similar, but the main etiologies differ, with malaria and meningitis more prevalent in the former. The global burden of pediatric neurological disorders is highest in Asia and sub-Saharan Africa, and many have an origin in the perinatal period. Besides a high burden, the capacity to provide optimal health care is lacking in poor resource regions. Due to the small number of properly trained child neurologists, the primary care personnel deliver most or all of the pediatric neurological care.

This paper addresses the challenges and opportunities in practicing child neurology from differently resourced settings across the globe. The main objective is to help the readers identify changes they could make in their practice related to pediatric neurology's local situation and become more active in supporting international educational programs. Training local medical personnel in poor-resource regions should be a priority to reduce the gap. There is a great need for affordable, easy-to-use, rapid diagnostic assays available at the point-of-care, especially to identify central nervous system infections. Further, the rollout of simple algorithms for primary health care workers to guide effective therapy and appropriate referral is needed. This can be achieved through collaborative efforts involving local leaders, regional centers of excellence, national and international medical societies, academic institutions, and private entities. In order to coordinate these efforts, the creation of a common platform for planning and communication is necessary to develop long-term and sustainable projects. Collaborative efforts are needed across the globe for patient care, research, funding, and seeking locally relevant solutions, keeping in mind the regional disparities and the need for different aspects of support. The growth curve of child neurology is rising across the world, and young child neurologists should be ready to face the challenges, seize the opportunities and effect the change. Greater collaboration shall lead to greater knowledge and greater hope for our patients.

Keywords: Global Neurology, Child Neurology, Low-income countries, resource-limited, Epilepsy, Africa.

Introduction

Neurological disorders are an important cause of disability and death. The current paper is a compendium of the talks delivered in the symposium on 'Global Neurology: Pediatric Neurology - A Global Perspective' in the 'Joint 16th International Child Neurology Society and 49th Child Neurology Society meeting' held in October 2020. The main objective of the symposium was to help the readers identify disparities in global health and neurological services, specific challenges in these regions, changes they could make in their practice related to local situation of pediatric neurology, and becoming more active in supporting international educational programs. Collaborative efforts are needed across the globe for patient care, research, funding, and seeking locally relevant solutions, keeping in mind the regional disparities and the need for different aspects of support. Greater collaboration shall lead to greater knowledge and greater hope for our patients.

A global situation of child neurology

Global security is dependent on health, and health and disease are very closely related to nations' economic and social development. Low-income countries (LICs) have the worst health conditions and the lowest indicators of health, high index of child mortality, and high prevalence of malnutrition [1]. Data from the World Health Organization (WHO) demonstrates that the risk of a child dying before the age of five years is eight times higher in the WHO African region than in the WHO European region. Five out of the six countries with under 5-year mortality rates above 100 deaths per1000 live births are in the African region. These disparities in child mortality between low- and high-income countries remain large. Half of the deaths in children under the age of 5y in 2018 occurred in sub-Saharan Africa. The WHO recognizes that reducing these inequities are important priority [2]. Low-middle income countries (LMICs) share a high burden of disease and lack the financial protection to cover the cost of health care, requiring out-of-pocket payments. Over 100 million people are pushed below the poverty line each year by expenditures related to health care [3]. Neurological disorders are an important cause of disability and death. In 2016, neurological disorders constituted the leading cause of Disability-adjusted life years and the second leading cause of overall deaths. Data indicate that this burden of neurological disease continues to increase as the population ages [4].

Neurological disorders in children have a significant contribution to the global burden of disease, but they have received very little attention [5]. Pediatric neurological disorders in resource-limited and high resource regions are similar, but the main etiologies differ, with malaria and meningitis more prevalent in LICs. The global burden of pediatric neurological disorders is highest in Asia and sub-Saharan Africa, and many have an origin in the perinatal period. The burden of disability in children aged 5-14 years has substantially increased in the last 25 years [5]. Five of the top 10 causes of years of life lost globally in 2016 are related to child neurology. These include malaria, preterm birth, neonatal encephalopathy, human immunodeficiency virus infection, acquired immune deficiency syndrome (HIV/AIDS), and trauma [6]. These disorders are overrepresented in LICs and carry a substantial morbidity and mortality, with most deaths occurring in Asia and Sub-Saharan Africa. Latin America has a long history of excellence in neurology [7, 8, 9, 10, 11, 12].

Argentina was the first country to open a neurology ward in 1885. Nevertheless, the existing political and economic problems led to poorly equipped academic centers and the emigration of well-trained professionals [13]. For example, the Pan American Health Organization report showed that two-thirds of the Latin American and Caribbean countries do not have an action plan to treat epilepsy, and discriminatory legal regulations with no scientific basis persist. The number of neurologists in this region is about 1.18 per 100,000 population. The availability of child neurologists is likely more limited but are no accurate estimates, and there are only few countries in the region with access to epilepsy specialists [14].

Besides a high burden, the capacity to provide optimal health care is lacking in poor resource regions. LICs have a ratio of 0.1 neurological workforce (including neurologists, child neurologists and neurosurgeons) per 100,000 population, in comparison to 7.1:100,000 in high-income countries [15]. Due to the small number of properly trained child neurologists, the primary care personnel deliver most or all of the pediatric neurological care [1]. Training local medical personnel in poor-resource regions should be a priority to reduce the gap. This can only be achieved through collaborative efforts involving local leaders, regional centers of excellence, national and international medical societies, academic institutions, and private entities (Figure 1). In order to coordinate these efforts, the creation of a common platform for planning and communication is necessary to develop long-term and sustainable projects.

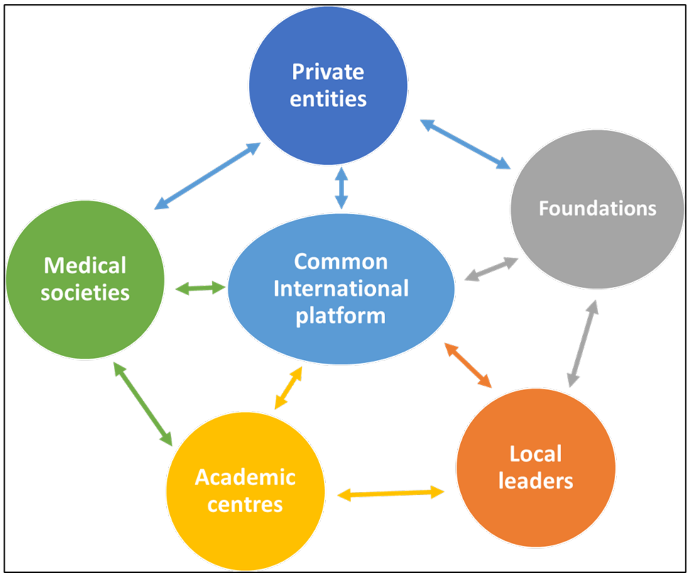

Figure 1. A Collaborative model for education and research, involving local leaders, regional centres of excellence, national and international medical societies, academic institutions and private entities

Child neurology in Africa: Narrowing the gap in access to medical care

A child's neurological health is affected by the environment that they are born into, inclusive of maternal health and socioeconomic state, direct influences such as malnutrition and infections of the central nervous system, their underlying genetic makeup or predisposition, and the available interventions to either prevent (e.g., vaccinations) or manage illnesses [16]. The first month of life is associated with the highest risk of dying; three-quarters of cases are related to prematurity, intrapartum events (e.g., birth asphyxia and birth trauma), and neonatal sepsis [17]. The leading causes of death of children under five years of age are acute respiratory infections, diarrhea, and malaria [18]. The disease burden is heavily skewed towards Africa, and many surviving children have neurologic sequelae [17, 18]. Relatively simple and cost-effective interventions could reduce the incidence and impact of these conditions, such as effective obstetric and neonatal facilities, comprehensive vaccination programs, oral rehydration interventions, sleep nets injected with insecticides, and prevention of mother-to-child HIV infection.

The prevalence of epilepsy in sub-Saharan Africa is twice that in Europe, Asia, and North America [19]. Perinatal insults in children and parasitic infections in adults constitute at least one-third of the causes. The treatment gap for epilepsy is nearly 49% across the African region [19]. Worldwide, in resource-poor countries, the treatment gap is around 46.8% in the urban regions and increases to 73% in the rural areas [20]. This is often related to the lack of resources, including manpower, cost of therapy, cultural beliefs, and poor access to antiseizure medications.

With regard to neurological infections, there were an estimated 1.7 million children under 15 years of age infected with HIV in 2018, and 90% of these were based in sub-Saharan Africa [21]. Children with HIV are at risk of neurologic disease from direct HIV infection, secondary or opportunistic infections, and treatment-related complications. In LMICs, antiretroviral therapy (ART) is accessed only by about 54% of the affected children [22].

In the regions where ART rollout is effective, children are surviving longer, and the disease phenotype is changing. There is an increase in the number of cases of immune reconstitution syndrome, and the prevalence of cognitive impairment and additional morbidities is higher [23]. This is compounded by underlying malnutrition and variations in endemic pathogens with the equivalent of a *layering effect* in health burden. The *layering effect* refers to the burden of multiple comorbidities such as poor nutrition and co-infections (e.g., tuberculosis and HIV), further challenging the child's diagnostic and management care. Worldwide measles virus outbreaks continue to occur typically due to vaccine failure associated with ineffective vaccination rollout or uptake. Over 2020 during the COVID-19 pandemic, vaccination uptake has been significantly disrupted [24]. There is a concern that following the next inevitable measles outbreak, there may be an upscale in cases of subacute sclerosing panencephalitis and other neurological sequelae. Other bacterial infections, such as tuberculous meningitis, and parasitic infections, such as malaria and neurocysticercosis, result in a significant disease burden in the African setting. In LMICs, where neurocysticercosis is endemic, this is a leading cause of seizures [25].

Compounding factors to the inadequate delivery of health care in LMICs include the distance to travel to health care facilities, especially from rural settings, restricted facility infrastructure with unreliable access to diagnostics tools (such as cerebrospinal fluid analysis, electroencephalogram), lack of subsequent treatments (antibiotics, antiseizure medications), and untenable costs for procedures and neuroimaging. Further, many people with neurologic conditions in LMICs, especially in Africa, are managed in psychiatric units, which further adds to the stigma associated with neurologic disease [26]. Although supportive of the associated comorbidities, it exacerbates the stigma of neurologic diseases.

There is a great need for better diagnostics in LMICs, which are often limited to basic tests. Neuroimaging is often unavailable, difficult to access, or costly. There is a great need for affordable, easy-to-use, rapid diagnostic assays available at the point-of-care, especially to identify nervous system infections. Further, the rollout of simple algorithms for primary health care workers to guide effective therapy and appropriate referral is needed.

According to the WHO, the number of child neurologists in Africa is significantly below the minimum recommended ratio of one specialist per 100000 population. With many African countries having no child neurologist, or at best two, the care is delivered by a diverse range of other healthcare practitioners such as adult neurologists, psychiatrists, primary healthcare workers, and traditional healers [27]. As such, upregulation of child neurology training is needed across all points of care delivery. In addition, focused education should be embedded into the undergraduate curriculums. Nurses, rehabilitation therapists, technologists, and other medical practitioners in complementary fields such as neurosurgeons, neonatologists, and developmental specialists are also needed. Coordinating multidisciplinary and translational care will not be possible without access to these resources.

Currently, most specialist training is based outside Africa. This results in poor return rates of trained clinicians in their home countries (the 'brain drain'). Enabling African clinicians to access training within Africa by African trainers and mentors leads to better retention and more relevant training [28]. These clinicians are empowered with the skills to practice effectively in their home environment and are less likely to leave. The collaborations formed between African centers via these training programs further strengthen training activities across the continent [29]. Clinicians need to be supported to develop leadership skills that extend into operational levels, with evolution in policy and upregulation of practice, resulting in sustained change at a macro and institutional level. These trainees should aspire to become trainers.

Global disparities in epilepsy care: The problem and possible solutions

Epilepsies are a potentially devastating, often progressive, group of diseases that can affect one in 26 individuals of any age, ethnicity, gender, or socioeconomic status [30]. Nearly 60,000 deaths every year are associated with epilepsy, including sudden unexpected death. The burden of comorbidities is up to 80%. The severe epilepsy syndromes of childhood are associated with intellectual deficits, autism, and in some cases, ongoing brain injury, leading to a lifetime of dependency and continually accruing costs - both medical and societal. The recurring seizures are a burden for those living with other diseases [31]. The costs involved in the care of children with epilepsy are huge. There are also educational issues and limitations in extracurricular activities, including participation in sports, compounded by the unpredictability of the seizures, the stress of chronic illness, and the social stigma and discrimination [32, 33]. There are wide gaps in knowledge, treatment, education, research, advocacy, and legislation. Diagnosis and management of epilepsy are suboptimal globally [34, 35]. Receiving inadequate treatment is a major component of the treatment gap, especially since epilepsy is often treatable with inexpensive medications. Originator drugs are more expensive than generic drugs and thus affordable mainly in the private sector [33]. The best treatment is not necessarily the newest drug. Factors that widen the treatment gap, especially in the resource-limited settings, are staff shortage, lack of knowledge, culturally driven misconceptions, social stigma, and limited, inconsistent access to antiseizure medications. Eventually, there is a need to step-up specialized epilepsy services in all countries as one-third of children are refractory to the existing treatments, which translates into over 20 million cases worldwide [36]. Table 1 discusses what we can do about epilepsy. The efforts are needed at the individual level: by the persons with epilepsy and the healthcare providers, and at the societal level, within and between the nations [1].

Table 1. What can we do about epilepsy: some solutions?

At the individual level (Person with epilepsy and healthcare provider)
• Understand the person's perspective
• Am I going to dement? Will my child be retarded?
• Am I going to die? Can I work or drive?
• Explain and develop realistic goals and expectations
• Encourage to seek treatment
• Help with motility and driving
• Effects on comorbid conditions
• Emphasize positives but do not hide negatives
• Be an advocate
• Sensitize the general public
○ Slogan: STAND UP FOR EPILEPSY with one voice
○ Testimonials-to elected officials
○ Champions-for the cause
At the society level
• Educate the public
• Educate the governments
• Build the infrastructure for proper diagnosis and deal with the chronic condition
• Address social issues
• Stigma
• Promote and effectively support research

We can reach out and teach or provide tele-support to primary care personnel on how to diagnose a seizure/epilepsy and initiate referrals or treatments, including the use of phenobarbital, one of the most effective available medications and probably the cheapest. In certain countries, there are regulatory issues that render the administration of phenobarbital difficult. We can improve the care at the individual level by empowering the people with epilepsy by explaining (destigmatizing, demystifying) the condition to them, guiding them on obtaining better treatments, and enhancing public engagement involvement. Such programs include educating patients and their families about the importance of research on epileptogenic mechanisms, learning from patients and their families about their most pressing needs and research concerns, and encouraging their participation in the clinical anti-epileptogenesis studies. The core of the epilepsy bioinformatics study for the anti-epileptogenic therapy (EpiBioS4Rx) program [37] uses the Participatory Action Research model, working with a community targeted for research or intervention, including representatives of stakeholders in all phases of the project, from planning to implement outcomes [38]. At the societal level, collaboration and communication are needed amongst several stakeholders. The WHO, the International League Against Epilepsy (ILAE), and the International Bureau for Epilepsy (IBE) published a volume titled 'Epilepsy: A Public Health Imperative' in 2019 that provides information and guidelines on several levels to make the necessary steps to improve the care [39]. This was based on a key resolution by the World Health Assembly in May 2015 titled 'Global burden of epilepsy and the need for coordinated action at the country level to address its health social and public knowledge implications' [40]. The key recommendations of this resolution are [39, 40]:

- Strengthen effective leadership and governance in health policies considering the specific needs of people with epilepsy and allocate resources for evidence-based plans and actions
- Introduce national health care plans of action for epilepsy management to overcome inequalities and iniquities affecting the care of people with epilepsy
- Integrate epilepsy management, including health and social care, into primary health care, by training health care providers and by empowering people with epilepsy for greater use of self and home care programs
- Improve access to affordable, safe, and effective epilepsy medicines
- Promote public awareness, particularly in schools, to reduce misconceptions, stigmatization, and discrimination
- Promote actions to prevent epilepsy through evidence-based interventions
- Improve investment in epilepsy research and increase research capacity
- For all these actions, engage civil society and other partners

Table 2 describes goals to improve care. The time to act is now, and we all have the opportunity to *Stand Up For Epilepsy* and with one voice to help people, especially children with epilepsy, live a normal life [41].

Practicing Pediatric Neurology in poor resource regions: Challenges and Importance of collaborative efforts

Looking at the diversity of landscape, cultures, economy, and population density in Asia, the distribution of pediatric neurology resources is far from homogenous and adequate. A survey of child neurology practices in India highlighted the lack of trained pediatric neurologists with no formal education in child neurology [42]. Child neurology services have made steady strides in several nations, with a steep rise of interest in neurological care, the commencement of structured long and short-term training courses, special interest and research groups, the establishment of several research registries, and an overall improvement in the diagnostic capacities. However, most of these advances are limited to the bigger cities, where most child neurology services are centered [43]. One can witness an increasing use of high-end technology, expanding research networks, branching out of child neurology sub-specialties, and constant funding support in developed countries. On the contrary, a child neurologist in the LMICs witnesses a high patient load, significant burden of endemic and tropical diseases, gaps in care (highlighting the preventable disorders), and a very variable resource distribution [44, 45].

From the point of view of a practicing clinician in a resource-limited setting such as India, there are several challenges to optimal pediatric neurology care. There is a high burden of walk-in patients at the institution or center level. The few available neurologists often attend the general pediatric outpatient clinics. As there is an absence of a refer-in or refer-back system, the patient can directly walk into the pediatric neurology clinic for the first and all subsequent visits and seek consultations from several physicians at the same time. This 'inverted pyramid' of patient load (Figure 2A) creates a mismatch of service utilization, doctor-shopping, duplication of work, unnecessary visits, and follow-ups. This all contributes to the increased footfall in the clinics, thereby reducing the time a neurologist can devote to each patient. As a result, the clinical time occupies a major share of the time distribution, whereas the research time is curtailed (Figure 2B).

Table 2. Goals to aspire to improve the care of children with epilepsy at the national level

- Promote epilepsy as a public health priority to reduce its burden.
- Improve public attitudes, reduce stigma and promote the protection of the rights of people with epilepsy.
- Invest in health and social care systems to improve accessibility to epilepsy care.
- Enhance access to cost-effective antiseizure medications global.
- Prevent acquired epilepsies such as those emerging following central nervous system infections, stroke, and traumatic brain injuries.
- Identify potential anti-epileptogenic treatments.

The burden of neurological disorders is still majorly contributed by tropical CNS infections, perinatal insults, neurodevelopmental disorders, and epilepsy, which is in most cases secondary to these causes. This scenario is common in several resource-poor countries [16, 45, 46]. These disorders prevail across the life course into adulthood [44]. Many of these disorders and the resulting neurological morbidity is preventable [47]. There is increased recognition of genetic disorders, but there are several impediments to their timely diagnosis and management. The absence of universal newborn screening, the lack or inaccessibility of diagnostic facilities, lack of awareness, and costly treatment strategies affect the care of inherited or genetic diseases [15]. This is compounded by the urban-rural imbalance in the distribution of child neurologists and the problem of 'brain drain'. Another factor is the under-recognized deficiency of the allied healthcare providers, such as child psychologists, electrophysiology technicians, nurse practitioners, nutritionists, therapists, social workers, etc., which are important cogs in the wheel of holistic neurological care. As less is known, so less is done! The absence of national registries and repositories underestimates the true burden of neurological disorders. This is essential for policy change, funding and collaboration. While some LICs face the challenge of a lack of resources to initiate pediatric neurological services, others have an imbalance in the funding preferences; and hardly any funding is available for primary prevention programs and rehabilitation [48]. At the community level, the major challenge is the interplay of social-economic-cultural barriers that determine the treatment-seeking behavior of families. A high out-of-pocket expenditure for a low-income family in the absence of state insurance, lack of awareness, social stigma, faith healing, alternative treatment practices, and poor access to health care are some of these barriers.

The importance of collaborative efforts

A single person or effort operating in isolation cannot effect a change; change needs a cause, direction, and togetherness. Taking child neurology forward in LMICs is no different, so collaborations are necessary [49]. The first step is to identify local needs and form 'micro collaborations' at an individual level, which address the problem in a cost-effective, locally relevant, and feasible way. Child neurologists and allied specialists can come together to form research groups for the generation of data and estimation of disease burden. Genetic research databases such as the 'The Genomics Research and Innovation Network' establish the technology, policy, and procedures for a scalable genomic research network and should be our future repositories for all research work [50]. At the national level, collaborations between several institutions involved in caring for children with neurological disorders and non-government organizations can effect a 'system or policy-based change. Such collaborations are important for information, awareness, education, and change in practice parameters in nations.

The triple burden of epilepsy, nervous system infection, and neurodevelopmental disorders secondary to perinatal problems in most Cs can be addressed by simple primary prevention mea-

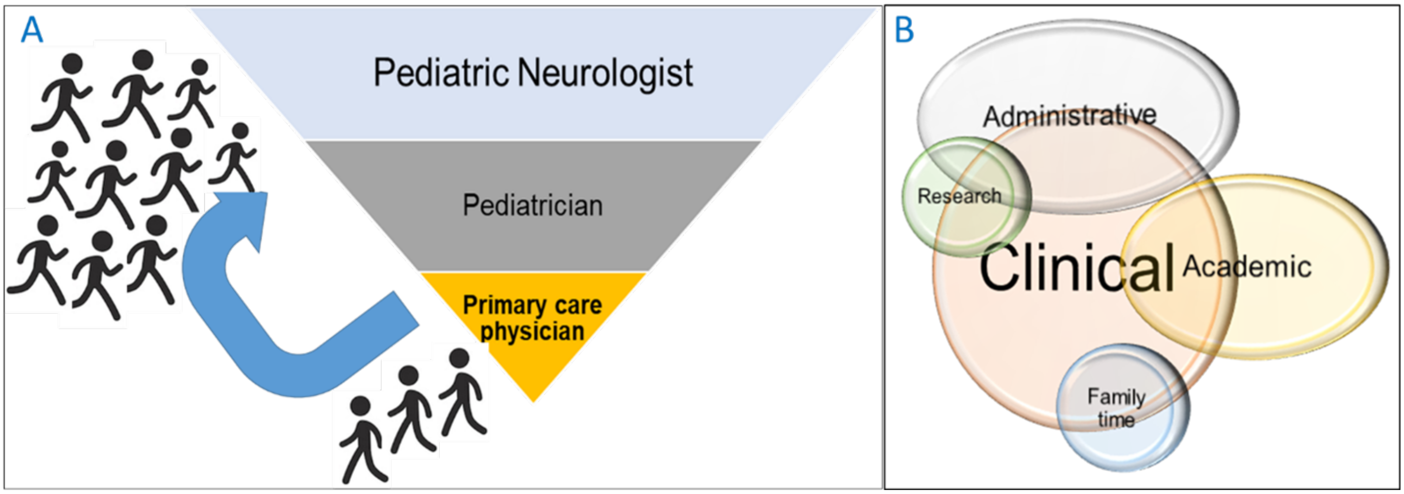

Figure 2. (A) The 'inverted pyramid' of patient load in resource-limited settings: As there is an absence of a refer-in or refer-back system, the patient can directly walk into the pediatric neurology clinic for the first and all subsequent visits and seek consultations from several physicians at the same time. Thus, fewer cases are seen by the primary care personnel than the neurologist, which creates a mismatch of service utilization, doctor-shopping, duplication of work, unnecessary visits, and follow-ups. (B) In the absence of division of clinical and research times for a child neurologist, the clinical time occupies a major share of the time distribution, whereas the research, administrative, and teaching time is curtailed.

sures such as supervision of antenatal care, improved perinatal care, universal newborn screening, administration of vitamin K after birth, prevention of perinatal asphyxia, early detection of neonatal jaundice and hypoglycemia, immunization, improving hygiene and vector-control measures, adequate treatment of adults with tuberculosis and HIV, etc. [16]. Primary care is the basis of the health system in most LMICs, serving all of the population [51]. The role of primary health personnel at the community level becomes paramount in LMICs. Hence, collaborative efforts should be directed towards strengthening the backbone of the health system in countries with meager resources and neurologists. Basic' neurology clinics' can be established in the peripheral and remote centers with a tele-consult connected to the main centers. A home-based rehabilitation model is a community-based approach to teaching parents the basic rehabilitation techniques, combined with regular check-ins by a community health worker in the family's home [52]. This ensures more success, fewer visits, and less drainage of resources and promotes parent empowerment and compliance. Community education should focus on policies and programs, and preventable neurological disorders should be added to the existing preventive and social pediatrics curriculum.

At the international level (macro collaborations), collaborative platforms help improve global health, patient care, and advocacy. This means that a common international platform is provided by bodies such as the International Child Neurology Association, Child Neurology Society, ILAE, The World Federation of Neurology, American Epilepsy Society, etc., in bringing all of us closer and together [53]. However, the local leaders and bodies are the key components to translating these collaborations. A translational approach is needed to utilize international collaborations (Figure 3) best. Long-term sustainable solutions to these problems can only come from within the region. This means we need to identify our problem, assess the map for collaboration, frame our time-bound objectives, seek targeted help, and then assess the outcomes. This way, the collaborations can be bilaterally fruitful with measurable benefits.

For the child neurologists in LMICs, a useful way to utilize the international collaborations is to transform the care of one disease within the specialty at their center or institution, which can go a long way in improving patient care. Another impactful area for international collaborations is the augmentation of training and teaching activities beyond the conventional conference or meetings. Some of these educational and training outreach models are presented in Table 3, which are themed on the 'need-based' training in different regions across the globe and using collaborative efforts to address the specific problems.

In conclusion, resource-limited countries face the challenges of high burden of tropical, perinatal, and infectious diseases, disparity in resources, urban-centered services, social-economic issues, and dearth of funding. There is an urgent need for quality research for affordable and sustainable healthcare solutions in LMICs. The focus should be on primary preventive measures such as improved perinatal care, sanitation, universal immunization, public health and education interventions, and system change. Joint efforts are needed for patient care, research, funding, and seeking locally relevant solutions, keeping in mind the regional disparities and the need for different aspects of support. The growth curve of child neurology is rising across the world, and young child neurologists should be ready to face the challenges, seize the opportunities and effect the change. Greater collaboration shall lead to greater knowledge and greater hope for our patients! Apart yet together is the way to go!

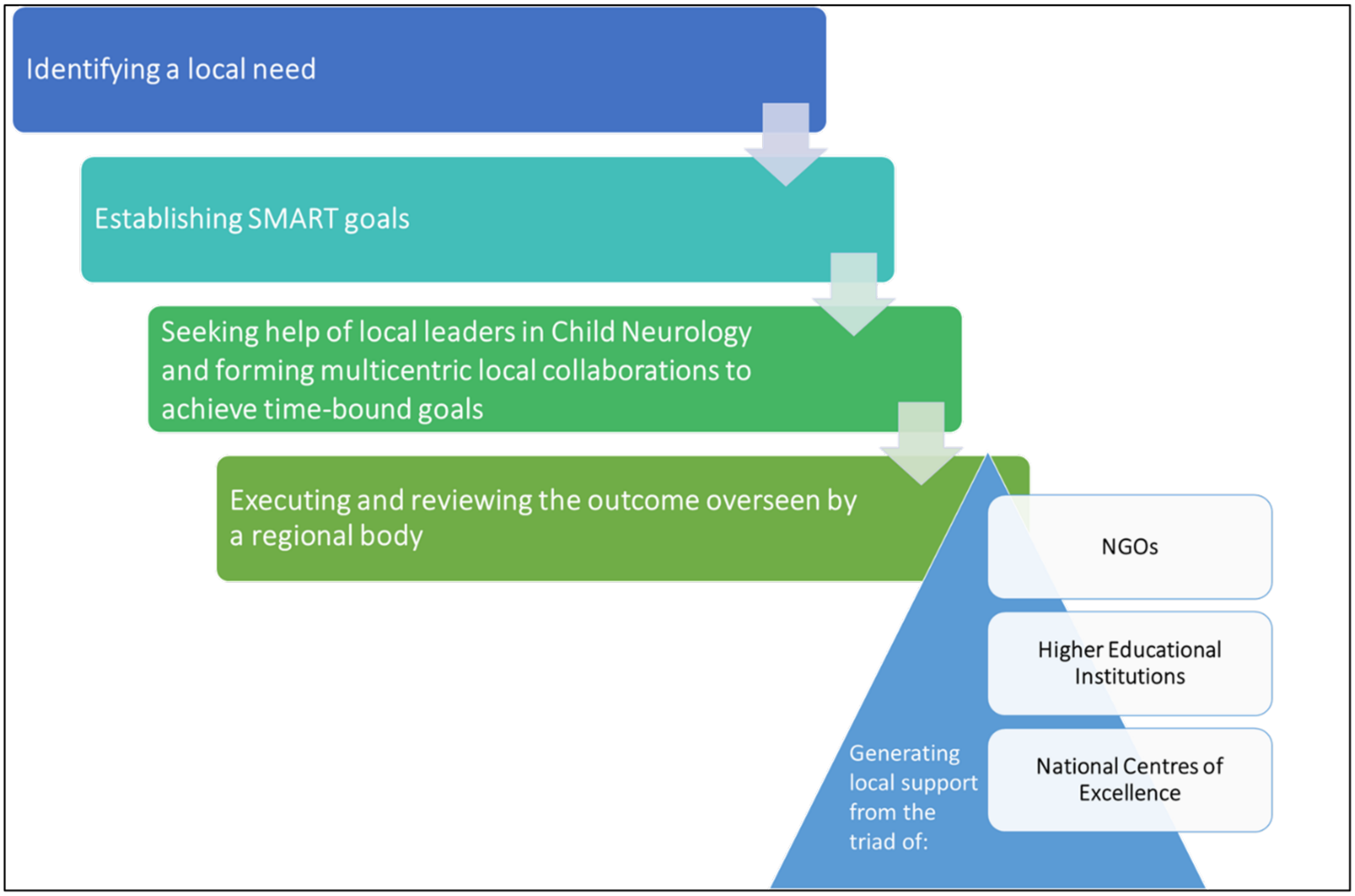

Figure 3. Translational approach to International Collaborations: The local leaders and bodies are the key drivers in translating international collaborations. Long-term sustainable solutions to the problems in LMICs can only come from within the region. This means we need to identify the problem, assess the map for collaboration, frame our time-bound objectives, seek targeted help, and then assess the outcomes. This way, the collaborations can be bilaterally fruitful with measurable benefits.

Table 3. Examples of training approaches for educational and training outreach activities for collaborative bodies that can help resource-limited settings.

TWIN approach (Two Week Initiative in Nations) program:
• Instead of the conventional model of 2-3 speakers zooming in and out over a few days, slightly longer visits are initiated in areas needing support where support is given for setting up a clinic, seeing complex cases, giving guidance for approaches, running of services • Return or follow-up visits to measure the outcome • Such programs will help the local people strengthen their program, help streamline the working, and help in removing their road-blocks in delivering good child neurology services (in their own socio-cultural-resource milieu)
GRIP (Group of Resourceful Interested Persons) approach
• Instead of the common practice of a team of experts leading a teaching program at the local level, a team of resourceful people (e.g., child neurologist, therapist, EEG technician, dietician) catering to the regional needs go in • This is a need-based approach and engages more people
TOT (Training of Trainers) meetings:
• Efforts to train and engage local and young child neurologists and even primary care physicians •Helps in capacity building and improvement of teaching
SSTIR (Survey and Solve Through International Resources) approach
• Focus on organizing courses, making research groups in the local and international setting (connectome), establishing consultation networks (consultome) • Based on the identified gaps and felt needs of the region
PLOTS (PLatforms for Online Teaching/Seeking help) approach
• Help for live or module-based courses to facilitate need-based learning such as in epilepsy, tropical neurology, inherited disorders, neuromuscular disorders, neurodevelopmental disorders • Self-initiated by the learner, with no or low fee, and preferable certified • Can act as bridging courses for physicians to train in specific aspects of their region's requirement

Competing interests

The authors declare that they have no competing interests.

Author contributions

Arushi Gahlot Saini has been involved in drafting the manuscript and revising it critically for important intellectual content and has given final approval for the version to be published.

Jo Wilmshurst has made substantial contributions to conception and design, acquisition of data, analysis, and interpretation; have been involved in drafting the manuscript or revising it critically for important intellectual content, and have given final approval of the version to be published.

Solomon L. Moshé has made substantial contributions to conception and design, data acquisition, analysis, and interpretation; has been involved in drafting the manuscript or revising it critically for important intellectual content; and has given final approval of the version to be published.

Alla Guekht has made substantial contributions to conception and design, acquisition of data, analysis, and interpretation; has been involved in drafting the manuscript or revising it critically for important intellectual content, and has given final approval of the version to be published.

Agustin Legido has made substantial contributions to conception and design, acquisition of data, analysis, and interpretation; have been involved in drafting the manuscript or revising it critically for important intellectual content, and have given final approval of the version to be published.

Jorge Vidaurre has made substantial contributions to conception and design, acquisition of data, analysis, and interpretation; have been involved in drafting the manuscript or revising it critically for important intellectual content and have given final approval of the version to be published ad shall be the guarantor of the manuscript.

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