# Comprehensive Policy Recommendations for Head and Spine Injury Care in LMICs

April 2019

Northwest School of Medicine

Program in Global Surgery and Social Change
Harvard Medical School

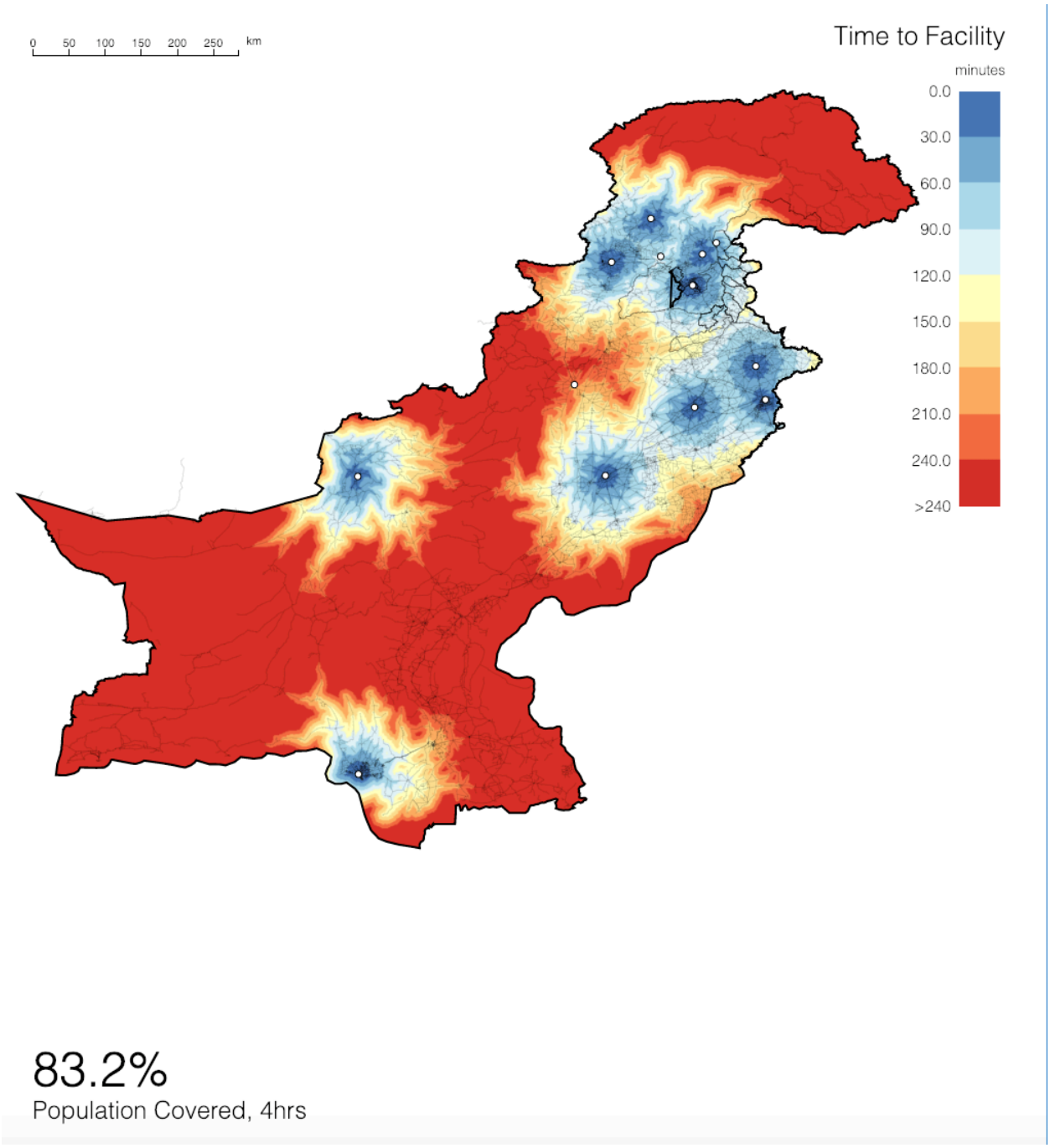


Figure: Neurotrauma coverage in Pakistan, 2018 (WFNS, 2018).

# Comprehensive Policy Recommendations for Head and Spine Injury Care in low- and middle-income countries

*No person experiences undue disability or death due to head and spine injury regardless of where they live*

Peshawar, Pakistan, March 2019


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**Acknowledgements**
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# Foreword

## A comprehensive set of policy recommendations for the management of head and spine injuries in low- and middle-income countries

In 2015, the Member States of the World Health Organization unanimously passed the resolution calling for "strengthening emergency and essential surgical care and anesthesia as a component of universal health coverage" during the 68th World Health Assembly. In four short years, 37 Member States have either completed or are in the process of drafting or initiating a National Plan for Surgical Care. The surgical landscape in LMICs is set to change dramatically.

These plans identify gaps in surgical care and develop a path to building sustainable surgical capacity as part of the overall health system so that most of the population within the country (80%) will be able to access timely, safe, and affordable surgical care when needed.

A robust surgical system is a cornerstone for Universal Health Coverage, Sustainable Development Goal 3, Target 3.8. It also contributes to the reduction of maternal deaths (3.1), deaths of newborn and children under five (3.2), reduction of premature deaths from Non-Communicable Diseases (3.4), access to sexual and reproductive health services (3.7), increasing health workforce (3.c), and improves readiness for global health risks (3.d).

However, in achieving SDG 3.6 ( i.e to halve the number of global deaths and injuries from road traffic accidents by 2030) surgeons, and in particular, neurosurgeons, have the added responsibility to provide strategic guidance and technical support to the policymakers. In this regard, the technical team, with guidance from the advisory group, has developed a set of comprehensive policy recommendations for the management of head and spine injuries in the developing world also known as "Peshawar Recommendations".

These recommendations are designed to assist policymakers in developing contextualized national plans to reduce deaths and injuries from road traffic accidents. To that end, the recommendations employ the same framework widely in use to develop national surgical plans – thus simplifying the integration of the recommendations into the national surgical plans.

We are grateful for the Khyber Pakhtunkhwa Health Department of Pakistan for their willingness to integrate the recommendations into their provincial surgical obstetric and anesthesia plan. The commitment to invest in the comprehensive management of head and spine injuries –including prevention and prehospital care–will doubtlessly save many lives and prevent a greater number of disabilities in the province. We encourage all governments to adopt the Peshawar Recommendations as a way to "halve the number of global deaths and injuries from road traffic accidents by 2030" – SDG 3.6.

Sincerely,

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"A robust surgical system is a cornerstone for Universal Health Coverage, Sustainable Development Goal 3, Target 3.8.

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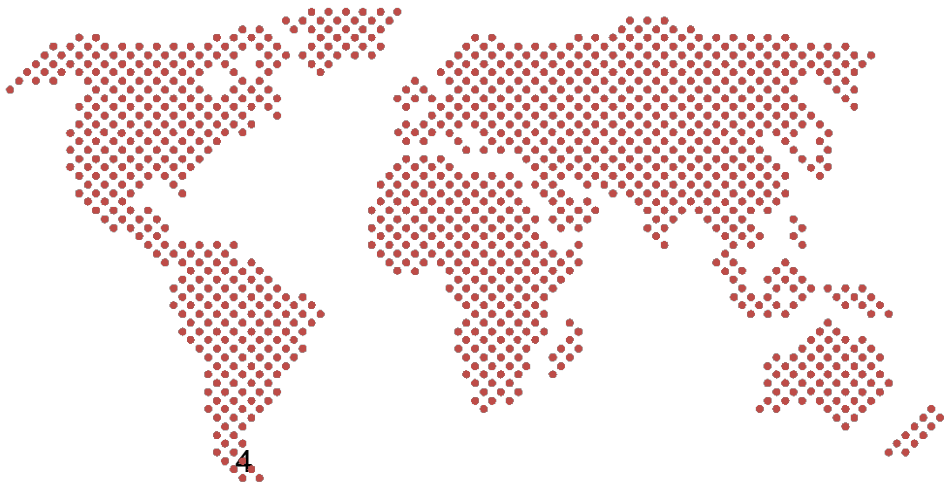

# Introduction

## Vision

No person experiences undue disability or death due to head and spine injury regardless of where they live

### Rationale

The Lancet Commission on Global Surgery catalyzed a momentous paradigm shift in global health following its publication in the year 2015. We now know that a large proportion of the world's burden of disease can be treated with surgical care; hence, new focus has been adopted to develop robust health systems and surgical infrastructure in low and middle income countries. The executive summary of the Lancet Commission can be summarized in the following 5 key messages:

"

1. 5 billion people do not have access to safe, affordable surgical, obstetric, and anesthesia care when needed.
2. 143 million additional surgical procedures are needed in LMICs each year to save lives and prevent disabilities.
3. 33 million individuals face catastrophic health expenditure due to payment for surgical, obstetric, and anesthesia care each year.
4. Investing in surgical services in LMICs is affordable, saves lives, and promotes economic growth.
5. Surgery is an "indivisible, indispensable part of health care".

- *Lancet Commission on Global Surgery, 2015*

Neurosurgical diseases represent a significant proportion of the unmet surgical need. According to the Executive Summary of the Global Neurosurgery Initiative at the Program in Global Surgery and Social Change, there is an estimated 22.6 million patients globally who suffer from neurological disorders or injuries that warrant a neurosurgical evaluation and of these 13.8 million individuals would require surgery. In LMICs, head and spine injuries combined make up the highest proportion of unmet neurosurgical operative burden, with almost 5 million cases per year in that category.

It is clear that global neurotrauma represents a significant burden in LMICs exerting great societal costs in the form of lost human capital. Thus, efforts must be made to improve the quality and access to neurotrauma care in these impoverished regions of the world. These efforts can take on many forms, but for maximal impact, policy changes must occur in the first instance to reflect the needs of neurotrauma health care systems. Historically, surgical policies have been omitted from national health plans, however, the creation and implementation of National Surgical, Obstetric, and Anesthesia Plans (NSOAP's) have begun to remedy this. The Lancet Commission has provided a theoretical framework (see appendix) to guide policymakers to include surgical, obstetric, and anesthesia components into the greater National Health Sector Strategic Plans.

With the emergence of NSOAP's across the world, there exists an opportunity to create neurotrauma-specific policy recommendations to be integrated in these guidelines and framework. The development of neurotrauma systems infrastructure is vital to help the large number of individuals who tragically suffer death or disability due to traumatic brain or spine accidents.

**For the purposes of this document, neurotrauma will be defined and used interchangeably as head and spine injuries.**

### Aim

To develop system-level policy recommendations for reduction of death and disability from brain and spine injury in low- and middle-income countries (LMIC).

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# Framework

## Part 1: The National Surgical, Obstetric and Anesthesia Plans

The Lancet Commission on Global Surgery recommends a specific framework to be used for stakeholders within Ministries of Health and other key players in national health policy.[1,2] The process of NSOAP development identifies current gaps in health care, prioritizes solutions, and provides specific time bound, prioritized implementation plans.[3] The components of an NSOAP include:

1) **Infrastructure**
2) **Workforce**
3) **Service delivery**
4) **Financing**
5) **Information management**
6) **Governance**

To date, five countries have completed their NSOAP's and close to 37 countries are in various stages of development. The benefits to NSOAP's have been well described and are summarized in the following four broad concepts: 1) Coordination and efficiency; 2) Visibility and accountability; 3) Priority setting; 4) Platform for investment and partnership.[4]

To achieve these targets, the framework has created a space and context to account for the six domains of a healthcare system, namely, infrastructure, workforce, service delivery, financing, information management, and governance. Each of these domains are synergistic and must be considered in order for successful scale up of surgical services.

## Part 2: Comprehensive management of head and spine injuries


Neurotrauma management can also be considered in each of these 5 domains. By maintaining this original framework, policymakers can overlay these recommendations onto current the NSOAP that will ultimately embed into the larger National Health Plan. Our recommendations have the added domains of the management of head and spine care adapted from proposals put forth by the American College of Surgeons for improving trauma systems.[5] These components include:

1) **Surveillance**
2) **Prevention**
3) **Pre-hospital care**
4) **Surgical system**
5) **Rehabilitation**

Our recommendations merge the policy-oriented methodology from the NSOAP framework and the existing practical guidelines already in place by trauma organizations. Thus, we hope to ensure a comprehensive approach to neurotrauma systems development.

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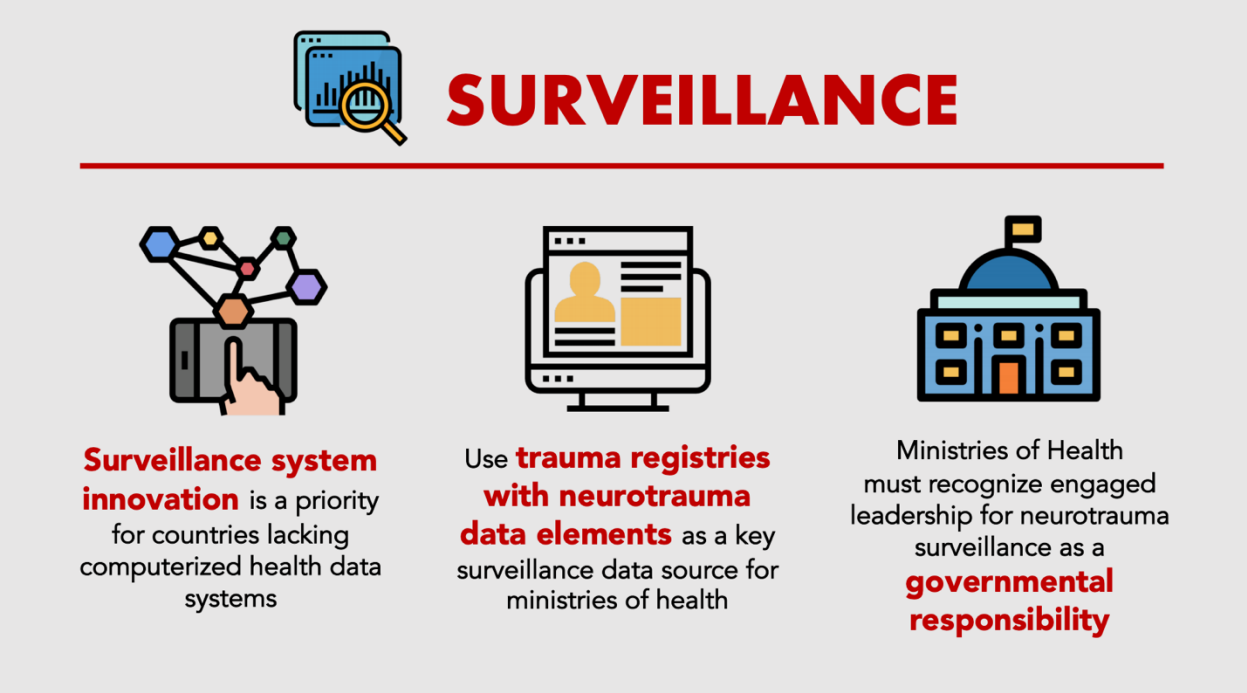
# Recommendations matrix

| | Surveillance | Prevention | Pre-hospital care | Surgical system | Rehabilitation |
|---|---|---|---|---|---|
| **Infra-structure** | -Integration through agile platforms<br>-Leverage international partnerships for surveillance | -Safe roads | -Contextualized pre-hospital system | -80% of population within 4-hours of neurotrauma center<br>-Strengthen pre-existing trauma infrastructure for neurotrauma | -Contextualized allocation of space and stuff for neuro-rehabilitation<br>-Facility stratification for severity |
| **Workforce** | -Fit for purpose workforce for data collection, analysis, and interpretation<br>-Align international collaborations to support local workforce capacity<br>- Flexible and strategic use task-shifting and task-sharing to optimize human resources | -Robust workforce for public health education and implementation | -Neurotrauma care training of emergency medical personnel | -1 neurosurgeon per 200,000 people at minimum<br>-Task-sharing of surgical workforce is preferred over task-shifting<br>-Dramatically increase neurosurgical training capacity | -Ensure rehabilitation training capacity is adequate<br>-Ensure competency throughout continuum education |
| **Service delivery** | -Minimum data to include demographics, diagnosis, mechanism, severity, and outcome measure<br>-Use existing trauma registry<br>-Use WHO Trauma System Maturity Index to monitor progress | -Strengthen public education<br>-Encourage safety-conscious “Ride hailing” services<br>-Strengthen enforcement of safety laws | -Prevent hypotension and maintain oxygenation<br>-Time from injury to neurotrauma facility should not exceed 4-hours | -Standardization of essential neurotrauma equipment<br>-CT scanner in all neurotrauma facilities<br>-Critical care unit in all neurotrauma facilities<br>-Leverage telemedicine as a tool for increasing coverage<br>- Innovate for low-resource settings | -Sensitive to gender and age sub-groups<br>- Partner with family for delivery of non-technical physical therapy |
| **Financing** | -Maximize external funding<br>-Build internal capacity<br>-Use open-source platforms | -Promote health benefits of public investment in safe roads<br>-Partner with external organizations for advocacy | -Cost-effective training models<br>-Utilize low-cost or free digital technology | -Embed neurotrauma within universal health coverage package<br>-International partnerships for neurotrauma capacity building | -Embed neurorehabilitation within universal health coverage package |
| **Information management** | -Utilize WHO International Registry for Trauma and Emergency Care (IRTEC) | -Tracking of safety law compliance | -Encourage data collection by emergency medical personnel | -Track neurotrauma workforce and operative mortality | -Collection of neurorehabilitation outcome data |
| **Governance** | -Empower ministry of health leadership<br>-Utilize reporting requirements to improve accountability and compliance | -Regulatory framework to strengthen enforcement<br>-Comprehensive helmet laws<br>- Workplace safety regulations | -Inclusion of pre-hospital care in national health plans | -Draw on existing international technical resources to assist with neurotrauma capacity building<br>-Promote neurotrauma as vital to achieving national and international health and development goals | -Rehabilitation is indispensable to a quality health system |

# Surveillance




In 1995, the WHO Safety Promotion and Injury Control Division of Emergency and Humanitarian Action joined the US CDC to produce a monograph establishing global standards for Neurotrauma Surveillance. [1] That report defines surveillance as, "…the ongoing systematic collection, analysis and interpretation of health data necessary for designing, implementing and evaluating public health programs." [1] Per WHO recommendations, attributes of public health surveillance systems that favor their success include simplicity, acceptability, sensitivity, predictive positive value, representativeness and sustainability. For the surveillance of brain and spinal cord injuries, key primary sources of data that may be useful for surveillance systems include death certificates, hospital discharge data, medical examiner or coroner records, emergency medical service records, trauma registries. [1] Supplemental sources of data that may augment neurotrauma surveillance systems include hospital medical records, records from social service or national insurance systems, or police and other public safety records. [1]

In the era of sustainable development, as the global neurosurgery movement has highlighted extraordinary data asymmetry across nations by income level, the need for developing effective neurotrauma surveillance systems for low- and middle-income countries has emerged as a priority for addressing the global burden of traumatic injuries of the brain and spine. [2, 3] Indeed, with virtually all high quality data and guidelines on neurotrauma care coming primarily from high-income countries, available evidence principally informs health systems in nations representing a small proportion of the global neurotrauma burden [4,5] The development of effective surveillance systems for neurotrauma in LMICs will therefore require collective action from the global neurosurgery and larger global surgery and health communities to address all dimensions of health system inequity that currently limit standardized data collection and aggregation that strengthens neurotrauma prevention and care on a global scale. [2,3,6,7]

## Infrastructure

### Integration through agile platforms

Effective surveillance systems for neurotrauma require data handling platforms that can aggregate and integrate surveillance data on neurotrauma from multiple sources, such as trauma registries, police reports, vital registries, health surveys, information systems and national insurance records. [13] Design and development of these platforms is therefore a requirement of effective national surveillance of neurotrauma. [1,8]

### Leverage international partnerships for surveillance

In countries lacking computerized health data collection systems, we recommend developing global neurotrauma partnerships between LMICs and HICs that promote synergy in surveillance system innovation. These partnerships should prioritize strengthening LMIC neurotrauma surveillance using tools such as operational systems engineering to establish platforms that are simple to use, acceptable to users, sensitive to local needs, representative of the local context, highly predictive of positive value, and sustainable. [9,10,12]

## Workforce

### Fit for purpose workforce for data collection, analysis, and interpretation

Given the variety of types and sources of surveillance data, effective neurotrauma surveillance requires multidisciplinary and cross-sectoral human resources engaged in every aspect of data workflow, from initial collection of data to its aggregation, analysis, interpretation and utilization for policymaking around neurotrauma and public health.[8,14]

According to the International Society for Disease Surveillance, investing in the development of surveillance workforce competencies improves organizational capacity to exploit technological advances for surveillance frameworks that are better prepared to meet the challenges of national surveillance. [13-15]

### Align international collaborations to support local workforce capacity

Global neurosurgery partnerships can strengthen LMIC neurotrauma surveillance capacity by collaborating with local, inter-country and inter-institutional public health training programs. Training partnerships of this kind have been effectively utilized to strengthen disease surveillance frameworks in Sub-Saharan Africa. [16-18]

### Flexible and strategic use task-shifting and task-sharing to optimize human resources

When trained human resources for neurotrauma surveillance are lacking, task-shifting offers a viable strategy for satisfying workforce needs in neurotrauma surveillance; this may include leveraging students and trainees for data collection at the facility-level. [9,19]

## Service delivery

### Minimum data to include demographics, diagnosis, mechanism, severity, and outcome measure

It is recommended that neurotrauma surveillance systems collect the following categories of data to inform brain and spine injury prevention programs and quality improvement for neurotrauma care: [1]

- Demographic information
- Coded diagnosis using the International Classification of Disease
- Mechanism and circumstance of injury,
- Severity using coded indices such as the Glasgow Coma Scale and the Injury Severity Score
- Outcome measures such as survival status, hospital length of stay, or Glasgow Outcome Scale.

### Use existing trauma registry

Trauma registries are significantly underutilized in LMICs despite the acknowledged need for these facility-level data platforms; we recommend the use of trauma registries with neurotrauma data elements as a key surveillance data source for ministries of health. [20,21]

The WHO Trauma System Maturity Index can guide MOHs in improving neurotrauma surveillance efforts as part of an overall strategy to strengthen national systems for trauma care. [20,22]

### Use WHO Trauma System Maturity Index to monitor progress

Health facility assessments (HFAs) offer ministries of health (MOH) a comprehensive approach to monitoring and evaluation of health system service delivery and strengthening initiatives. As the WHO develops a new platform for harmonized HFAs, the platform promises to strengthen the MOH armamentarium for neurotrauma surveillance. [23]

## Financing

### Maximize external funding and build internal capacity

Lack of funding is the most commonly cited barrier to the development of national trauma surveillance systems in LMICs. [9, 24] This can be overcome with grant or other development funding from HIC partners, or external healthcare financing agencies. While these sources may offer transient solutions for neurotrauma surveillance funding, local buy-in at the Ministry of Health level is, however, an indispensable component of sustainable funding paradigms for national surveillance systems. [9]

### Use open-source platforms

Free and low-cost information technology tools for neurotrauma surveillance can help LMICs to surmount prohibitive financial barriers to enacting effective neurotrauma surveillance programs. [9,22]

## Information management

### Utilize WHO International Registry for Trauma and Emergency Care (IRTEC)

Employing uniform standards for neurotrauma case definitions and data elements facilitates comparison of neurotrauma epidemiology between countries and localities, as well as communication regarding neurotrauma surveillance across contexts. In order to strengthen prevention and treatment policies for traumatic injuries of the brain and spine, ministries of health should therefore prioritize the development of local standards for neurotrauma case definitions and data dictionaries. [1,25]

A survey of data dictionaries from the national trauma registries of six low- and middle-income countries (LMICs) revealed 18 TBI-specific data elements across databases, with great heterogeneity across registries. [28] The most commonly shared data elements included GCS score (shared by four countries), mental status (shared by three countries) and helmet use (shared by three countries). Standardization of these neurotrauma data dictionaries across LMICs could facilitate local and global collaborations on head and spine trauma research and trauma quality improvement efforts. [29] It is therefore recommended to prioritize the definition, and standardization of neurotrauma data elements in MOH-level trauma registries and health policy research agendas.

LMICs are encouraged to embrace computerized platforms to improve data collection and aggregation for neurotrauma surveillance. These platforms may be customized from existing internet-based platforms such as the DHIS2 or Epi-Info, and they may also leverage mobile technologies to facilitate neurotrauma data capture. [4,9,26]

In 2019, the WHO released the International Registry for Trauma and Emergency Care (IRTEC), a platform for global collection of trauma data that includes fixed and open fields that can be used for neurotrauma data collection, such as GCS, pupillary reactivity, and, "injury anatomic location;" the platform offers a further cost-effective solutions for the technology infrastructure requirements of head and spine injury data aggregation, with an explicit focus on trauma and emergency care. [27]

## Governance

### Empower ministry of health leadership

National neurotrauma injury surveillance is a MOH-level function that can only be effectively undertaken with moral commitment and financial engagement at the MOH level. [9, 29]

In order for health systems to continually improve upon their methods and frameworks of service delivery, their effectiveness must be periodically assessed. Mock et al. highlighted the importance of capturing timely, accurate data on the epidemiology of traumatic injuries, particularly in contexts such as many Sub-Saharan African countries, where a gap in this data stymies efforts to strengthen the trauma system. [8] The implementation of standardized protocols for neurotrauma data collection can decrease head and spine trauma mortality in LMICs. [30] Rubiano et al. highlighted the LMIC data gap in TBI care, concluding that using quality control programs and TBI registries are low-cost resources that can be implemented to strengthen trauma system efficiency and effectiveness in LMICs. [31]

### Utilize reporting requirements to improve accountability and compliance

The most essential requirement for development of effective neurotrauma surveillance on a national level is strong leadership. [32] Lessons from recent communicable disease outbreaks in LMICs are a reminder of the critical role for public health leadership in the organization, direction and deployment of limited resources for disease surveillance. [33-37] Ministries of health must therefore recognize engaged leadership for neurotrauma surveillance, and its integration into overall disease surveillance, as a governmental responsibility. [32]

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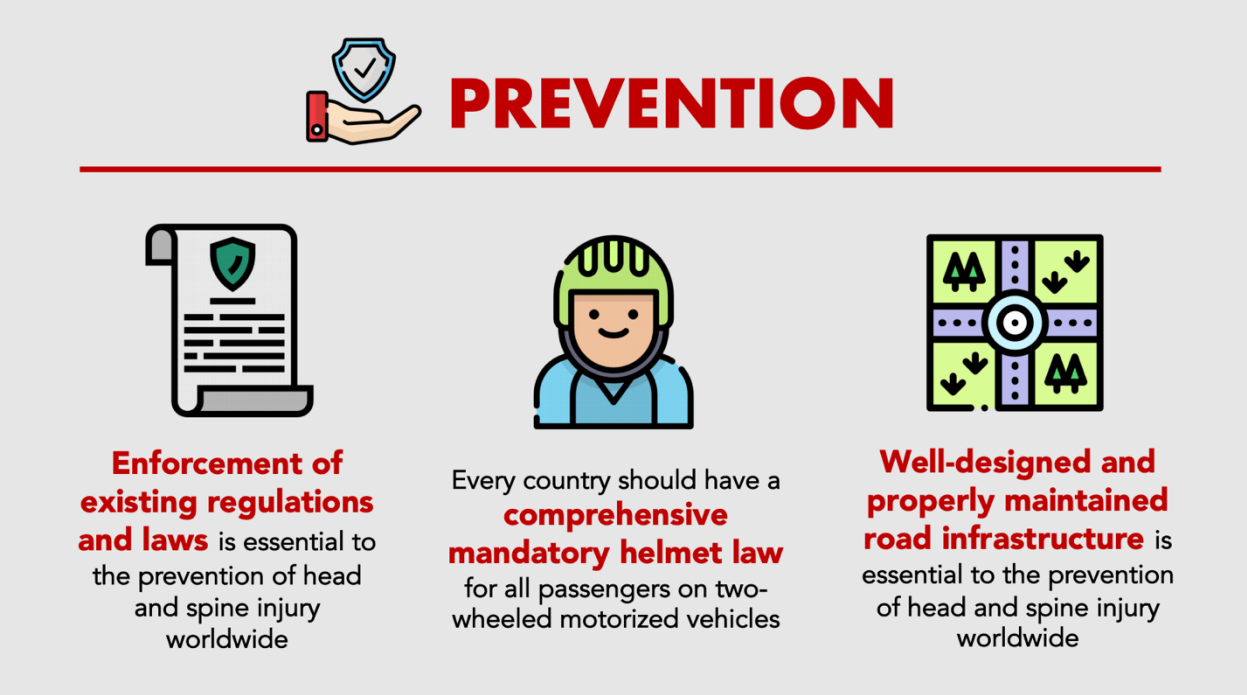
# Prevention




## Infrastructure

### Safe roads

We support the implementation of the World Health Organization (WHO) Global Plan for the Decade of Action in Road Safety as well as the United Nations Road Safety related Conventions and Agreements in every country. The key pillars of these documents include: safer roads and mobility, safer vehicles, and safer road users.[1] Based upon this we recommend that well designed and properly maintained road infrastructure be a priority of every national government in order to maximize injury prevention and access to emergency medical care. A study by Pebalo et al., noted poor road design to be a root cause of approximately 24% of road traffic accidents in Northern Uganda.[2] This effect is magnified as developing countries with poor transportation infrastructure experience the rapid growth related to globalization. We therefore recommend core amenities such as reliably paved roads, streetlights, and enforcement of traffic laws be an area of priority in the developing world.

It is estimated that in low-income countries pedestrians represent up to 45% of road traffic fatalities.[3] Based upon this we recommend the prioritization of pedestrian safety with the identification of high risk areas and the use of sidewalks, crosswalks, speed bumps, and pedestrian bridges in those areas.[4] Additionally, when feasible we recommend the development of reliable public transportation systems for major cities which can reduce road congestion and decrease high risk situations such as pedestrians in high traffic areas.

## Workforce

### Robust workforce for public health education and implementation

Education remains a critical component of injury prevention and is primarily accomplished by both governmental[5] and non-governmental public health initiatives.[13] We recommend the encouragement of non-governmental programs to work alongside government initiatives to maximize public safety awareness and compliance with legislative efforts.

## Service delivery

### Strengthen public education and encourage safety-conscious "Ride hailing" services

Any legislative based policy measure is dependent upon adequate law enforcement and public compliance in order to see effect. This relies heavily upon law enforcement workforce in order to see this through.[6–8]

Enforcement of drug and alcohol restrictions are key components of preventing road traffic accidents as these represent high-risk activities.[2] As such, strong governmental emphasis should be placed on law enforcement in these areas.

Effective injury prevention strategies must include public education and media campaigns in order to increase compliance

### Strengthen enforcement of safety laws

We propose that an effective injury prevention strategy must include public education and media campaigns in order to increase compliance. For instance, Pervin et al. found that a primary reason for adults not having young children wear helmets in Vietnam is the fear that it increases the risk of neck injury.[9] Such beliefs are countermanded by an effective education strategy. One example is the Helmets for Kids initiative undertaken by the Asia Injury Prevention (AIP) Foundation, which saw an increase in helmet usage among school age children after several short school-based education initiatives.[10] Important examples of several key injury prevention and public health organizations are included below.

World Health Organization (WHO): In 2010 the WHO declared a decade of road safety as a priority in attaining the United Nations Sustainable Development Goals. As such, significant effort and funding has been placed on improving road safety world-wide.[11]

Think-First: A U.S. based injury prevention organization with strong international focus with 39 chapters in 18 countries emphasizing knowledge of safe behaviors in school age children. They have served as the public health interface for the neurosurgical community for the last several decades.[12,13]

Asia Injury Prevention Foundation: The AIP Foundation provides helmets and education to school age children through initiatives such as the Global Helmet Vaccine Initiative and Helmets for Kids. Such interventions have seen significant increases in use of preventive measures among young children in several key Asian and African countries.[10]

## Financing

### Promote health benefits of public investment in safe roads

Financing of road construction, legislative processes, and law enforcement and workforce should continue to be publicly funded

### Partner with external organizations for advocacy

Partnerships with NGO's can aid in the funding of safety initiatives and public health campaigns

## Information management

### Tracking of safety law compliance

Data regarding legislation compliance should be gathered in national databases as well as subsequent traumatic head and traumatic spine outcomes

Encourage collection of vital statistics that will allow tracking of road traffic accidents, injury rates, in line with the core indicators listed in the WHO Global Plan[1]

Several core indicators that we recommend emphasizing include:
Number of road traffic deaths, as a core composite indicator for all activities
Compliance with blood alcohol concentration limits less than or equal to 0.05 g/dl
Collection of national data on helmet-wearing rates

## Governance

### Regulatory framework to strengthen enforcement

In particular legislation regarding the “5 killers” - speed, seat belts, child restraints, drunk driving, helmets is of paramount importance to the prevention of head and spine injury. If national governments have not adopted these measures, it should be given high priority.[5,14]

We recommend cross-sectorial cooperation between transportation, health, and department of interiors to promote health in all policies.

### Comprehensive helmet laws

Multiple studies have demonstrated the effectiveness of helmet usage in the prevention of traumatic brain injury due to road traffic accidents.[15–18] Indeed, countries that have adopted mandatory helmet laws for motorbike drivers and passengers have seen

significant decrease in rates of TBI and road traffic mortality. This is particularly true for developing countries in which two-wheeled motorized vehicles represent the greatest proportion of road transportation.[6] Unfortunately, passing a helmet legislation alone is not sufficient for effective prevention of neurologic injury. Bachani et al. found the rate of helmet usage among motorbike riders in Cambodia to be as low as 33% three years after the passage of helmet legislation.[7] This highlights the need for public education campaigns and adequate law enforcement in addition to legislative efforts.

We recommend a comprehensive helmet law that includes enforcement for not just drivers of vehicles but also passengers. Conrad et al. demonstrated significant disparity between helmet usage among drivers (89%) versus passengers (20%) in Indonesia, a country with a mandatory helmet law.[19] Gupta et al. demonstrated significantly significant reduction in odds of death (OR 0.44, CI 0.21-0.84) and severe head injury (OR 0.42, CI 0.24-0.72) between helmeted drivers and non-helmeted passengers of two wheeled vehicles in India.[20]

We recommend mandatory helmet usage for child passengers with no minimum age limit for required use. A study by Pervin et al. demonstrated  a rate of helmet usage in Vietnam as low as 15% for children younger than seven years, and as low as 38% for children seven to fourteen years of age.[9] This highlights the particular susceptibility of these age groups to road traffic injury and the need for specific mention within the law.

Enforcing the laws on helmet-use in LMICs: This is one issue that demands urgent attention in the developing countries in the light of the burgeoning burden of neurotrauma from motorcycle crash therein, and where, as a rule, helmet use is not adhered to by motorcycle riders, and the law-enforcement officers take no pain whatever to enforce the rules. A suggestion has been made by some workers in the USA to incentivize the law-enforcement officers in enforcing the helmet-use law. It is suggested that the officers be allowed a certain proportion of the monetary returns from the fees to be paid by the traffic law breakers. This is probably worth giving a try in the LMIC, whilst working at means of mitigating the possible corrupting influence it might have in the social landscapes of these countries[24].

**Workplace safety regulations**

A significant proportion of head injury worldwide is attributable to falls from height, which in the adult population largely represent work-place related injuries while performing tasks related to construction or agriculture.[21] We recommend the creation and enforcement of work-place safety restrictions which minimize the risk of falls from height, crush injury, and other preventable measures of work-related TBI. In particular we recommend the strengthening of workplace safety regulations specifically around prevention of brain and spine trauma - hard hats, harnesses, and workplace safety education.

It is recommended that national governments adopt policies favorable to the introduction and maintenance of organized “ride hailing” services to the local transportation market

Private motorcycle taxis have been a known public health concern in the developing world for decades, with high-risk driving, low helmet usage, and high contribution to road traffic accidents.[22] In the last several years commercialized lift hailing services such as

Uber©, Taxify©, Lyft©, and Grab© have spread into developing countries in the form of motorbike transportation. Preliminary studies have demonstrated that drivers employed by one of these services versus private operation have significantly higher likelihood of safe driving practices and helmet usage, independent of national helmet legislation or road safety enforcement infrastructure.[23] It is also notable that Uganda has had difficulty in the past with availability and affordability of motorcycle helmets for routine use.[6] The finding by Tumwesigye et al. of high rates of helmet usage may represent an example of private industry overcoming availability barriers by properly incentivizing, thus creating a market demand and naturally reducing availability barriers. Based upon this we recommend governmental economic policies that incentivize the presence of these companies in major cities as they represent an additional tactic in promoting safe road practices.

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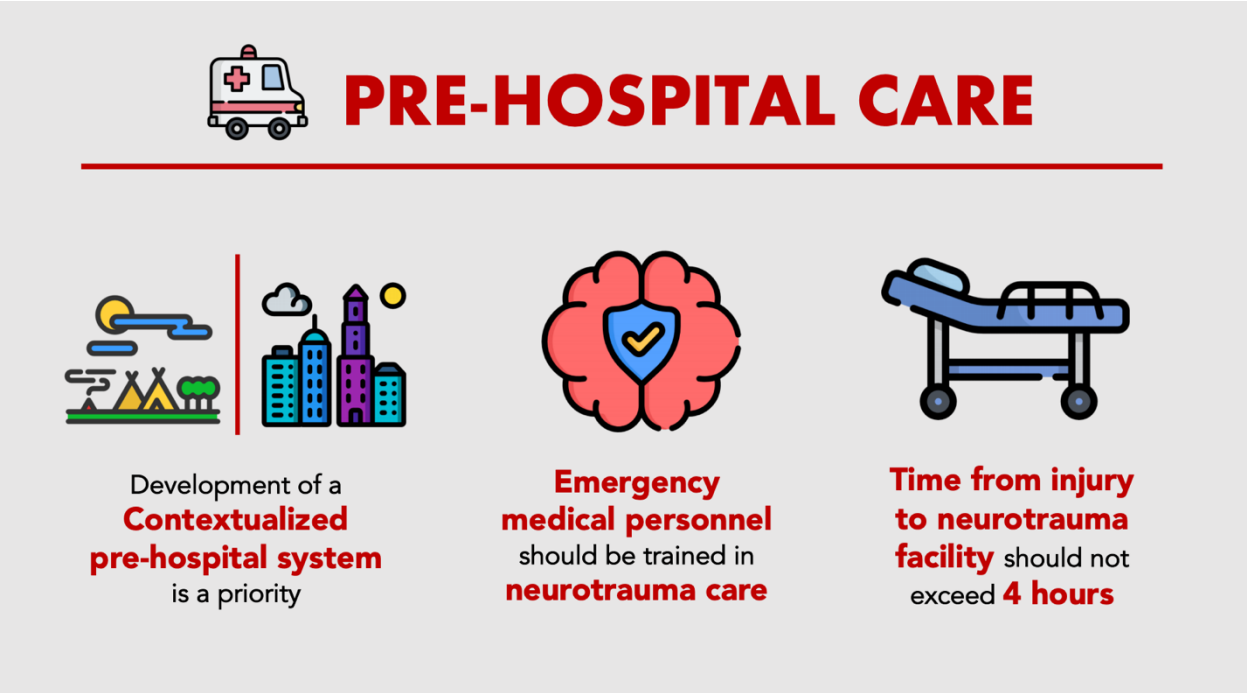
# Pre-hospital care




## Infrastructure

### Contextualized pre-hospital system

Development of contextually effective prehospital systems is a priority of prehospital care systems for traumatic head or traumatic spine patients (Hauswald 1997)

Infrastructure priorities for neurotrauma care in LMICs include safe roads, reliable communication systems between emergency care providers and health care facilities, and ambulance-based prehospital transport to include oxygen saturation monitoring and blood pressure control capacity

## Workforce

### Neurotrauma care training of emergency medical personnel

Workforce requirements for neurotrauma-ready prehospital care systems include education and training for the various levels of emergency medical providers; while these are ideally addressed by specialized EMTs, innovative approaches such as development and expansion of lay provider Emergency Medical Service training programs may strengthen prehospital care for TBI in LMICs. (Debenham 2017)
Specialization requirements of LMIC workforce for prehospital care of TBI is a research priority that includes determining optimal strategy regarding patient stabilization vs. expedient

transport during the prehospital phase of care (Cnossen 2019)

In environments where no dedicated emergency medical technicians or paramedical providers exist, we recommend exploring task-shifting and task-sharing paradigms that either look to existing health care providers, or train community health workers to provide basic prehospital care for victims of traumatic brain or traumatic spine accidents.

## Service delivery

### Prevent hypotension and maintain oxygenation

We support WHO recommendations to monitor neurological function and maintain cerebral perfusion by preventing hypotension and assuring adequate oxygenation throughout the prehospital phase of care for patients with traumatic brain injuries (WHO prehospital trauma care 2009)

The design and implementation of prehospital neurotrauma protocols that optimize parameters of traumatic brain or traumatic spine care for improved outcomes is a priority of countrywide health policy research

According to the World Health Organization, most of the world's population does not have access to prehospital trauma care, and very few patients in developing countries can hope to be transported to the hospital in an ambulance, which may lead to needless death at the scene or during the first few hours following injury.[1] Despite limited available data for evidence-based guidelines, the WHO specifically recommends continuous monitoring of blood oxygen saturation, and maintenance of normotension in the prehospital setting for patients with TBI.[1] While cost-effectiveness of advanced prehospital emergency care must be investigated for each LMIC's socioeconomic context, available evidence supports the prioritization of ambulance-based transport systems with personnel capable of stabilizing blood pressure and oxygen saturation for victims of TBI.

### Time from injury to neurotrauma facility should not exceed 4-hours

We recommend limiting hospital transport times for TBI to a period not exceeding four hours (Vaca et al.; Barthelemy et al.)

Delays in hospital transport time are an acknowledged priority for TBI care in LMICs.[2] Lengthy delays in receiving definitive care for TBI are positively correlated with mortality, and inversely correlated with functional outcomes.[3,4]
In particular, expediting patient transport to a neurosurgery-capable facility within a maximum 4-hour window from the time of injury is associated with better outcomes than admission following longer time frames. [3,4]

## Financing

### Cost-effective training models

We recommend prioritizing low-cost methods of expanding prehospital care, such as use of

community health workers and cost-effective training models, to overcome financial barriers to scaling up prehospital care for neurotrauma (LCoGS, Arreola-Risa)

### Utilize low-cost or free digital technology

It is recommended for the use of publicly available technology platforms and innovative prehospital care solutions to optimize neurotrauma outcomes without undue financial cost (Latifi et al. 2016; Latifi et al. 2018)

## Information management

### Encourage data collection by emergency medical personnel

It is recommended to obtain systematic collection of neurotrauma care indicators such as prehospital transit time and delays in admission to tertiary care centers in order to understand and improve the preparedness, delivery, and financial impact of prehospital care delivery on neurotrauma outcomes.

## Governance

### Inclusion of pre-hospital care in national health plans

It is recommended that MOHs specifically prioritize the development and implementation of policies for organization and deployment of human, capital and financial resources required to effectively provide countrywide prehospital care for traumatic head and traumatic spine injuries

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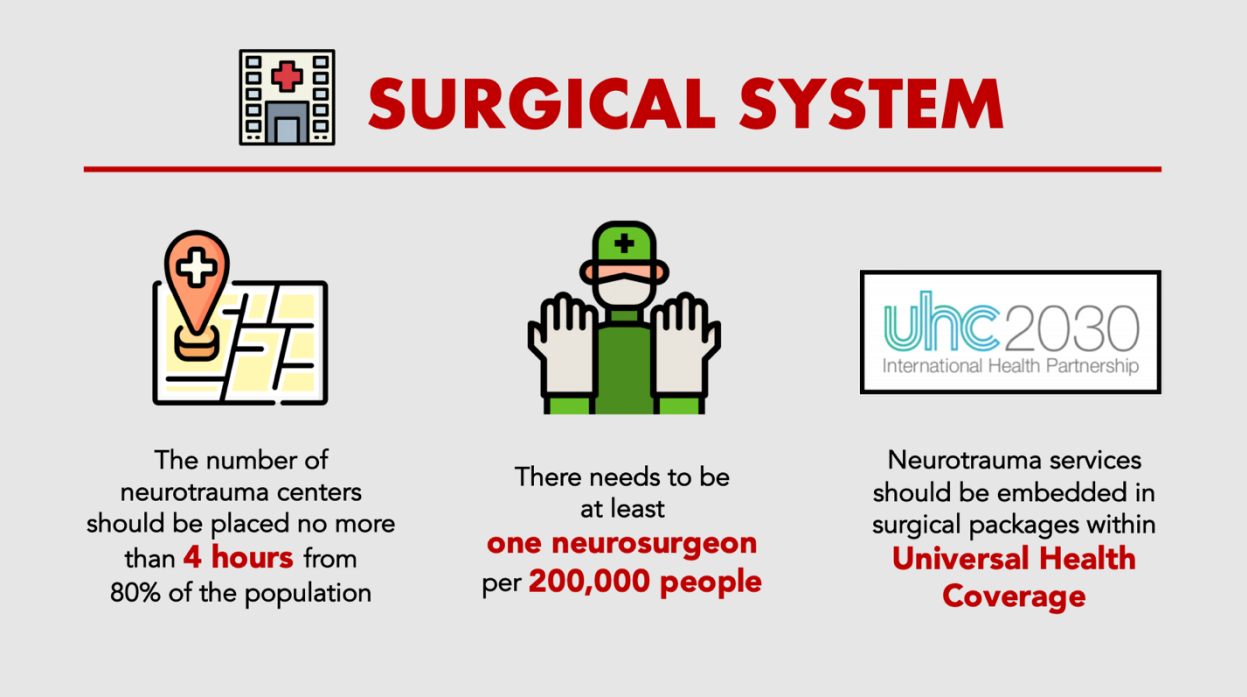
# Surgical system




## Infrastructure

### 80% of population within 4-hours of neurotrauma center

The Lancet Commission on Global Surgery recommends that all people within a given population live within 2 hours of a facility that can perform essential surgical procedures, which was derived from obstetric literature, as 2 hours is commonly cited as the threshold of death from complications of childbirth.[1] However, recommendations for disbursement of neurotrauma centers will differ. This is dependent on the burden of head and spine trauma and the optimal timing if intervention. Anecdotal evidence suggests that head injuries, in most cases, are more urgent than spine injuries, therefore data pertaining to traumatic brain injury and timing of surgery or intervention will guide recommendations for neurotrauma facility disbursement. Historically, there has been conflicting data to provide evidence for the optimal timing of surgery for head injuries and many studies that have evaluated subdural hematomas or epidural hematomas found no significant difference in outcomes related timing of injury and operation.[2,3,4] However, many of these patient populations were heterogeneous and other confounding factors were likely present, for example patients who received earlier surgery were more likely have more severe injuries. However, other studies have found correlations with outcomes and timing of surgery for brain injuries. Seelig et al reviewed consecutive patients with traumatic acute subdural hematomas and found that surgery within the first four hours of injury had a 30% mortality rate, as compared with 90% in those who had surgery after 4 hours.[5] Another important factor to consider is not the time between injury and surgical decompression, but the time from neurologic deterioration and surgical decompression. Haselsberger and colleagues demonstrated mortality rates for acute traumatic subdural hematomas and epidural hematomas were improved if decompression occurred within two hours of coma onset.[6] Similarly, Cohen and colleagues found that patients who suffered traumatic epidural hematomas had better outcomes if surgery was within 70 minutes of anisocoria.[7] These results have been replicated in observational studies, and it seems that for best patient outcomes, surgery should be performed prior to neurologic decompensation, such

as decreased mental status or anisocoria. However, if this has already occured, surgery should be performed as soon as possible.[8,9,10,11] Given these mix of findings, it is clear that early presentation to a neurotrauma facility is preferred, but 4 hours seems to be an important time marker in the course of a TBI patient. We recognize that the Commission on Global Surgery has a target of 80% of the population living within 2 hours of a trauma center, however, the required number of neurotrauma centers can be placed further apart, but no more than 4 hours from 80% of the population.

### Strengthen pre-existing trauma infrastructure for neurotrauma

Successful integration into existing trauma systems is paramount for the effectiveness of neurotrauma systems. Trauma systems are recommended for comprehensive neurotrauma care. For example, the development and implementation of trauma protocols has been shown to reduce TBI morbidity and mortality in certain high income settings.[12] In low income settings, delays in seeking care and presenting to the hospital has been associated with poor outcomes in TBI. Vaca and colleagues analyzed these temporal delays in traumatic brain injury patients in Uganda and found a significant association of hospital arrival delay and mortality in the moderate TBI group.[13] It has been demonstrated that lack of prehospital care and poor or absent logistical referral and trauma systems worsen outcomes by exacerbating secondary injury in TBI. There are a number of barriers for the development of effective LMIC trauma systems for TBI, and these include inadequate regionalization of specialty care, the need for cost effective resource mobilization, poor or absent emergency medical services and intensive care, lack of adequate imaging capacity, excessive referral to centers without definitive care capacity, and the need for use trauma registries.[14] Effective disbursement, utilization, and functionality of neurotrauma centers will require first the development of trauma centers and referral networks. Efforts to scale up trauma systems should be supported so that integration and development of neurotrauma facilities can occur.

## Workforce

### 1 neurosurgeon per 200,000 people at minimum

Corley et al described modeling methods using existing data regarding the incidence of TBI and TSI in LMIC's and current neurosurgical work force and estimates of case load capacity to calculate the minimum number of neurosurgeons needed to address neurotrauma per population. At minimum, there needs to be one neurosurgeon per approximately 200,000 people.[15]

### Task-sharing of surgical workforce is preferred over task-shifting

The model should include a structured training curriculum with oversight by a neurosurgeon, competency-based evaluation, integration into the workforce, defined scope of practice, referral networks, maintenance of certification, financial compensation, and opportunities for continued professional development.

Both task-shifting and task-sharing (TS/S) in neurosurgery are controversial because of safety, ethical, financial, legal, and professional implications.[16] On one hand, having a necessary operation via TS/S may be superior to no care, and TS/S may offer acute stabilization of emergency patients to enable safer transfer to tertiary care facilities, particularly for the diagnosis of an epidural hematoma. Conversely, TS/S raises concerns for lower quality care and disrupting professional roles if less-skilled workers displace higher skilled staff. We recommend task-sharing over task-shifting, as the former implies regular oversight by an experienced neurosurgeon.

First, it is recommended that the TS trainee has obtained a degree in medicine and is currently in or has completed a surgical training program prior to beginning neurosurgical TS training; this is to ensure adequate understanding of both medical and operative management and experience in clinical decision making. Systematic training programs should occur locally and involve competency-based evaluation prior to allowing TS providers to practice. Local supervision should follow the completion of formal training to ensure maintenance of skills and competencies. Subsequently, local supervision should happen periodically to ensure maintenance of skills and competencies, and proper referral networks should be established for complex cases and complications to allow for tele-consultation and physical transfer of patients when necessary. Finally, task-sharers should be officially recognized and supported by their institutions with a clear definition of their scope of practice, adequate financial remuneration, and clear opportunities for career progression in order to prevent attrition of practitioners and prevent task-creep: practicing beyond the scope of their training.[19]

### Dramatically increase neurosurgical training capacity

In order to meet the workforce demand needed to address neurotrauma, residency education and training needs to be prioritized.[1] This can be accomplished via several different strategies, including the creation of local hospital based programs, twinning programs with high income country university partners, and fellowship programs from international organizations such as the World Federation of Neurosurgical Societies and The Foundation of International Education in Neurological Surgery.[20,21,22,23]

The WFNS has addressed this initiative with the creation of the WFNS Foundation Training Centers and Fellowship.[24] Applicants are accepted from countries with a limited number of neurosurgeons and be committed to service in his/her native country. Similarly, to qualify to be a Post-Graduate Training Center, the facilities must meet minimum requirements for comprehensive neurosurgical practice and training.

It should be noted that the training needs of each country are dynamic and should be tailored to meet the demands of local epidemiology. For example, many countries may need to prioritize neurotrauma and basic neurosurgery education over highly specialized neurosurgical training. In these cases, the it is possible to shorten the length of a residency or fellowship program to meet the minimum basic training requirements and thus attain the necessary national workforce faster.

## Service Delivery

### Standardization of essential neurotrauma equipment

In order for a trauma facility to have the ability to address neurotrauma and perform neurosurgical procedures, not only does it require a specialized neurotrauma workforce as described above, but it requires essential neurosurgical equipment that differs from basic trauma equipment. There have been some efforts by the WHO to standardize a basic equipment list for LMIC district hospitals, however while these inventories lack specific needs for neurosurgical practice.[25] Fortunately, the WFNS has recognized the benefit of equipment standardization and started this process by devising a basic set of neurosurgical instruments.[26,27] Since 2000, this program has included an equipment donation program to help alleviate the otherwise prohibitive costs of surgical equipment for LMIC units.[28] These programs should be monitored and evaluated for maximal impact.

Additionally, with the increased use of neurosurgical equipment, ongoing maintenance and supply of disposable parts are essential for sustainability. Surgical facilities require sterilization capabilities to allow the reuse of instruments and continued safe surgical practice.[29]

### CT scanner in all neurotrauma facilities

While there are new and emerging methods for cheap or portable devices to infer intracranial pathologies, accurate head imaging is unreplaceable and necessary for appropriate neurotrauma practice. Empirical evidence as well as historical data from the 1970-80's demonstrates improved outcomes in facilities after the implementation of CT scanners.[30,31,32] CT scanners have been installed in many LMIC neurotrauma facilities and have proven to be suitable for LMICs in both cost and serviceability.

### Critical care unit in all neurotrauma facilities

Neurotrauma centers require workforce, instruments, and operating rooms. Additionally, intensive care units (ICU's) are required for the management of neurotrauma patients.[33] These ICU's need trained staff, sufficient bed capacity and adequate equipment such as ventilation and other monitoring equipment.[34] If neurotrauma facilities are built off of existing trauma facilities, many will have ICU's for general trauma practice. However, the needs of neurotrauma patients are unique and will require modifications or additions. For instance, nursing staff may need extra neurological training for in addition to standard critical care education.

### Leverage telemedicine as a tool for increasing coverage

One strategy to to bridge the physical distance and knowledge gaps between neuro trained specialists and other health care providers is telemedicine technologies. This allows neurosurgeons to triage patients at other facilities via electronic videos, imaging, and documentation. Local providers are then able to provide basic care or arrange for transport to a higher level facility for other interventions and ICU level care. [35,36]

### Innovate for low-resource settings

The benefits of bioengineering and innovative device development should not be underestimated and when tailored for low resources settings, there can be an increased access to devices and instruments that are cost effective.[37,38,39] This can be accomplished by partnering with biomedical engineers, medical device companies, and other NGO's to develop low-cost, durable alternatives to the traditional equipment items used in HICs.[40] Examples include the development of battery powered surgical headlights and pulse oximetry for intraoperative monitoring.[41,42] Another well-known example is the use of the Chhabra ventricular shunt, which costs 35$, compared to its Codman counterpart, which costs about $650. Investigators have found no statistical difference in any outcome category between patients treated with the two shunts.[43] There is a clear need for this kind of innovation when recognizing the need for affordable and functional imaging equipment such as CT scanners.

Other examples of innovative solutions include the use of artificial intelligence (AI) to assess for radiographic findings or apply clinical algorithms to guide management of patients. Azimi and colleagues demonstrated that an artificial neural network (ANN) could predict endoscopic third ventriculostomy (ETV) failure better than current standard scoring systems.[44] Shi and colleagues validated the use of ANN models to predict in-hospital mortality after traumatic brain injury.[45] Similar findings have been replicated in other ANN models of head trauma.[46] While still in preliminary stages, the results of AI studies are promising and may be an avenue to explore in settings where workforce and resources are scarce.

Structural interventions to increase available diagnostic technologies and increase hospital capacity can help but represent long term, resource-intensive solutions. The use of artificial intelligence as a clinical decision support tool, in theory, could optimize the use of existing resources and support timely treatment decisions in LMICs.

## Financing

### Embed neurotrauma within universal health coverage package

The original drafted template for National Surgical, Anesthesia, and Obstetric plans calls for basic surgical service packages to be included in universal health coverage.[47] Neurotrauma is no exception and should also be embedded within larger surgical packages.

### International partnerships for neurotrauma capacity building

In certain instances, national and international societies provide funds for specific neurotrauma initiatives. For example, the WFNS Foundation provides funds to trainees at the Rabat Reference Training Center. [48] NGO's are also known to play a role in financing, as exemplified by the funding for fellows in the Cure Hydrocephalus and Spina Bifida (CHSB) Fellowship. Financial support for the fellows comes from scholarship support via CSHB as well as from home institutions or departments.[49] Finally, numerous academic institutions from HICs have partnered with LMIC institutions in a twinning model, and in many cases, financial support comes directly from the HIC institution or department.[50, 51,52]

## Information management

### Track neurotrauma workforce and operative mortality

Standardized national data collection for neurosurgical workforce and the quality and safety metrics should be collected integrated into global tracking databases

Data elements recommended by the Lancet Commission for assessment methods are well described.[1] This includes density and distribution of surgical, anesthetic, and obstetric (SAO) providers, the number of SAO retirees and graduates, the proportion of surgical workforce training programs and accredited, the presence of task sharing or task shifting programs, the proportion of surgical facilities offering Bellwether procedures, the number of surgical procedures done per year, perioperative morbidity and mortality, and availability of system wide communication. These should be collected and tailored for neurosurgical patients, for example, tracking proportion of facilities capable of neurotrauma, or perioperative morbidity and mortality of neurosurgical patients.

Some of these processes has been started by the WFNS via the World Neurosurgery Workforce Mapping Project.[53] Data was collected by a variety of different methods including literature search and surveys. Countries with complete data demonstrate neurosurgeon density in relation to population.

Similarly, WFNS has also created the Neurosurgical Capacity and Access Map with the goal to map out facilities and their neurotrauma abilities.[54] Facilities are categorized into levels, where level 0 provides no neurosurgical services, level 1 provides macro-neurosurgery, mainly trauma care, level 2 provides basic micro-neurosurgery, and level 3 provides advanced micro-neurosurgical care. These data points are uploaded onto an interactive mapping software such

that visual reports can be created that demonstrate the percentage of the population with access to the different WFNS level facilities.

## Governance

### Draw on existing international technical resources to assist with neurotrauma capacity building

Responsibility of overseeing workforce expansion, credentially, and neurotrauma capacity building lies with individual county governments. However, neurosurgical societies should take an active role in the governance, information management, and in some cases funding of neurotrauma systems development. Academic pursuits and research projects should be emphasized and created to guide policy. Additionally, societies are in a position to collaborate with societies and leadership of other surgical and medical specialties, such as neurology, trauma, general surgery, and anesthesia. The WFNS can play a role in overseeing many of these initiatives, coordinating fragmented efforts and partnering with other larger health organizations such as the World Health Organization.

### Promote neurotrauma as vital to achieving national and international health and development goals

The World Health Organization has been named the "de facto global coordinator and normative institution for surgical care".[55] In general, the WHO has a role in setting surgical, anesthesia, and obstetric standards, providing manuals and guidelines, and organizing benchmarks and best practices as requested by countries and surgical communities. With these current responsibilities, it is important for neurotrauma care to be included across the continuum and recognized as a substantial component of

Currently, the WFNS-WHO Liaisons meet in a Bi-Monthly Committee Meeting where these shared interests can be addressed.[56,57]

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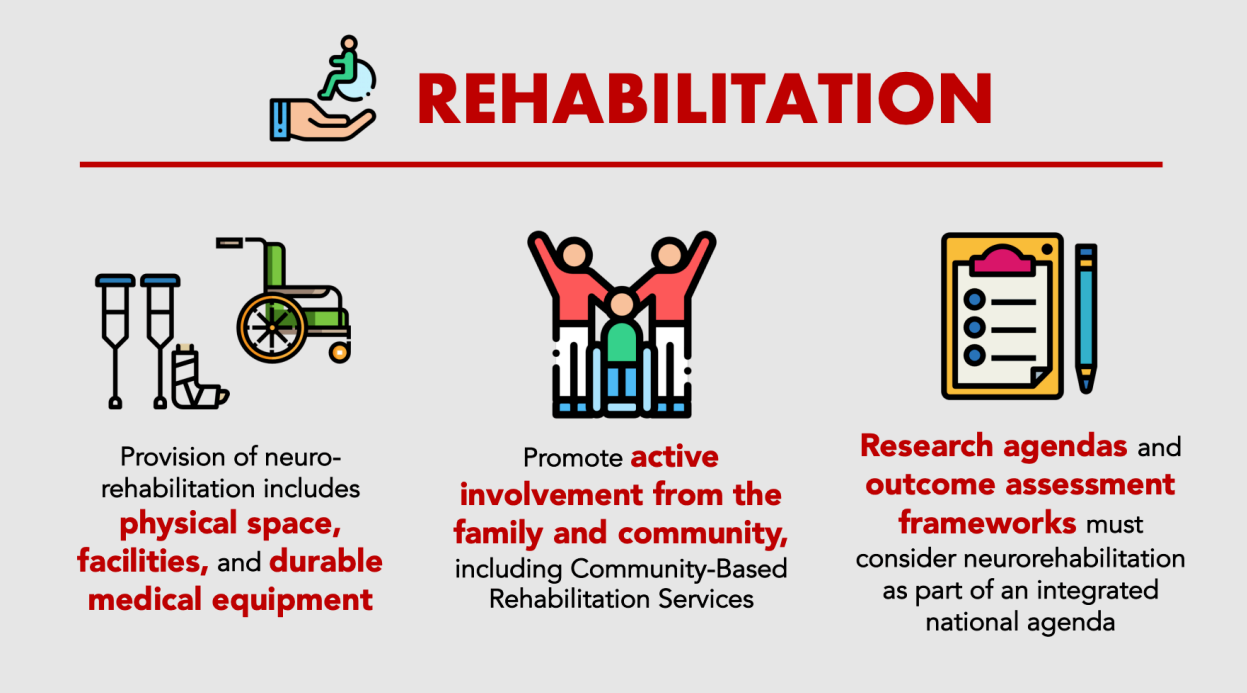
# Rehabilitation




## Infrastructure

### Contextualized allocation of space and stuff for neuro-rehabilitation

Several landmark studies draw a globally poor picture concerning Neurorehabilitation in LMIC´s: 60% of developing countries have no Neurorehabilitation services (Neurorehabilitation in developing countries., 2015), 45-74% did not receive the needed rehabilitation; and 77-95% did not receive vocational training (review by Chamberlain et al., 2015).

Indeed, 63-83% of those in need did not receive the assistive devices deemed necessary within the hospital context and in daily routines following discharge. (by Chamberlain et al., 2015). Lack of access to assistive devices by the patients and families directly influences long-term functional outcomes and is often dependent on budget constraints. Affordable assistive devices and products should be a priority, as depicted in many initiatives by WHO and other organizations (Khasnabis et al., 2015).

New technologies may help bridge these gaps. Several recent reports underline the possibility of robotic-aided Neurorehabilitation (Ona et al., 2018). Ideally, these can be easily deployed, are reliable and ubiquitous in their uses concerning different degrees of motor impairment, and capable of delivering high-dosage, high-voltage controllable training protocols (Riener et al., 2007; Huang et al., 2009). Computational motor learning principles and robotic devices have the potential to promote a very important principle in Neurorehabilitation – the avoidance of premature emphasis on compensation and prolong the focus on restoration of impairment (Huang et al., 2009).

Rehabilitation concerns both acute injuries/illnesses and chronic conditions with/without progressive course (Hudon et al., 2015). It can be organically divided in 3 categories:

- General Rehabilitation – generic process, long-term focused, mostly led by non-medical staff
- Specialist Rehabilitation – medically-led process, specific interventions in clearly defined diagnostic groups
- Complex Rehabilitation – consultants (or similar) in Rehabilitation Medicine are involved, specific and focused therapeutic strategies.

When assembling or re-organizing evolving Health Systems and its national/regional coverage, the goal should be to develop Specialist Rehabilitation, providing sufficient coverage on the short-term and hopefully laying ground for soon-to-be Complex Rehabilitation Centers. A proper strategy should implement at least one Complex Rehabilitation Center for every region, with a specialist multidisciplinary team led by a Rehabilitation Medicine consultant (preferably with a sub-specialization in Neurorehabilitation), supported by community-based Rehabilitation services with culturally sensitive and appropriate services and working closely with an inpatient Neurological/Neurosurgical unit within each region/district. This unit should also lead the efforts on assembling adequate discharge pathways (ideally with outreach teams), coordinating with General Practicioners and corresponding local institutions and community-oriented structures such as social services, family, home nurses and others. (Ward et al., 2003; Gladman et al., 2007).

### Facility stratification for severity

The role for intermediate care facilities (ICF´s) is increasingly gaining relevance as a necessary component of a desirably integrated Health System. This has the potential to bring entities together, aiming for common goals (Kodner et al., 2002), and above all connecting “the acute, rehabilitative and chronic phase of care” (Rosendal et al., 2002; Minkman et al., 2005). As it is not always possible to discharge a patient directly to their home and families, strengthening of ICF´s and staff is mandatory. Appropriate referral and continuity of care down the healthcare pathway are needed and personnel awareness of doctors, nurses, and rehabilitation therapists is essential.

A broader context for ICF´s, run by multidisciplinary teams, should ideally include (with adjusted combinations depending on specific needs): geriatric day hospitals; community hospitals; Rehabilitation teams; community assessment and rapid response teams (Young et al., 2009; Sikhumbuzo et al., 2018). Ensuring continuity of care on a mostly rehabilitative perspective (Kane et al., 2007), ICF´s represent a desirable bridge between acute-care hospitals and the community and should be a priority in the future.

## Workforce

### Ensure rehabilitation training capacity is adequate

Neurorehabilitation services are often underdeveloped and under-resourced (Krug et al., 2017). The available workforce is obviously inadequate and far from what is required (Rehabilitation 2030., 2018). Although there is no official recommended minimal number of physiotherapists and Rehabilitation Medicine doctors (Rehabilitation 2030., 2018), the shortage of these professionals is evident in LMIC´s. According to recent reports by the WHO, many countries of Sub-Saharan Africa and South-East Asia region have fewer than 10 physiotherapists per million inhabitants (WHO Rehabilitation 2030 – A call for action)

Lack of trained professionals in Rehabilitation is a problem limiting the efficacy of policies worldwide. The WHO estimates that the number of trained professionals required to meet the demand for Rehabilitation services (physiotherapists, occupational therapists and others) is, in some areas, a tenth of the intended and desired (Rehabilitation 2030., 2017).

As an example of adequate Rehabilitation coverage, the Royal College of Physicians recommends “(…) 60 RM beds per million population with a minimum size of 20 beds per unit” and (…) 6 RM consultants per million” (Royal College of Physicians. 2008).

A viable option to ensure intermediate care, with proper referral if needed, is to train mid-level workers, proficient in basic care routines – including, monitoring, insulin administration and basic rehabilitation protocols. This approach should always keep in mind the need for proper awareness on possible complications and a swift and effective referral to informed professional therapists (Doherty et al., 2012).

### Ensure competency throughout continuum education

Active participation from members of the disability community can also become a valuable asset - peer support can be included in health facilities routines or CBR programs, including disabled people as aids, as they can prove more effective in overcoming communication and empathy / attitude issues.

Health professionals education and training is crucial in the field of Rehabilitation, as available workforce is frequently misused or underused. The long-term prospect of intervention on complex patients requires dedicated and well-prepared health personnel. Besides specific Rehabilitation residency programs, one can delineate basic programs aimed at health professionals, namely in regions especially in need (Wijeratne et al., 2011). Trainees should focus on basic mechanisms of recovery from neural injury, including techniques for specific conditions (spasticity, aphasia and others), and effective use of adaptive equipment and occupational therapy.

Some form of cooperation or partnerships between clinical and research departments in high-income countries and their counterparts in LMIC´s has a great potential (Crisp et al., 2011). Education and progression assessment can take place not just face-by-face but also via telemedicine technologies. (Chamberlain et al., 2015).

Institutions such as as the WHO and NGO´s can be of great importance in issuing updated reports and providing useful guidelines (e.g. WHO´s website-based report “Minimum technical standards and recommendations for Rehabilitation) (WHO Minimum technical standards., 2016), setting a framework for aligning practices and maximizing training and team performance.

## Service delivery

### Sensitive to gender and age sub-groups

Approximately 15% of world population experiences some kind of disability (WHO., 2011), representing about 1 billion people worldwide (Rathore et al., 2016), with 80 to 90% living in LMIC´s (Chamberlain et al., 2015). Marginalised sub-groups of vulnerable populations, such as people with disabilities in developing countries and often women are especially disadvantaged (Neurorehabilitation in developing countries., 2015), and should undoubtedly be part of all Global Health efforts concerning Rehabilitation as a necessary agent towards individual´s empowering and desired return to society and work. Focusing in specific vulnerable groups, such as children under the age of 5 or pregnant women – seems necessary in certain contexts (Richard et al., 2013).

Concerning trauma, nearly half of injury-related mortality occurs in individuals aged 15-44 years (Wesson et al., 2013), stressing the impact of trauma/neurotrauma at all levels and ages.

Traumatic brain injury is a good example of the major impact Neurorehabilitation can and should bring to Global Health (Hyder et al., 2007). Traumatic brain injury represents the major cause of disability in people under age 40 (Fleminger et al., 2005), with a huge predilection for developing countries. Some authors call it an “endemic disease” in LMIC´s (Roozenbeek et al., 2013; Servadei et al., 2018), in the context of significantly higher risk factors such as the high incidence of road traffic accidents. (Nantulya et al., 2002; Schmucker et al., 2010). Numerous

clinical consequences, such as permanent neurological deficits, bowel/bladder problems and spasticity, impaired cognitive functioning (memory, learning, etc), anxiety and depression, and psychosocial changes will tremendously impact the individual´s lives and caregivers assistance.

### Partner with family for delivery of non-technical physical therapy

Independently from specific pathology and phase of treatment, Leith et al have identified five major needs concerning family and direct caregivers (Leith et al., 2004): oficial and reliable support systems; facilities and outlets for information on the pathology and treatments; support and encouragement from health professionals; positive environment and emotional support; and expectation of reintegration in the community.

For several decades now, the importance of Community-Based Rehabilitation (CBR) services has been acknowledged (WHO., 2003; Hamid et al., 2017). Interventions and policy reviews at population and community levels can only be relevant if they are able to integrate disparate interventions (legislation, public information campaigns, regulations) in different sectors such as schools, workplaces, hospitals and health delivery facilities, and community-based groups. Evaluating feasibility and effectiveness, is crucial in decision-making processes. Local realities and cultural contexts are potential aids to clinical-scientific tools and protocols, bringing the experiences and world-views of local culture into modern healthcare – specifically in Neurorehabilitation, where social constructions of personhood can be a crucial link to damaged brains and “selfs” (Coetze et al., 2018), therefore employing a more holistic and relationship-based neuropsychological approach to Rehabilitation (Bowen et al., 2010; Caracul et al., 2012). Community involvement is positively associated to satisfaction with life after TBI (Wiliams et al., 2014) and is inversely related to emotional distress

Predictability, collaborative community-based approaches are most effective, specially if supported in solid facility-based care (Chaterjee et al., 2014).

## Financing

### Embed neurorehabilitation within universal health coverage package

Concerning the debate surrounding external aid effectiveness in health development, multiple sources of bias are well identified as a source of inappropriate conclusions. Aid analyses frequently rely on inappropriate exposure and outcome variables (Stuckler et al., 2013), not respecting adequate time lags (Costache et al., 2009; Hansen et al., 2010) nor identifying dubious causal mechanisms and net effects. As no one denies the need for appropriate resources tailored to the country/region circumstances (Sachs et al., 2005), the critics on aid programs draw conclusions mostly from case studies on individual countries (Stuckler et al., 2013), on which aid programs are just one of several factors affecting health and wealth development (Grepin et al., 2012).

Non-profit Organizations can indeed fill some gaps but the long-term prospect of Neurorehabilitation demands well-planned and easily implemented programs.

Basic neurotrauma services should be embedded in surgical packages within universal health coverage
The original drafted template for National Surgical, Anesthesia, and Obstetric plans calls for basic surgical service packages to be included in universal health coverage.

## Information management

### Collection of neurorehabilitation outcome data

Research agendas and outcome assessment frameworks must consider neuro rehabilitation as part of an integrated national agenda. Several tools and instruments can provide a framework for classification and assessment of disability in its objective nature (e.g. quantifying deficits) (World Health Organization Disability Assessment Schedule) (Garin et al., 2010; Bachani et al., 2016) and its intrinsic functional nature (social role, functional capacity, participation, daily activities) (WHO International Classification., 2001).

Population-level interventions are seldom assessed in its usefulness when applying the consensual criteria in randomized controlled trials. Retrospective analysis and/or before-and-after data obtained from official statistics or surveys, despite its intrinsic value, shall never possess the same analysis power. Several authors and institutions are now implementing more objective and easy-to-use systematic approaches, with cost-effectiveness analysis (Dua et al., 2011) and intuitive categorical classifications – e.g. “best practice”/ “good practice” (Petersen et al., 2015) – complemented with narrative review of suitable approaches if deemed necessary (Petersen et al., 2016).

Clinical and social-economic databases are useful and can be taken into consideration as complementary (Freeman et al., 2005), in order to assess global outcome within organizations (Freeman et al., 2005), provide comprehensive counselling by social workers and effective communication between family members and medical professionals (Webster et al., 2015) aiding and advising on several issues and concerns arising on short and long term, and comparing procedures and outcomes among different organizations and countries/regions (Trabin et al., 1997; Johnston et al., 2003).

## Governance

### Rehabilitation is indispensable to a quality health system

For effective integration and inclusion of neurorehabilitation within neurotrauma care, strategies for the effective governance at the community, district, regional and national level must be considered

Rehabilitation, with its intrinsic long-term profile, cannot rely solely in outside forces and aid delivering services (Dempsey., 2018). Self-sustaining programs embraced by the developing country on itself are mandatory. Foreign volunteers can be crucial in training all involved health technicians but their impact is short-lived if their teachings and examples are not correctly assimilated and put in practice by local personnel, with the potential aid of telemedicine and web-based conferencing for needed corrections and advising

Comprehensive initiatives should include experienced agents or platforms for global coordination/ Multiple stakeholders have intentions and goals that must be complemented by cost-benefits analysis and adequate assessment of Public Health planners and public perception on the programmes to be implemented (Roberts et al., 2003), specially when outcomes are uncertain and distant in time. Experienced  organizations as the World Health Organization should emphasize governance models, interoperability and infrastructures integration. Attention to both ethical and political processes within a specific cultural context is mandatory (Robert set al., 2002).

On a larger scale, Global Health awareness is sustainedly growing but still fails to acknowledge shortcomings of misdirected strategies. As mentioned by Yamey on a recent report: “High level commissions on global health or development can be influential in raising the profile of a neglected topic, in stimulating discussion and debate and in shaping policy.” (Yamey et al., 2018). Neurohabilitation will, by definition, escalate the impact of other health services – surgical and trauma care, management of noncommunicable diseases – while saving costs (Howard-Wilsher et al., 2016).

World Health Organization is, in our opinion, the natural platform for global coordination of efforts from all stakeholders, along with regional and national Societies. Recent awareness for investing in Essential Surgical Care World Wide (Ljungman et al., 2018) as a pressing issue is useless, specially in the case of Global Neurosurgery, if not supported on a long-term view concerning outcomes and the individual, addressing functional recovery in adequate Neurorehabilitation programs. Programs as the WHO Global Initiative of Emergency and Essential Surgical Care (Ljungman et al., 2018) or the Lancet Commission on Global Surgery (Meara et al., 2015) were followed by similar, comprehensive initiatives in Rehabilitation/Neurorehabilitiation: WHO´s Global Cooperation on Assistive Technology, WHO Global Disability Action Plan 2014-2021 (WHO Global Disability., 2015) and the Rehabilitation 2030 – A call for action program.

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