



# TRAUMATIC BRAIN INJURY

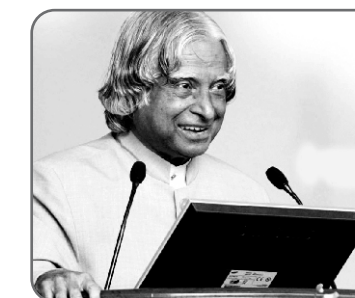
Multi Organizational Consensus  
Recommendations for India



## NOTES :

“ This book is dedicated to all patients who lost their lives due to Traumatic Brain Injury and their relatives who apart from losing their loved ones have also undergone immense emotional trauma.”

## SPECIAL THANKS



**Late Dr. A. P. J. Abdul Kalam**  
Former President of India

who had supported the development of Neurosciences in India for the last 7 years, and had also been a great source of immense inspiration for the development of these guidelines. Without his guidance this project would not have seen the light of the day.



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  - Indian Head Injury Foundation
  - NBRC (National Brain Research Center)
  - JPN Apex Trauma Center, AIIMS, Delhi
  - National Institute of Mental Health and Neurosciences (NIMHANS), Bengaluru
  - CMC Vellore
  - SMS Jaipur
  - Center for Advanced Brain and Spine Surgery, Super Specialty Hospital Chennai
  - Kokilaben Dhirubhai Ambani Hospital, Mumbai
  - North Shore LIJ Health System, Manhasset, NY
  - Medical College of Wisconsin, Milwaukee WI
  - Rusk Rehabilitation NYU (Neuro-rehab), NY USA
  - Medical College of Wisconsin (MCW)
  - University of Toronto. ATLS, Canada
  - Ziqitza Healthcare Head 108 Services, Punjab
- Joint Section of Neurotrauma and Critical Care of the AANS/CNS
  - Neurotrauma Society of India
  - Association of Surgeons of India (ASI)
  - Indian Federation of Neurorehabilitation
  - Andhra Medical College; King George Hospital (KGH), Visakhapatnam (A.P.)
  - WHO Collaborating Center for Injury Prevention and Safety Promotion, NIMHANS Bangalore
  - Medtronic, USA
  - NIMS, Hyderabad.
  - Cushing Neuroscience Institute, Manhasset, NY.
  - North Shore University Hospital
  - Save life Foundation, Delhi
  - Clement J. Zablocki VA Medical Center in Milwaukee
  - ICMR
  - School of Management Sciences at Hyderabad University
  - ATLS Committee of the American College of Surgeons
  - GVK EMRI (108), Emergency Medicine Learning Center & Research



**Guideline Development Team**  
would like to thank some special eminent people without  
whom this project would have not started.

American Association Of Indian Origins its office bearers, its members: AAPI Past  
President Dr Ravi Jahagirdar, AAPI President Dr Seema Jain for their relentless  
support and taking the cause of Traumatic Brain Injury guideline process to a  
incredible start.

A special thanks to AAPI and AASAN members Dr Raj Narayan & Dr Jogi Pattisapu  
for spearheading and being mentors for this project

Mr Anwar Feroz Siddiqi in spearheading the project for scientific writing and designs.

Dr Mamta Jain & team of Medwiz Healthcare Communications Pvt Ltd for scientific  
writing and design.

The Guidelines Development Team would like to acknowledge the  
support from Medtronic and Abbott.



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# INTRODUCTION AND RATIONALE FOR TBI GUIDELINES



## OVERVIEW

A group of concerned neurosurgeons, with the support of the American Association of Physicians of Indian Origin (AAPI) and several other organizations named above, initiated this project in 2014 to improve the management of traumatic brain injury (TBI) in India. It was apparent to all that this was a monumental task and would require the help and support of many people and numerous organizations. However, it was also obvious that trauma in general and TBI in particular posed a major public health crisis in India and in many developing countries. Some of the initiators of this project had helped to establish the TBI Management Guidelines in the US a couple of decades ago and watched their implementation substantially improve TBI care in the USA. However, due to the lack of infrastructure, it was clear that these guidelines would not be immediately applicable in India. Furthermore, we did not have a set of India-centric guidelines that could be used for the education and training of trauma care providers in India. This document is our first effort to develop such guidelines.

Although trauma is not a 100% preventable problem, it is however a condition where post injury care creates significant social and economic burden on the patient and family. There is lack of best treatment practice of patients who do not experience spontaneous recovery in the Motherland. The road to recovery from TBI is long and arduous, and persistent symptoms/neurologic deficits demand prolonged continuous treatment and management. Many TBI patients experience significant symptoms beyond the normal recovery period, which can include post-traumatic headache, sleep disturbance, disorders of balance, cognitive impairments, fatigue, and mood or affective disorders. With high incidence of TBI this potentially translates to a significant number of individuals who may experience associated disability.

### Therefore, the following questions needed to be addressed –

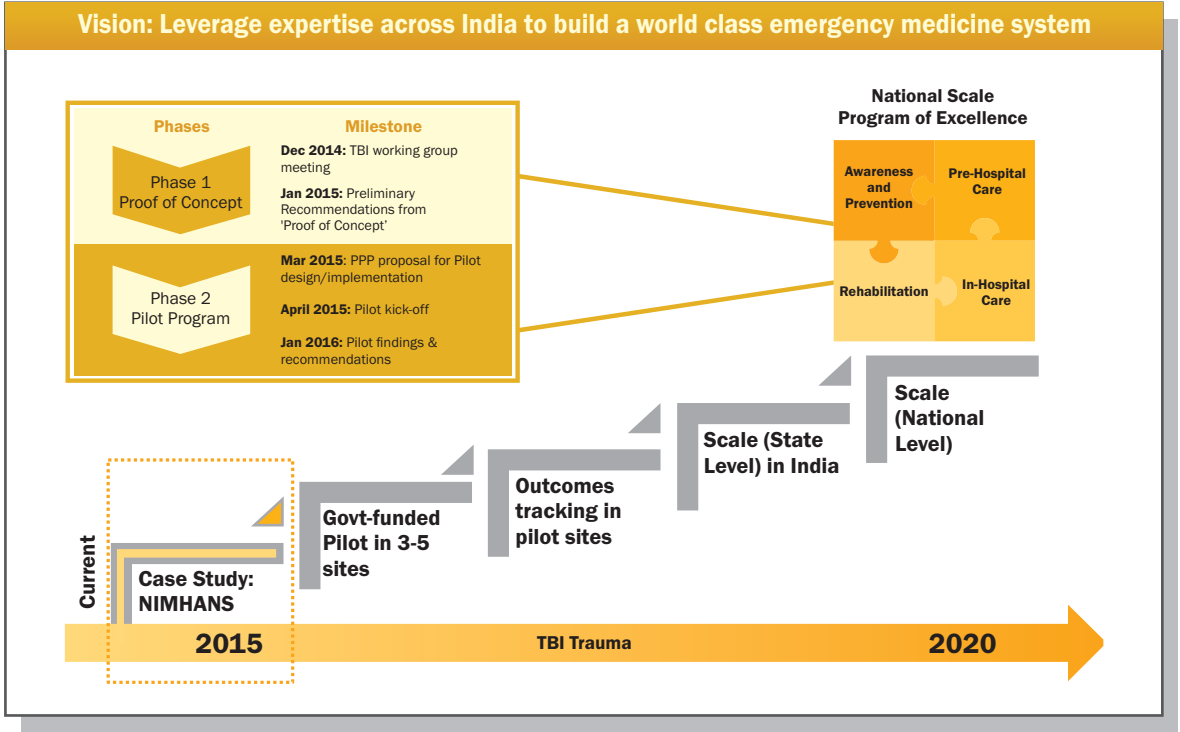
Can an approach be devised to wherein effective prevention by means of stricter laws on road safety be enforced, or good Samaritan law be enforced, or can we have a functional identification of levels of trauma, and victim or patient be transported to the nearest center based on his or her injury? Can a complete management plan be developed, not just at the center but also in terms of what rehabilitation strategy can be developed so that best integration in social life is possible post acute care? Can we also have training plan to enhance our inadequate paramedic staff and also first point of contact?



## SCOPE

In India the diversity is not only in terms of geographical terrain, landscape, language, but also in terms of patient care. We have few centers of excellence and some institutions where minimum standards are difficult to maintain at the primary care center level. This instrument aims to be a peer driven living document which will evolve constantly, bringing together multiple stake holders such as Government, policy makers, road safety authorities, police, ambulance services, primary care centers,, and the general public. Fully equipped ambulances actively integrate with properly accredited trauma centers, with proper equipment and trained staff associated with neurorehabilitation centers are a part of these guidelines. AAPI, Indian and Global experts on Traumatic Brain Injury will leverage each other's support for analyzing various ground realities and start the initial step towards a model emergency medicine system across India.

**The purpose of developing these Indian centered guidelines is to improve patient care by creating a framework for health professionals to effectively identify, prevent, and treat TBI. AAPI, Indian and global experts on Traumatic Brain Injury will leverage each other's support for analyzing various ground realities and start the initial step towards a model emergency medicine system across India.**



THE CURRENT SITUATION WITH TRAUMATIC BRAIN INJURY IN INDIA



This unique initiative to develop Indian specific guidelines engaged experts from both sides of the globe. Models from well established trauma care centers, their evolution and approach to TBI, combined with scenarios of trauma care at various evolutionary stages provided an opportunity for healthy discussions. Sharing the international expertise on system development offered newer options for Indian centric neurotrauma care scenario designed for a developing nation.

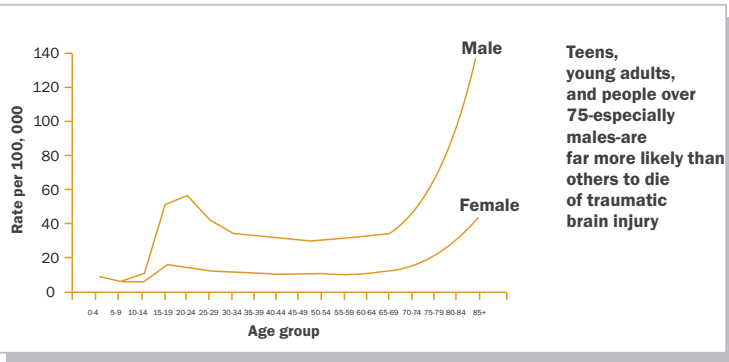
II. A. THE RATIONALE FOR TBI GUIDELINES - GLOBAL PERSPECTIVE

The brain—like other organs—bruises and swells from impact injuries. Such injury can also severely limit blood-flow and deprive tissue of vital oxygen, causing cell death and irreversible brain damage. Fortunately, such catastrophic downturns need not occur in many cases.

TBI continues to pose a serious worldwide public health challenge, with numerous deaths at the scene and a large percentage of surviving patients have lifelong disabilities. These neurologic limitations cause a significant burden for the victim and entire families over many generations.

The psychological social financial burden of this preventable problem runs in billions of dollars, significantly impacting economical growth of a developing nation.

Unfortunately, traumatic brain injury most often occurs in males during the most productive years of their lives, and a rise in incidence is also seen in people over 75 years, associated with falls.



Why Are Evidence-based Guidelines Important?

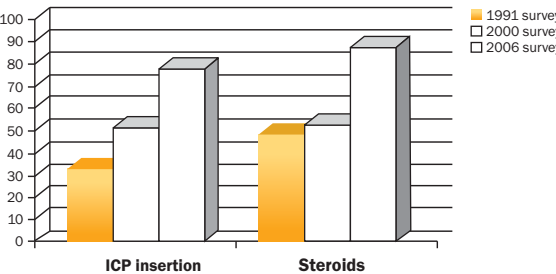
ALIGN CLINICAL PRACTICE WITH THE EVIDENCE

- Reduce use of ineffective or harmful therapies
- Increase use of effective therapies

REDUCE PRACTICE VARIATIONS

- Increase efficiency of healthcare

IMPROVE PATIENT OUTCOMES



II. A. THE RATIONALE FOR TBI GUIDELINES - GLOBAL PERSPECTIVE



Evidence based approach in developed countries have established that there has been a significant decrease in associated mortality and disability by adopting standardized guideline based approach. There has been a significant improvement in outcomes in USA, wherein post TBI death incidences have decreased from 51% in 1977 to 20% currently.

Our understanding regarding the cascade of events that follow traumatic brain injury has improved and with evidence based medicine approach it is now evident that systemic treatment take precedence over CNS symptom management. For example evidence guided guidelines have proven that managing hypotension on a priority basis has a significant impact on mortality.

Role of Hypoxia & Hypotension in Determining Outcome from SHI

	No.	%	G/MD	SD/V	Dead
Total cases	699	100	43	20	37
Neither	456	65	51	22	27
Hypoxia	78	11	45	22	33
Hypotension	113	16	26	14	60
Both	52	7	6	19	75

Hypotension (SBP <90) is much worse than hypoxia (pO2 <60); together they are disastrous







Chestnut RM, J Trauma 34:216-22, 1993



THE CURRENT SITUATION WITH TRAUMATIC BRAIN INJURY IN INDIA



Countries both very developed like USA and countries developing like Croatia, Hungary, Slovakia, Slovenia, also have documented scientific evidence based medical care reduces deaths by 50%. Adaptation of ATLS (Advanced Trauma Life Support), protocols and guidelines and its adaptation across USA and now in many countries have improved outcomes, and this has a significant impact on cost of treatment and healthcare cost burden on government, families involved.

FIRST BRAIN INJURY	SECOND BRAIN INJURY			RECOVERY	OUTCOME
					
OLD WAY	<ul style="list-style-type: none"><li>• Nearest hospital</li><li>• Inadequate resuscitation</li><li>• Hyperventilation</li></ul>	<ul style="list-style-type: none"><li>• Surgical delays or omissions</li><li>• Inadequate resuscitation</li><li>• Inadequate facilities and personnel</li></ul>	<ul style="list-style-type: none"><li>• No brain pressure monitoring</li><li>• Steroids</li><li>• No protocol</li></ul>	<ul style="list-style-type: none"><li>• Delay in rehab</li><li>• Medical complications</li></ul>	<b>BAD OUTCOME</b> <ul style="list-style-type: none"><li>• \$\$\$ costs</li><li>• 😞 Family</li><li>• Violence/ asocial behavior</li><li>• Severe disabilities</li></ul>
NEW WAY*	<ul style="list-style-type: none"><li>• TBI-Trauma Center</li><li>• Full resuscitation</li><li>• Brain targeted therapy</li></ul>	<ul style="list-style-type: none"><li>• Rapid surgeries</li><li>• 24hrs CT Scan</li><li>• Adequate facilities</li></ul>	<ul style="list-style-type: none"><li>• Brain pressure monitoring</li><li>• Optimize brain perfusion</li><li>• Bedside vigil</li><li>• Use of protocols</li></ul>	<ul style="list-style-type: none"><li>• Integrated rehab</li><li>• Prevent medical complications</li></ul>	<b>GOOD OUTCOME</b> <ul style="list-style-type: none"><li>• \$ costs</li><li>• 😊 Family</li><li>• Socially integrated</li><li>• No severe disabilities</li></ul>

Scientific Guidelines

→ Patient tracking/ QA reports/Practice improvements →

\*First Brain Injury may be so extensive that any treatment is futile based on Program Guidelines

Systematic approach leads to rapid and accurate diagnosis. Adherence to guideline based TBI management protocols have proven to decrease deaths by 50% and significantly improve neurologic outcomes, thereby reducing nation's long-term neurologic injury related healthcare costs by billions.

Unfortunately, there has been very little scientific publication in India regarding neurotrauma.

Geocentric data is vital and a basic prerequisite to define the enormity of the problem, its determinants and various dimensions required to formulate, implement and evaluate programs aimed at mortality, morbidity/disability reduction, and socioeconomic losses in every country.

II. A. THE RATIONALE FOR TBI GUIDELINES - GLOBAL PERSPECTIVE



Injuries are a major public health problem today. Injuries and TBIs in India have been increasing significantly due to rapid motorization, industrialization, migration and changing value systems of Indian society. Apart from instantaneous deaths, health care consequences and the tremendous suffering and poor quality of life among survivors is a living testimony to the impact of TBIs and the need of the hour.

Although trauma care in India has improved in recent times, it is still far away from being a standard or protocol driven approach, and the process is relatively slow even if coordinated work is done at all levels from government, health authorities, road safety department and then significant strides can be made by following evidence driven trauma care.

Based on global and especially USA experience if a roadmap has to be laid down for Indian Traumatic Brain Injury Guidelines then it would be:

- Review the US and European Experience and Guidelines.
- Assess the current situation in India.
- Create a set of guidelines that are practical and applicable to India.
- Try to establish a statistical baseline of the current incidence and outcomes from TBI.
- Get buy-in from all other concerned entities.
- Widely disseminate Indian guidelines.
- Create training courses for different providers.
- Establish model Centers of Excellence for Trauma Care.
- Work towards creating a trauma system in collaboration with the Central and State Governments and industry.

Unraveling the factors - causes, situations, circumstances, is crucial to initiate action in a scientific way. This understanding is also crucial to move from present pessimistic attitudes to more optimistic thinking in the area of prevention and rehabilitation.

# THE CURRENT SITUATION WITH TRAUMATIC BRAIN INJURY IN INDIA



## II. B. EPIDEMIOLOGY OF TRAUMA IN INDIA

### Traumatic Brain Injury in India

The epidemiological and socio demographic transition in India has resulted in emergence of injuries as a major public health problem in recent years. The rapid urbanization, unprecedented motorization, growing industrialization and increasing impact of media along with changing life styles and values of people in the absence of safety policies and programmes has contributed further to this scenario. Simultaneously, as India has made significant strides in prevention and control of infectious, nutritional and communicable diseases the disease patterns and profiles have changed, thus increasing the contribution of injuries to death and disability. Consequently, injuries are a major cause of mortality, morbidity and disability in the burden of disease in India.

Among the various type of injuries, Traumatic Brain Injuries (TBIs) are at the forefront resulting in significant number of deaths, hospitalizations, disabilities and socio economic losses. TBIs are known to be increasing over a period of time, have a huge impact on individuals and families and contribute for a significant but an unestimated socio economic impact, specially affecting the poor and middle income sections of the society. **As TBIs affect young and productive sections of the society, it results in significant socio economic losses as poor people sustain higher number of TBIs and also have limited access to quality care.**

### Burden of TBIs : Incidence and mortality

The current understanding of TBIs in India is limited due to lack of good quality population based information in this area. Apart from absence of community based epidemiological studies, trauma registries as seen in High Income Countries (HICs) are absent in India. Further, the available data from the existing national sources of health and police sectors have inherent limitations in completing the epidemiological picture and profile of TBIs. Small number of studies from individual centers provide a limited understanding of the problem and at the same time cannot be generalized due to data limitations.

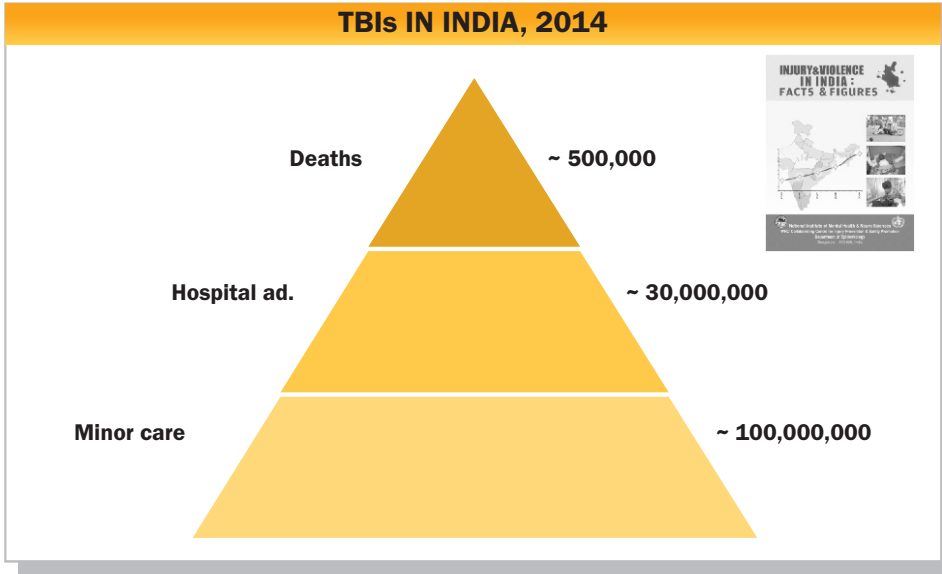
- A hospital based epidemiological study undertaken by NIMHANS during 1994 revealed that the incidence and mortality of TBIs was 160 per 100000 per year and 20 per 100000 per year. **Applying these figures to the current population of India it is estimated that nearly 2.5 million new TBI cases occur every year resulting in death of 250000.** Further, the same data indicate that nearly 1.5 to 2 million people are hospitalized every year due to TBI. **These numbers can be underestimates as the data is nearly two decade old and predominantly hospital based in nature.** As mentioned earlier there have been no large scale epidemiological studies in the country.

## II. B. EPIDEMIOLOGY OF TRAUMA IN INDIA



- Information National Crime Records Bureau reveals that **nearly 500000 deaths occur every year due to injuries and 1/3 of them are due to a Road Traffic Injury (RTI).** The availability and quality of national data has been examined by independent researchers and it has been observed that the official numbers are underreported for both fatal and non-fatal injuries. Thus, it is estimated that nearly a million deaths occur every year due to injuries.
- Estimates from the global burden of diseases, world health organization, and few independent estimates confirm these observations by reporting **more than a million deaths and 50% of them are being TBIs.** Further, some of the population based verbal autopsy studies in India inform that nearly 13 to 18% of deaths in the community are due to injuries.
- In a nationally representative mortality survey of 1.1 million homes, it was estimated that nearly 1 million injury deaths occur every year and 60% of them would have an injury to the brain. **With this observation it is estimated that there could be nearly 500000 deaths every year due to TBIs in India.**
- Interestingly, the case fatality rates of TBIs , specially in apex institutions and advanced trauma care centers seems to have reduced due to aggressive management practices. In addition, the availability of specialized manpower and diagnostic – managerial facilities would have contributed to this process. However, this is not true of all other centers in the country.

**Based on these observations it is estimated that nearly 500000 deaths, 15000000( 1: 30) severe to moderate TBIs and about 50 million( 1: 100) hospital or emergency room contacts could be due to a traumatic brain injury in India.**





# THE CURRENT SITUATION WITH TRAUMATIC BRAIN INJURY IN INDIA



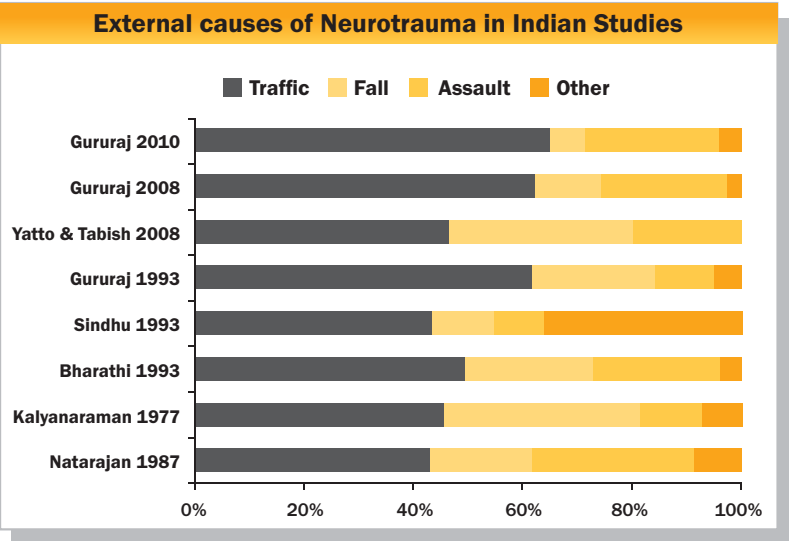
## Nonfatal TBIs

Several hospital based studies indicate that nearly half of the injury deaths and hospitalizations will have an injury to the brain/central nervous system at admission time and consequently, it is estimated that about 500000 TBI related deaths occur every year in India. Further, for every death nearly 30-50 people hospitalized and consequently a minimum 15 million severe to moderate TBIs are seen in India. Data from the three years of Bangalore Road Safety and Injury Prevention Programme indicated that nearly 20% of ER Registrations, 10% of admissions, and 1/3 of hospital deaths are due to injuries and more than half of them will have sustain a TBI. **The prevalence of TBIs is not clearly known and a population based study undertaken in Bangalore reported a prevalence of 94 / 100000 population in rural Bangalore.**

## External causes of TBIs

Among the various external causes, it is clearly known that road traffic injuries, falls, work place injuries (industrial/agricultural), violence, sports injuries, and those resulting during disasters contribute for TBIs. The problem, profile and pattern of TBIs due to these external causes vary and are influenced by several macro and micro factors. Among these causes listed above, **RTIs are currently recognized as a major public health problem; however, limited research and information systems exist in India.**

Epidemiological studies of Neurotrauma over a period of time indicate that RTIs contribute for 60% of TBIs with the reminders contributed by falls and assault. The NIMHANS TBI registry indicated that 60% of TBIs were due to road crashes, 25% due to falls, 10% due to assaults/violence, and the rest due to other causes. With road deaths increasing at an annual rate of 5 to 8% year, the number of TBIs also increases at a corresponding pace in the coming years. **As per WHO, road crashes will be the 5<sup>th</sup> leading cause of death in India by 2030.**



RTIs will be the 5th leading cause of death in India by 2030

# II. B. EPIDEMIOLOGY OF TRAUMA IN INDIA



Data from NCRB also indicate that the **economically progressive Southern states of India have a higher incidence of road crashes as compared to other states.**

Most significantly data indicate that pedestrians, two wheeler riders and pillions and bicyclists are major victims of road traffic injuries in India as compared to the situation in high income countries where motor vehicle occupants are at greater risk.

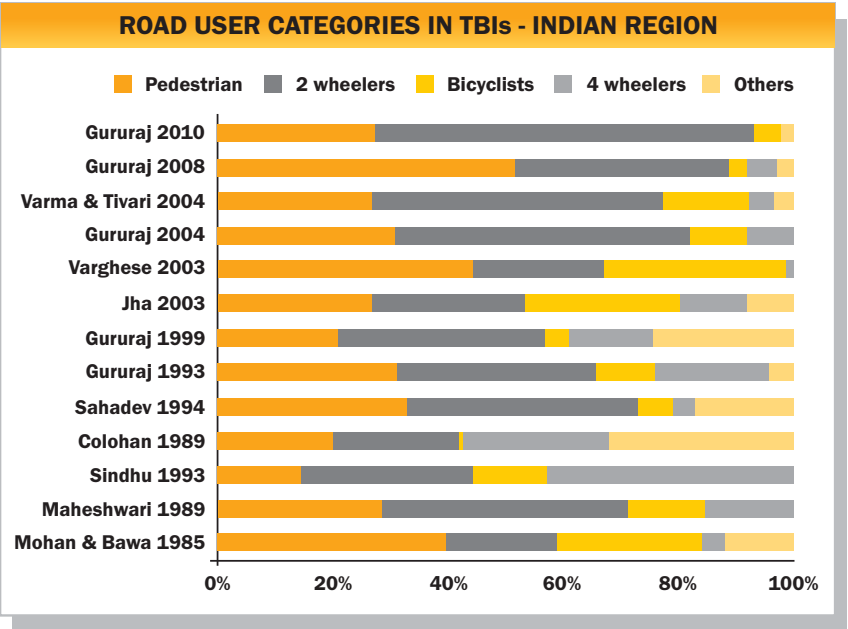
**Indian highways that are at a stage of rapid expansion are known to contribute for nearly 40 % road deaths and injuries in India with variations seen among different states.**

The precise causes of road crashes in India are still to be delineated . **However, the available research indicates that some of the risk factors include – road design and operating factors, safety of the vehicles, nonuse of helmets - seat belts and - child restraints, drinking and driving, driving at excessive speeds, poor visibility, pedestrian mobility and walkability issues are some major factors.** Limited emergency and trauma care services are a major cause for poor trauma outcomes. These factors need to be addressed for prevention of Neuro trauma in India.

## Sociodemographic correlates

TBIs are predominantly a problem of the young people. Data indicates that the incidence of TBI increases from the early ages of 5-10 years, reaches a peak between 20-39 years and a second peak is observed among the elderly. Further, the male to female distribution is on a scale of 1:3 to 1:4 varying between urban and rural areas. These indicate that young people are affected more at the prime periods of their life which in turn affects their education, work, marriage, and other aspects of life.

The urban rural distribution of TBIs is not clearly known; however, data on road crashes indicate that less than 20% of deaths, crashes and non-fatal injuries occur in urban areas with the remaining seen in rural India. This assumes significance as rural India lacks systematic prevention and trauma care services resulting in delayed care as well as greater number of referrals.



## THE CURRENT SITUATION WITH TRAUMATIC BRAIN INJURY IN INDIA



### Patterns of TBIs

Limited data from India indicate that cerebral concussion, contusion, hemorrhage and skull fractures are the common injury patterns of TBI as seen in other parts of world. The severity distribution indicate that nearly 60 % of TBIs are mild (based on GCS), 20 % are moderate and 15 – 20 % are severe in nature. Studies have also indicated that nearly ¼ of the injured persons are likely to have poly trauma requiring aggressive and intense management of hospitalized patients. **Moderate to severe injuries specially in situations of poly trauma pose major challenges for management and recovery.**

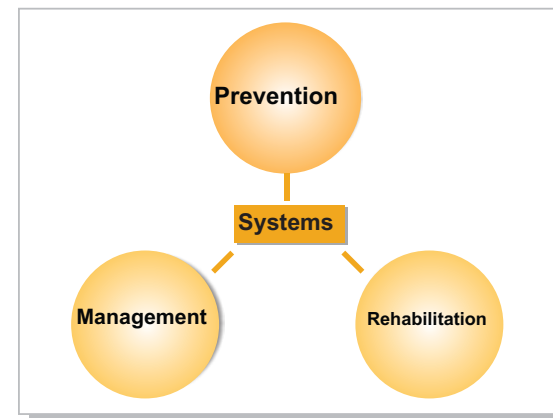
### Disability

It is well acknowledged that **nearly 100% of those with severe, 50% with moderate, and 10-20% of those with mild brain injuries need long term rehabilitation services covering physical, psycho social, vocational and economic rehabilitation for their survival. Based on available limited data, it is estimated that nearly 5 million people with a TBI require rehabilitation services.**

The three years of population and hospital based traumatic brain injury registry at NIMHANS demonstrated that brain injury survivors had significant problems in the areas of education, marriage, work, social activities, and other areas of life leading to poor quality of life. TBI survivors had variety of health problems affecting physical health, locomotor abilities, speech and memory, information processing, cognitive abilities, and had variety of psychosocial problems affecting their quality of life. The type, extent, nature and severity of problems faced are directly related to age, gender, socioeconomic status and others. Most significantly, individuals and families with a TBI faced considerable financial difficulties most often leading to discontinuity of care and a worsening of their health status.

### Need for an integrated and public health approach

**The goals of TBI prevention, management and rehabilitation are to ensure that injuries do not occur in the first place as majority of TBI causes are predictable and preventable.** Even if it occurs, it should not lead to death and disability as enough global and Indian knowledge exists to manage them better in health care institutions. Further, those who are affected should be efficiently rehabilitated to see that they return to their optimum levels of functioning. Experience of many HICs demonstrates that all three are possible and India has a long way to go to achieve these goals.



## II. B. EPIDEMIOLOGY OF TRAUMA IN INDIA



**For Neurotrauma programmes to be effective, specific – focused and defined activities need to be implemented based on data and evidence and these include various public health strategies and approaches:**

- On the prevention front, recognition and intervention of modifiable risk factors.
- On the care, defined systematic activities to scale up services.
- On the rehabilitation front, implementing both hospital and community based activities.

**All the 3 domains of activities need to be driven by good quality information systems and should include a component of monitoring and evaluation to track progress and to see the results of interventions.**

### Services and resources for TBIs

The health infrastructure in India, though limited has been progressing over time despite limited resources. Trauma care in India is still more of an urban phenomenon and vast majority of districts and rural areas do not have access to quality care. At the same time, it has been observed that trauma care in the private sector is expensive and many common citizens will not be able to afford the same in a country where insurance coverage is limited.

There are a few centers of excellence in the country that provide specialized neurotrauma care. The precise numbers of these are not known, but are only few in number. Thus, it becomes essential to strengthen trauma care, especially TBI care, in the nearly 398 medical colleges, 750 district hospitals, 200 trauma care centers that have been recently established and nearly 5000 community health centers apart from large numbers of primary health centers. The EMRI 108 is the principal emergency care provider and is involved in safe transportation of injured. The programme has nearly 12,000 ambulances distributed in both urban and rural areas. India has recently started an Emergency Medicine course following the recognition of the same from the Medical Council of India.

In addition, a number of private healthcare providers at both individual and institutional level exist and provide services for neurotrauma patients in India. Their services range widely and these include ambulance services, smaller nursing homes, private colleges, corporate hospitals and several others. It is crucial to involve and engage them in trauma care through appropriate regulations.



**The Public Health Model**

To achieve these goals, it is important to focus on public health principles and practices at macro and micro level activities and these include:

1. National Policy on neurotrauma prevention, care and rehabilitation.
2. Defined policies on road safety and injury prevention.
3. A plan of action that specifies roles and responsibilities of stake holders, timelines, budget and sustainability plans.
4. A research agenda that guides policies and programmes.
5. Capacity building of health and related professionals.
6. Choice and selection of interventions that are scientific, cost effective and technologically feasible.
7. Systematic training of health professionals.
8. Surveillance and research.
9. Monitoring.
10. Evaluation measured in terms of changing TBI burden and, most importantly an implementable plan in geographically defined areas that is also cost effective and sustainable.



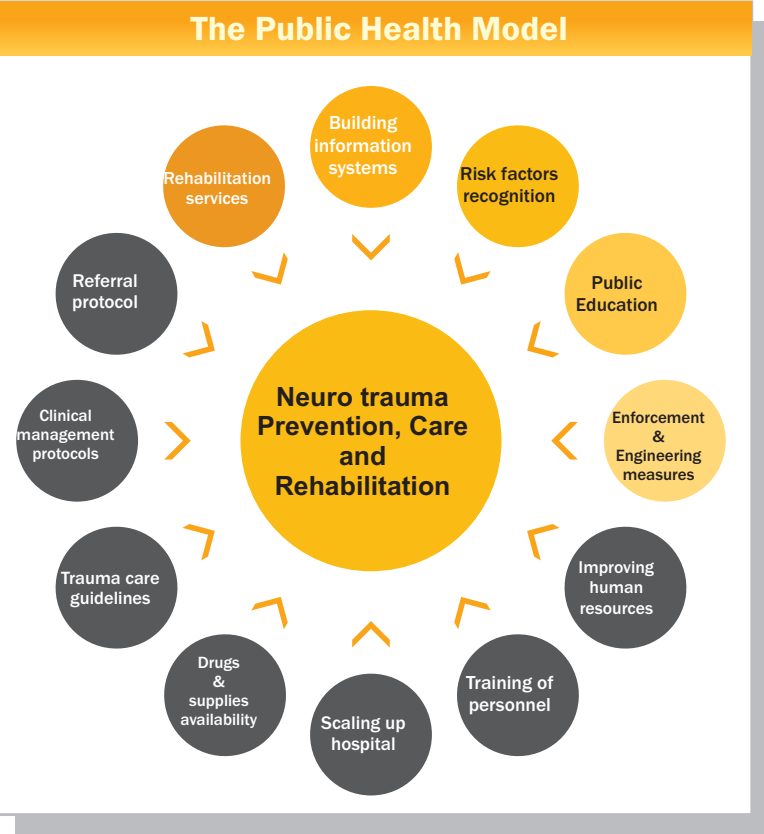
Specific public health tools that have been adopted in neurotrauma prevention, care and rehabilitation include an integrated set of activities focusing on

- Education and public awareness.
- Enforcement along with legislative measures.
- Engineering for product and environment design.
- Emergency care along with trauma care.

The specified goals of TBIs are possible only through a public health model and approach. It requires coordinated – integrated and interlinked approaches for delivery of preventive, promotive, curative and rehabilitation services. The identified activities shown in figure above should be designed, planned, implemented, monitored and evaluated. Indicators to measure progress should be developed to track changes and see efficiency. The real change in scenario should be the reduction or change in deaths, hospitalizations and disabilities measured through scientific information systems.

**Towards goals**

For these to be accomplished, there is need for establishing systems that are inter disciplinary and evidence based at both central and state levels. There is a clear need to improve TBI information systems that can provide good quality data for design, development, implementation, monitoring and evaluation to develop a scientific approach in our future efforts. There is also a clear need to increase awareness, understanding and engagement of policy makers, professionals, press and the public to work towards TBI prevention and care.





II. C. CURRENT STATUS OF PRE-HOSPITAL CARE

Among all types of injury, neurotrauma (injury to the central nervous system) has serious consequences and major implications. These injuries cause enormous suffering and losses not just to individuals, but also families and communities. The damage from a traumatic brain injury to an individual would range from a minor shock to instantaneous death. A survivor will have brain injuries varying from superficial injuries to a permanent vegetative state. Apart from physical damage and neurological disabilities of different types, psychosocial problems like fear, anxiety and suffering will affect the individual even after discharge from the hospital. The recovery from injury can take years, depending on physiological factors and pathological damage. The affected individual goes through pain and suffering of immense nature for long periods of time.

Brain resuscitation should be started at the earliest as the traumatized brain is very susceptible to hypoxia and ischemia, and this makes pre-hospital care a crucial link in the chain of trauma care. All efforts should be made to prevent further neuronal damage which otherwise will continue unchecked. Pre-hospital and emergency care has been a major issue in India and there is a lot to be desired in this area, as the quality of pre-hospital care is a major determinant of long-term outcome for patients with traumatic brain injury. It has been estimated that up to 20% of injured patients die after accidents because of inadequate treatment prior to hospitalization. The morbidity and mortality of severe head injury could be remarkably reduced by simply securing and maintaining the airway and providing ventilation to such patients at the accident scene. **There is a significant lack of Basic Life Support (BLS) EMS on site, and almost no Advanced Life Support (ALS) EMS.**

**For trauma care, basic skills include airway management (maneuvers to open an airway, oral and nasal airway adjuncts, and bag-mask ventilation), cardiopulmonary resuscitation and automated external defibrillation, hemorrhage control, and fracture and spine immobilization, and this training is missing in most hospitals in India.**

Even first aid services are often not available at first contact with a health care provider. Poor recognition and early management of brain injuries, unnecessary referrals from local hospitals (even for injuries which could have been managed at peripheral level as many transfers to hospitals are in private vehicles, ambulances were used only in 25%) and delays between injury and reaching definitive hospital (only 24% arrive within 1 hour, 30% within 2-3 hours and 24% take more than 24 hours) are some of the other issues with pre-hospital care. Communicating with trauma centers and ambulances with trained personnel are other crucial links that are missing or underutilized.



Some crucial steps of communication which have to be functional-

- Sensitize personnel for effective pre hospital communication.
  - Early information of injury.
    - ↳ SOS telephone
    - ↳ Highway patrolling
    - ↳ Emergency ambulance
  - Transport - equipped Transport Ambulance.
  - Medical assistance – Manpower, drugs & equipments.
  - Legal formalities.
  - Financial implication.





II. D. CURRENT STATUS OF IN HOSPITAL CARE

Currently in India head injury patients are managed either at state funded or private hospitals, and both have their own problems and concerns, which is why optimum care to patient is not given. **There is an imbalanced distribution of trauma care, with concentration in urban areas, while many districts lack even CT scans, and crucial equipment like ventilators.**

Government facilities are overburdened, with inadequate man power, resources, medicines and equipment for the patient load. Privately provided care is expensive and therefore unaffordable to majority of trauma patients. Also due to lack of standardization in trauma care, the quality of care varies widely, with some centers of excellence and others not even capable of administering first aid. **One of the reasons for this is that there is no central government agency to integrate policy making, planning, financing, drafting legislation or establishment of minimum standards for the performance of a trauma care system. Available personnel and their skills often do not match the needs of the patients, and the concept of a dedicated trauma team is not accepted at all levels.**

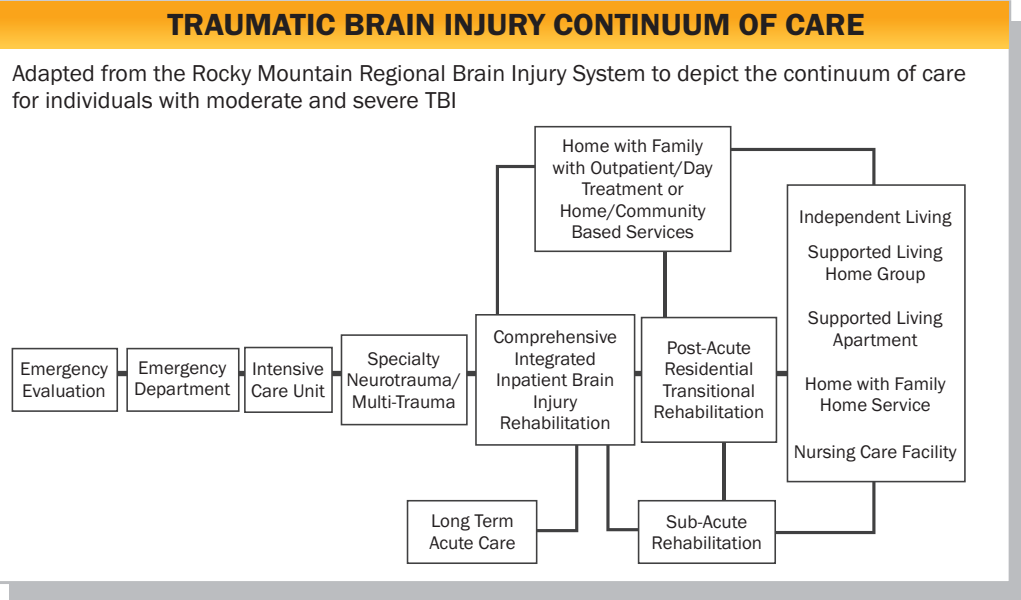
Small hospitals and clinics mushrooming across India are unable to cope with polytrauma, and because of lack of multidisciplinary support they provide substandard care and high mortality is the result of lack of governing guidelines. There are no trained personnel in EMS or as casualty medical officers, and Inter hospital transfers have no set protocols. Nationally accepted guidelines on management of traumatic brain injury would go a long way in solving many of these issues. There is no national trauma registry, so data is center specific, making it difficult to form clear protocols on what should be the priority while managing trauma patients.



II. E. CURRENT STATUS OF REHABILITATION IN INDIA

Need for rehabilitation in Traumatic Brain Injury (TBI)

- Patients who need rehabilitation: 1.5 million/year.
- Less than 10 integrated multidisciplinary in patient neurorehabilitation facilities in the country.
- Although long term neurorehabilitation services are available, these are not enough to provide optimum care and to all those who need it.
- Any patient with TBI who has persistent and stable neurological deficit, who requires medical monitoring and has impairment in at least two key domains should be transferred to in patient neurorehabilitation facility.
- A person with TBI should be evaluated and treated for impairments in cognition, vision speech and language, behavior, swallowing, sensory motor system, and bowel and bladder function.



Barriers For Implementing Neurorehabilitation

There are four major barriers to implement ideal neurorehabilitation system.

- Lack of rehabilitation
- Lack of awareness
- Lack of finances
- Lack of human resources





SECTION III. RECOMMENDATIONS

*"Neurotrauma" is an important public health problem and deserves global attention for a surveillance system with uniform definitions, and collection of data to compare the epidemiologic characteristics across time and space. A standard national database of traumatic brain injuries based on the causes and trends will help in defining public health priorities and establish the necessary surveillance systems.*

III A. AWARENESS AND PREVENTION

Preventing brain injuries from its occurrence need to essentially focus on its underlying causes. Some of the known causes as outlined in the previous section include road traffic injuries, falls, assault/violence, sports injuries and mechanical injuries. While the prevention of these causes has been addressed globally and specially in High Income countries, efforts in India have been limited due to poor understanding of causative mechanisms. Amongst them, only Road traffic injuries (RTIs) have drawn the attention of policy makers and professionals in recent years due to active involvement of media and judiciary.

Prevention of RTIs

Global experience clearly indicates that road traffic injuries are amenable to prevention and require systematic approaches. India needs a clearly defined road safety policy, a central coordinating agency, allocation of adequate resources, strict implementation of proven and effective interventions and an intersectoral approach. There are some efforts in progress and neurotrauma should be specifically included in all these activities.

The preventive efforts for road safety in India should focus on vulnerable road users like pedestrians, two wheeler riders and pillions and bicyclists along with other road users. Undoubtedly, there is need for integrated and coordinated approaches and health professionals need to take a greater role advocating for prevention of RTIs and TBIs.



The 'Safe Systems approach' recommended all over the world recognizes the fact human beings are likely to make mistakes in transport environments and these mistakes should not lead to death and disabling injuries. It recognizes that the human tolerance of an individual to energy generated in an injury act is the principal mechanism and should be addressed through safe roads, safe vehicles, post crash care in safe transport environments.

Primary prevention of TBIs and RTIs includes all efforts that need to be undertaken to see that crashes do not occur and even if it occurs, they do not lead to life threatening injuries. Thus, it includes making our roads and vehicles safer along with making people safer in transport environments.

Some known interventions that are proven to be effective and to be implemented in India are outlined below and include:

- Strengthening safe and efficient public transportation.
- Separation of traffic between fast and slow moving vehicles on all possible roads.
- Safety measures on national and state highways.
- Pedestrian safety measures in all locations with safe walking and road crossing facilities.
- Mandatory helmet use among two wheeler riders and pillions.
- Mandatory use of seat belts among motor vehicle drivers and occupants.
- Use of child restraints in all motor cars.
- Strict enforcement of drinking and driving legislation.
- Combined measures of road and vehicle engineering to control speeds.
- Increasing visibility of vehicle and people.
- Implementation of laws that discourage use of cell phones while driving.
- Implementing graduated driver licensing systems.
- Improving safety standard of all vehicles, specially Indian manufactured vehicles.
- Designing better road systems.

# RECOMMENDATIONS



Experience of many HICs has demonstrated that road traffic injuries are predictable and preventable. Further, as the road crashes are multifactorial solutions need to be multisectoral and integrated. In addition, it is known that a safe systems approach that understand limitations of human behavior and the vulnerability of the human body to injury forces us need to be considered in the larger framework of prevention and awareness activities. **The four E's of injury prevention viz. Enforcement, Education, Engineering, and Emergency Care needs to be integrated for each of the interventions listed above in its implementation.** For prevention programmes to be effective there is need for a mix of education, enforcement, engineering and emergency care strategies that have a clear focus.

## THE ROAD SAFETY PARADIGM SHIFT

### ROAD INJURY PREVENTION AND CONTROL - THE NEW UNDERSTANDING

Road crashes are largely predictable and preventable

A problem amenable to rational analysis and counter measures.

Moving beyond driver's errors, human mistakes, crisis approaches, knee jerk reactions and adhocism – Needs scientific and systematic approaches.

Multisectoral issue – all sectors need to work together.

Vulnerability of the human body and energy transfer.

social equity issue- equal protection to all road users.

Needs proactive approaches.

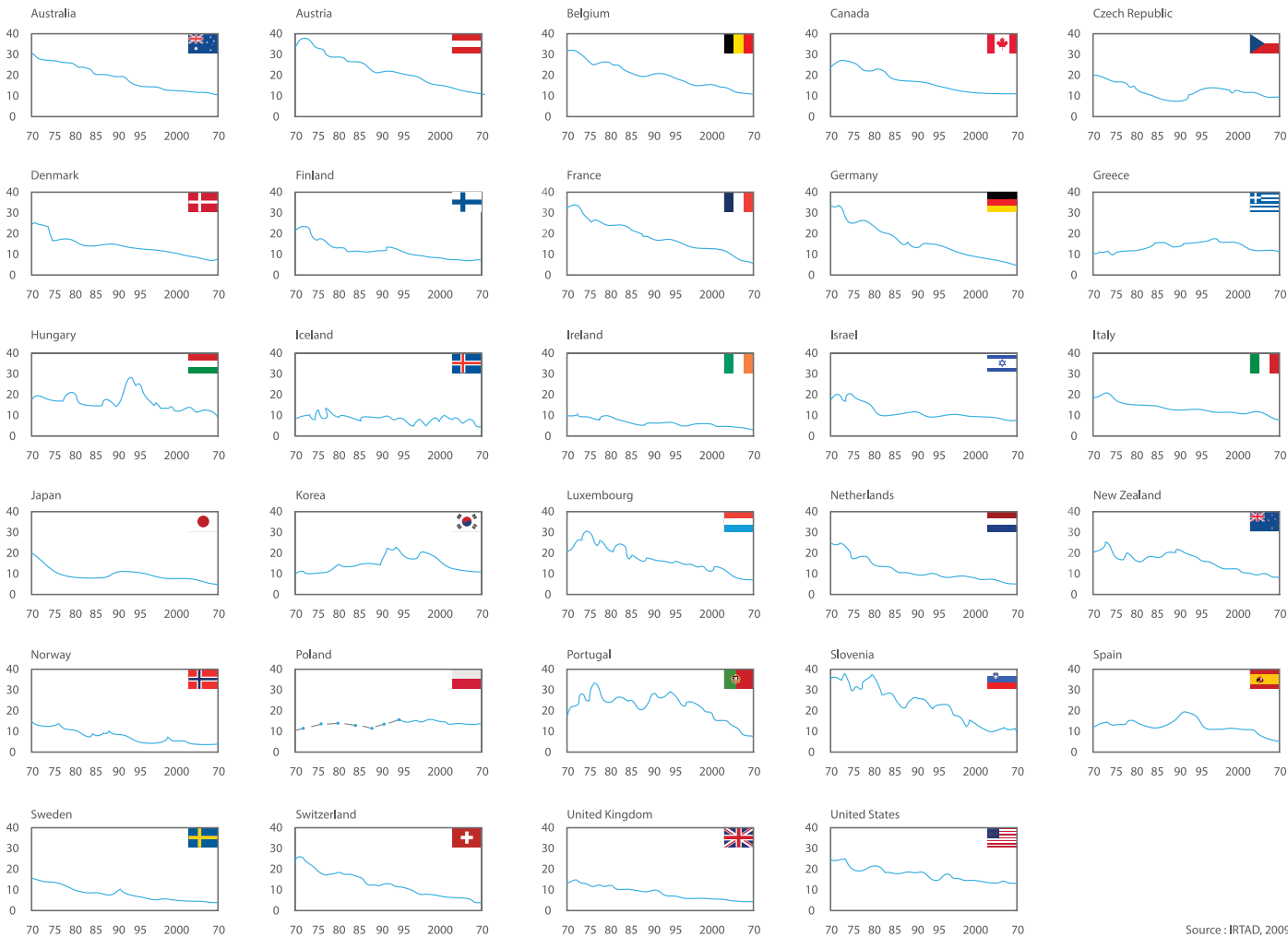
Local knowledge needs to inform the implementation of local solutions.

Better understanding over time – Haddon matrix, public health model , safe systems approach.

# III A. AWARENESS AND PREVENTION



## Traffic deaths per 100,000 population, 1970 - 2009



# RECOMMENDATIONS



**Primary prevention of TBIs and falls** needs better understanding through focused research studies in India. Available data from India indicate that nearly 20 – 30 % of TBIs are due to falls and commonly due to fall from heights (building, construction places, roof tops, balconies, tress etc.), fall from stair cases, and fall on same level due to tripping along with other mechanisms.

**Commonly, young children and elderly are involved in falls. Thus, preventive measures should focus on:**

- Setting safety standards and strict implementation for construction of houses, factories, schools and public play areas.
- Careful (especially in kitchen and bathrooms) design of houses with antiskid flooring areas and safer stairs and steps.
- Decreasing the height of play site equipments and use of soft and energy absorbing materials in construction of play areas.
- Proper maintenance of footpaths and roads to avoid falls among elderly.
- Improving the health of elderly, specially preventing conditions like osteoporosis.
- Limiting the use of alcohol and drugs like barbiturates, sedatives and hypnotics.
- Provision and mandatory usage of safety equipments like helmets, boots, harness and others for workers involved in construction activities.
- Parental supervision of young children in all places, specially play areas and while playing at home in balconies, staircases etc.
- Improved safety mechanisms and supervision in public places.
- Public awareness activities on importance of following safety standards at home and in work places.
- Violence in Indian society leading to TBIs has not been understood clearly. Most commonly, it is seen among young and middle aged people, predominantly among males, in both urban and rural areas and through use of blunt commonly available objects.

# III A. AWARENESS AND PREVENTION



**Secondary prevention primarily focuses on early recognition of injuries and implementing measures to save lives and prevent complications. Activities in this area need to focus on**

- Strengthening availability of early first aid, triage and safe transportation.
- Ensuring preparedness of hospitals.
- Referral based on triage.
- Scaling up human and physical resources in public sector hospitals.
- Training of doctors and allied health professionals in advanced and basic trauma care.
- Developing standard guidelines for care.
- Implementing trauma care protocols.
- Use of telemedicine services as required.
- Monitoring quality of care.
- Implementing trauma team concept in medical college hospitals and all higher centers.
- Implementing trauma registries and injury surveillance.
- Real time evaluation of services on a continuous basis.
- Improving in-hospital trauma care services.

# RECOMMENDATIONS



**Tertiary prevention focuses on rehabilitating survivors to return them to optimum levels of functioning. Activities in this area need to focus on**

- Initiating rehabilitation early during the course of hospital stay .
- Focusing on involvement of family members .
- Strengthening district rehabilitation service programmes .
- Greater involvement and use of village rehabilitation workers, ASHAs, ICDS workers and teachers .
- Combined physical and psychosocial rehabilitation .
- Creating economic and employment opportunities .
- Establishing suitable referral services for integrated care of disabled persons.
- Extending social support systems in the areas of education and employment through legal, administrative and social service mechanism.
- Early and timely compensation for injured persons or for families with an injury death with necessary and required legal changes.

## Approaches for injury prevention and care

- Educational programmes are primarily intended to provide and increase individual’s knowledge, with the expectation that it will result in a change of attitude, reduce risk behaviors and result in safe practices. Educational approaches have been the commonest method used in India based on the assumption that injuries occur due to inadequate knowledge, skills and attitudes; however, the efficacy and effectiveness of these programmes needs to be evaluated.

# III A. AWARENESS AND PREVENTION



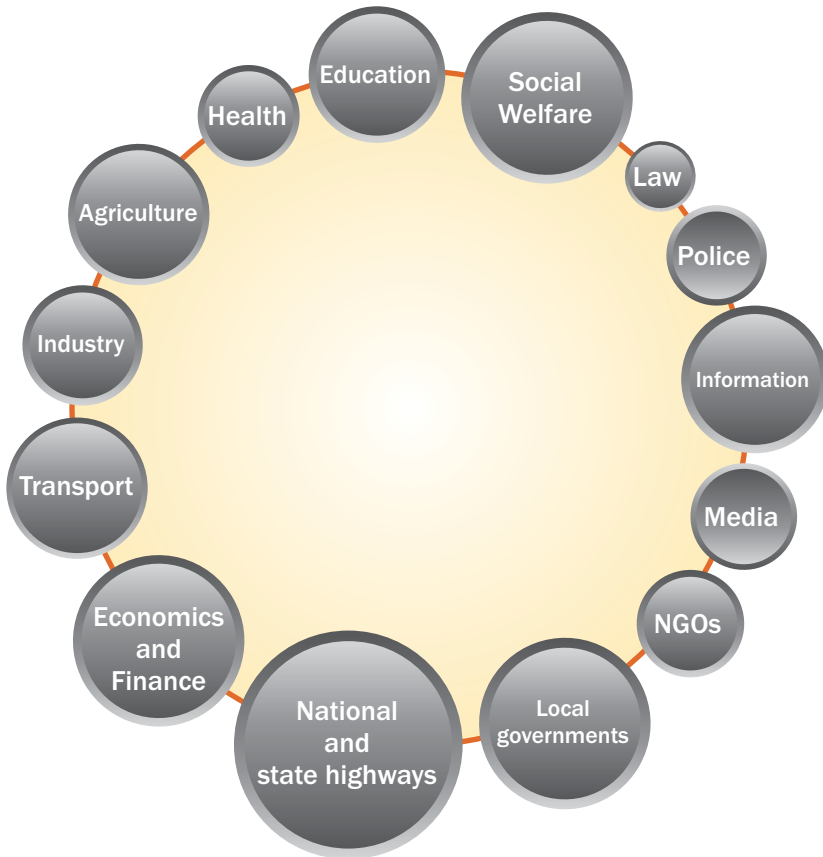
- As educational approaches in isolation are ineffective, take a long time to bring in the desired changes, resource intensive and are often influenced by number of factors like nature of products people use or the value they give for information related to safety - Legislation and enforcement - have been given importance in recent times. **Regulatory interventions can be at the macro level to influence the authorities, vehicle manufacturers, product makers and civic authorities to follow and implement safety standards (eg. regulations on road making, building standards etc.) and also at an individual level requiring people to follow safety norms on roads that would in turn reduce injuries.**
- Engineering by making products and environment safer at the time of design, manufacture and use is a more beneficial option considering the risk taking nature of individuals (especially children and teenagers), limitations of human behaviour (in adapting safety practices on a day to day basis at different stages of their life) and less importance given to safety. **Thus, a road designed with separated traffic through collapsible medians will prevent head on collisions with vehicles and rigid barriers.** These approaches, referred to as passive countermeasures illustrate that making people safer through safe products and environment, irrespective of their knowledge levels, types, and patterns of use, is far more beneficial.
- **An important determinant of survival and death is the availability of good prehospital and Emergency care soon after an injury.** Factors like immediate availability of first aid, triaging, safe transportation (by any available mode), and proper referral play an important role. The earliest an injured person can reach a definitive hospital, better are the chances of his / her survival; this also decreases the secondary impact of injuries. Availability, accessibility and affordability of emergency care play crucial role in accessing emergency services and prehospital care.

# RECOMMENDATIONS



## Need for intersectoral and integrated approaches in prevention in TBIs

### INTERSECTORAL APPROACH TO RTI PREVENTION AND CONTROL



Injury prevention and care, and especially neurotrauma prevention is a collective and shared responsibility of several ministries and departments in India due to the absence of a central lead coordinating agency. For effective implementation of the recommendations mentioned above, it is crucial to involve all related departments in implementation. The policy makers and professionals need to be actively engaged in prevention efforts.

Increasing awareness on road safety needs to be continuous, targeted and focused to be done from a health and safety point of view. Further, public education and awareness programmes needs to be evaluated for coverage, quality and impact.

# III A. AWARENESS AND PREVENTION



Prioritized ideations	Road users	Enforcement agencies	Policy makers	Engineering people	Press
PEOPLE					
Speed limits	✓	✓	✓	✓	
Helmets	✓	✓	✓		
Alcohol	✓	✓	✓		
VEHICLE					
Road worthiness	✓	✓	✓		
Safety standards	✓		✓	✓	✓
Vehicle certification	✓	✓	✓	✓	✓
ROADS					
Road engineering		✓	✓	✓	✓
Safety audits		✓			
Footpaths	✓	✓		✓	✓
SYSTEM					
Enforcement of laws		✓			
Lead agency		✓	✓		✓
Education		✓	✓		✓



# RECOMMENDATIONS



Some of the programmes that need to be implemented in TBI prevention include:

- Increasing public awareness programmes in the areas of helmet use, seat belt use, child restraints, drinking and driving, excessive speeding , proper driver licensing and others through community involvement and engagement with advocacy and education programmes at state, district or city levels. The programmes should focus on increasing safety awareness, acceptance of legislation, cooperating with authorities for implementation and demanding safety in society.
- Engaging with policy makers to develop or modify appropriate legislation, introduce safety components (like public transport) in the above mentioned areas that cover total geographic areas.
- Informing local enforcement agencies to implement road safety laws in a random, visible and uniform manner with stiff penalties and bring in safety behaviors in society

**A Joint plan of action should be developed at state level and implemented across cities and rural areas with the participation of all stake holders including media, celebrities, public figures and others .**

# III B. PRE HOSPITAL CARE



## III B. PRE-HOSPITAL CARE

Traumatic brain injury (TBI) is one of the most crucial medical and socio-economic problems. The processes entailing the Trauma System includes stages from resuscitation to rehabilitation. Further these stages are broken down into pre-hospital care, in-hospital care, in-hospital definitive care and rehabilitation.

The pre-hospital assessment and treatment by first responders are critical steps in initiating safe and appropriate care for the patient. There is an urgent need to establish a first responder training program and a basic first responders course which should be targeted to police, traffic police, drivers of taxi, bus, trucks rickshaw. The odds of survival may be greatly enhanced if first responders promptly initiate first aid.

## PRE- HOSPITAL CARE - THE WAY AHEAD.

### Current Communication Systems

- Due to lack of uniformity of emergency call numbers, the basic response time of ambulance is affected negatively. To address this problem, the government should introduce a uniform national emergency number.
- There is a major lack of coordination between the team EMS workers and designated hospital staff. This issue needs proper training (such as mock exercises) which could enable faster and well coordinated services.

## NEED FOR A NATIONAL CAMPAIGN BASED OR DESIGNED UPON AMERICAN - FIRST THERE, FIRST CARE

This American programme is designed to teach bystanders to perform five basic actions at the scene of a crash or some other emergency. These actions are:

1. Stop to help.
2. Call for help.
3. Assess the victim.
4. Start the breathing.
5. Stop the bleeding.

**Having a first aid kit in every vehicle to be made mandatory.**

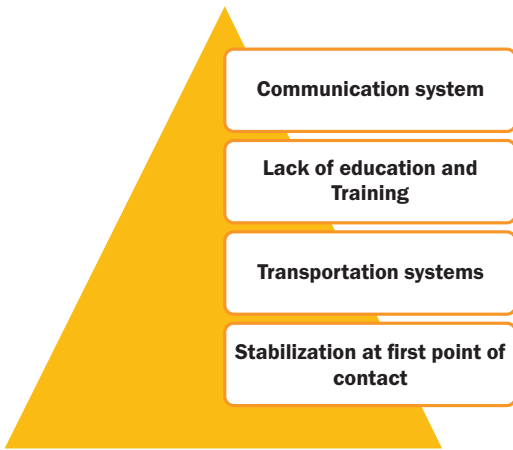


- Methods of communication like GPS, mobile applications and revised protocol for various communication modes can strengthen the communication processes. To extract benefits of these tools, the budget can be revised to efficiently upgrade the existing systems.
- Standardization of Protocols and SOPs with Do's and Don'ts can reduce various problems associated with pre-hospital care.
- Effective and spontaneous coordination with various agencies viz. police, fire, army, Red Cross etc can be harnessed to improve pre hospital care systems.
- There should be a well devised central monitoring system which can coordinate the EMS team, designated hospital and necessary agencies.

Education and Training Requirements

- There is a need of educate and train EMS staff as well as increase their number and full time availability. Staff should be made aware and assured of the fact that there are no legal problems as per the Supreme Court Directives regarding their involvement in care of medico legal cases.
- Public awareness about existing pre hospital medical assistant system should increase through brochures and local social agencies.
- Eligibility criteria for the EMT/ Paramedics must be well defined with minimum criteria of 10+2 (preferably with science background) along with a training period of 40 days for EMT and 60 days for Paramedics.
- Curriculum can be revised for EMT/ Paramedics which should include revaluation in specific period to reassess the staff capability in emergency. The plan can further be redesigned as per emergency and need.
- Pre-hospital care training program including mock drills should be introduced and incorporated in the curriculum of schools.

INDIAN SPECIFIC PROBLEMS IDENTIFIED AND PROBABLE SOLUTIONS



Transportation

- There is a need to increase the number of ambulances and care related assistance. The bad conditions of road and connectivity further hamper rapid transportation.
- Standardization in ALS (Advanced Life Support)/ BLS (Basic Life Support) should be properly made and implemented.
- Nearest and most appropriate hospital facility (Govt. /Private hospital) can be planned.
- Resuscitation and stabilization of the patient at first point should be incorporated in the plan.
- Standardization of EMS staff, uniform and equipments in ambulances/medicine is required.
- Sufficient funding through Govt. /PSUs/NGOs is required.
- Annual recertification of vehicles/ instruments is necessary.
- The program can be made more effective through public availability and easy access of a database which must include a categorized list of hospitals by various signs, map facilities and demo programs.

Stabilization of patient at first point of contact

- Stabilization at nearest hospital can be done.
- Knowledge of availability of multispecialty facility and its details.
- ALS/ BLS ambulance capabilities/ protocols should be at place.
- Hospitals must be verified and designated for various kinds of emergencies.
- Real time data of availability of the team at the hospital should be known to EMS staff.
- Regulation of unnecessary referrals should be avoided.
- Clear and well comprehensive clinical guidelines should be made available.



Available resources and recommendations

- Skill development protocol from NSDC (National Skill Development Council) for EMT should be adopted for effective operation.
- Resuscitation with various equipments and medication facilities (various drugs etc) should be incorporated in the guidelines.
- Regarding the verification and designation of hospital levels, currently five levels have been planned which require proper implementation.
- National ambulance coding system for basic equipment and safety need to be familiarized and adopted by designated hospitals and EMS workers.

Three critical tasks must be rapidly performed by pre-hospital providers caring for trauma victims:

- For the individual victim: examination with recognition of severe injuries and injuries with potential to cause rapid decompensation.
- For multiple victims: triage with initiation of life-saving treatment.
- Stabilization and transport to a hospital capable of addressing the identified injuries.

The pre-hospital management of TBI produces:

- Correct identification of TBI.
- Optimal treatment in the ambulance.
- Direct transfer to a TBI trauma center.



The application of in-hospital guidelines results in:

- Reduced length time spent in ICU days along.
- Reduced healthcare costs.
- Decreased death and disability by 30-50 %.
- Increased neurological outcome upon discharge by 30-50%.

**It is important that ambulance services arrive at the earliest, have trained personnel and can effectively identify the center where the patient has to be admitted.**

TRIAGE

Triage of trauma victims is the process of rapidly and accurately evaluating patients to determine the extent of their injuries and the appropriate level of medical care required. The goal is to transport all seriously injured patients to medical facilities capable of providing appropriate care, while avoiding unnecessary transport of patients without critical injuries to trauma centers.

Most scoring systems incorporate several types of criteria to differentiate major from minor trauma, including:

- Physiologic (e.g. blood pressure, level of consciousness).
- Anatomic (e.g. long bone fracture, surface area of burn).
- Mechanistic (e.g. height of fall, pedestrian hit by car).
- Age and co-morbidities.



Training of paramedics in pre hospital techniques should be mandatory.

- Primary assessment (i.e., primary survey) follows the ABCDE pattern: Airway, Breathing, Circulation, Disability (Neurologic status), Exposure.
- The pre-hospital providers first task is to secure the patient's airway. If breathing is labored or absent, assisted ventilations should be provided using a bag-valve mask device and high-flow oxygen.
- Once the airway and breathing is secure, providers must manage any uncontrolled hemorrhage using direct pressure. Once hemorrhage is controlled, neurologic status is assessed. One simple assessment scheme is AVPU: Alert, responds to voice, responds to pain, or Unresponsive. Spinal immobilization is continuously maintained.
- Next, pre-hospital personnel place definitive spinal immobilization (i.e., rigid cervical collar and backboard). Special care must be taken with patients who have suspected spinal injuries, including those with an altered level of consciousness.
- Pre-hospital providers obtain vital signs as part of their assessment of patient circulation. Ideally, blood pressure measurements are obtained in each arm.
- The presence of pre-hospital hypotension must be clearly communicated to the emergency department clinicians assuming care of the patient.

SECONDARY SURVEY

After completion of the initial assessment and stabilizing treatments, the pre-hospital provider performs a quick but thorough review of the entire body. Common pitfalls include not thoroughly inspecting the back, the axillae, the gluteal region, and pannicular folds. Such inspection is particularly important if the clinician suspects penetrating trauma. Providers must also assess for pelvic instability and, if present, attempt to provide stability and control retroperitoneal hemorrhage by applying a pelvic binder. Following secondary survey, the patient should be prepared for transport. Performing full spinal immobilization is prudent; prolonging scene time to initiate intravenous lines, bandage non-hemorrhaging wounds, or splint minor fractures is unnecessary and potentially deleterious.



AIRWAY SUPPORT

Most important in the pre-hospital setting is to protect the airway and control ventilation of head-injured patients in the least invasive manner, thereby minimizing elevations in intracranial pressure. If transport time is brief, often bag-mask ventilation (BMV) alone is sufficient.

**In a head-injured patient with a clenched jaw or other airway-compromising conditions, the first step is to perform manual maneuvers (e.g., jaw thrust) to open the airway, care must be taken to maintain cervical immobilization.**

Proper technique for transferring the intubated patient includes:

- Limited hyperventilation prior to moving.
- Removing the bag-valve mask device prior to moving.
- Holding the tube securely at the lips throughout the move.
- Using clear, verbal commands to coordinate the move.
- Immediately reattaching the bag-valve mask after the move.
- Reassessing ETT placement once the move is complete.
- Proper guidelines are required to understand the level of hospital patient needs to be transferred.

# RECOMMENDATIONS

# III B. PRE HOSPITAL CARE



## RECOMMENDATIONS

### Assessment: Oxygenation and Blood Pressure

- A. Patients should be monitored in the prehospital setting for hypoxemia (<90% arterial haemoglobin oxygen saturation) or hypotension (<90 mmHg systolic blood pressure [SBP]).
- B. Percentage of blood oxygen saturation should be measured continuously in the field with a pulse oximeter.
- C. Monitoring of blood oxygen saturation, systolic and diastolic blood pressure .

Paediatric hypotension is defined as follows:

AGE	SBP
0 to 28 days	< 60 mmHg
1 - 12 Months	<70 mmHg
1 - 10 years	<70 + 2 x age in years
> 10 Years	< 90 mmHg

### Assessment: Glasgow Coma Scale Score

Prehospital measurement of the Glasgow Coma Scale (GCS) is a significant and reliable indicator of the severity of traumatic brain injury (TBI), and should be used repeatedly to identify improvement or deterioration over time.



The GCS and the paediatric GCS (P-GCS) are reliable indicators of the severity of TBI in children and should be used repeatedly to identify improvement or deterioration over time.

The adult protocol for standard GCS measurement should be followed in children over 2 years of age. In pre-verbal children, the P-GCS should be employed, with a full verbal score of 5 assigned to infants cooing or babbling.

### Assessment: Pupil Examination

#### Adult and Paediatrics

- A. Pupils should be assessed in the field for use in diagnosis, treatment, and prognosis.
- B. When assessing pupils:
  - ↪ Evidence of orbital trauma should be noted.
  - ↪ Pupils should be measured after the patient has been resuscitated and stabilized.
  - ↪ Left and right pupillary findings should be identified.
    - Unilateral or bilateral dilated pupil(s).
    - Fixed and dilated pupil(s).

Asymmetry is defined as > 1mm difference in diameter. A fixed pupil is defined as < 1mm response to bright light Decision Making Within the EMS System: Dispatch, Scene, Transportation, and Destination.





Treatment: Airway, Ventilation, and Oxygenation

Adult and Paediatrics

- A. Hypoxemia (oxygen saturation [SpO2] < 90%) should be avoided, and corrected immediately upon identification.
- B. Establish an airway , by the most appropriate means available.
- C. Protocols should monitor blood pressure, oxygenation.
- D. When endotracheal intubation is used to establish an airway, confirmation of placement of the tube in the trachea should include lung auscultation and end-tidal CO2 (ETCO2) determination.
- E. Patients should be maintained with normal breathing rates and hyperventilation should be avoided unless the patient shows signs of cerebral herniation.

Treatment: Fluid Resuscitation

Adult

- A. Hypotensive patients should be treated with isotonic fluids, In TBI patients with a Glasgow Coma Scale Score (GCS) < 8, Hypertonic resuscitation is a treatment option.

Paediatrics

- A. For the paediatric TBI patient, hypotension should be treated with isotonic solutions.



Treatment: Cerebral Herniation

- A. Mild or prophylactic hyperventilation should be avoided.
- B. Patients should be assessed frequently for clinical signs of cerebral herniation. **The clinical signs of cerebral herniation include dilated and unreactive pupils, asymmetric pupils, a motor exam that identifies either extensor posturing or no response, or progressive neurologic deterioration (decrease in the Glasgow Coma Scale [GCS] Score of more than 2 points from the patient’s prior best score in patients with an initial GCS < 9).**
- C. In patients who are normoventilated, well oxygenated, and normotensive - and still have signs of cerebral herniation - hyperventilation should be used as a temporizing measure, and discontinued when clinical signs of herniation resolve.

Hyperventilation is administered as:

- 20 breaths per minute in an adult.
- 25 breaths per minute in a child.
- 30 breaths per minute in an infant less than 1 year old.

The goal of hyperventilation is ETCO2 of 30-35 mmHg.

Decision Making: Dispatch, Scene, Transportation, and Destination

Protocols are recommended to direct Emergency Medical Service (EMS) personnel regarding destination decisions for patients with severe traumatic brain injury (TBI).

# RECOMMENDATIONS



## III.C. IN-HOSPITAL CARE IN TRAUMATIC BRAIN INJURY

Trauma care systems in India are at a nascent stage of development. Industrialized cities, rural towns, and villages coexist with a variety of healthcare facilities and an almost complete lack of an organized trauma care. There is gross disparity between trauma services available in various parts of the country. Rural India has inefficient services for trauma care, due to the varied topography, financial constraints, and lack of appropriate health infrastructure. There are no mechanisms for accreditation of trauma centers and professionals. The education in trauma lifesupport skills has only recently become available. A nationwide survey encompassing various facilities has documented significant deficiencies in current trauma systems. Henceforth, there is a need of creating a rationale for developing guidelines and protocol.

### TO ORGANISE CARE IN THE INDIAN SCENARIO, HOSPITALS COULD BE CATEGORISED INTO FIVE LEVELS.

#### Hospital categories

Level I

24 hour neurosurgery and neurocritical care  
CT scan  
ICP monitoring  
All specialties

Severe TBI

Level II

Neurosurgery on call within 1 hour  
Basic ICU,  
CT scan  
Most trauma specialties

Mild, Moderate and severe  
TBI requiring neurosurgery

## III.C. IN-HOSPITAL CARE IN TRAUMATIC BRAIN INJURY



### TO ORGANISE CARE IN THE INDIAN SCENARIO, HOSPITALS COULD BE CATEGORISED INTO FIVE LEVELS.

#### Hospital categories

Level III

CT Scan  
General surgery, orthopedics

Mild TBI requiring CT  
Means for consulting Nsg

Level IV

Able to handle most ABC's

Mild TBI not requiring CT

Level V

Basic ABC's May not be  
intubation

GCS 15 not requiring CT  
no ABC issues  
no other significant trauma

#### Patients to be treated at each level (referral not necessary)

- **Level 1** hospitals should have neurosurgery, neurocritical care and polytrauma round the clock. Research component must be emphasized.
- **Level 2** hospitals should treat all moderate and severe head injuries, as well as minor head injuries requiring neurosurgery. These will be the hospitals where transient ventilation is possible but full-fledged neurocritical care is not possible.

# RECOMMENDATIONS



- **Level 3** hospitals are hospitals where patients with GCS score of 13 – 15 who need CT scan can be treated. They should have an organized means of consulting a neurosurgeon in level 1 or 2 (whatsapp / docsapp / telemedicine) who can advise further management.
  - ✍ Any abnormal CT scan should be referred to higher level if transfer time is more than 2 hours.
  - ✍ Liability issues for the consulting neurosurgeon need to be sorted out.
- **In Level 4** hospitals patients with GCS score of 14-15 with no indication for CT scan can be managed, and most ABC problems and other trauma can be handled.
- **In Level 5** hospitals patients with GCS score 15 who do not require CT scan, have no ABC issues, and no other significant trauma can be treated.

*Following are the key recommendations for distribution of hospitals and verification of facilities/ care provided by them.*

## Distribution of hospitals

- ✍ Every state should have at least one level 1 center.
- ✍ Level 2 hospitals should be located in large metropolitan areas.
- ✍ Every district hospital should have at least Level 3 facilities.
- System to categorize and verify facilities should be implemented.
- System to ensure the hospital provides the care expected from that level.

## Resources

One of the main barriers in the management of traumatic brain injuries is lack of resources such as qualified neurosurgeons, trained staff and functioning equipment. There are no minimum stipulated educational standards for paramedics and ambulance personnel. Paramedic training programs are offered in major institutions but there is no accreditation, review, or provision for periodic update of skills and knowledge. Emergency technician courses are offered but are very few in number. Available personnel and their skills often do not match the need of the patients.

# III.C. IN-HOSPITAL CARE IN TRAUMATIC BRAIN INJURY



## Steps which can be implemented:

### Personnel

1. **Neurosurgeons:** More neurosurgeons are needed. Resident numbers have been increased, and overall numbers should improve; presently India is training about 200/year.
2. **Intensivists:** More personnel needed. Presently there are only a few training programs and and critical care has just been recognised by the MCI as a specialty.
3. All medical students / junior doctors should be taught **ATLS / equivalent**.
4. Nurses / paramedics: Can be trained to **monitor ABC and intervene in minor problems**. They can be trained to **monitor GCS and pupils**.
5. Personnel to **operate and maintain equipment** – radiographers, technicians.

### Equipment

1. **CT scanners** must be widely available (level 3, districts).
2. Critical care **facilities must be expanded** initially at level 1 and 2. However, they can later target level 3 trauma centers. This will include trained personnel, ventilators, monitors, etc.

## General Principles

The principal focus of critical care management for severe TBI is to limit secondary brain injury. In general, treatment efforts are aimed at intracranial pressure management and maintenance of cerebral perfusion as well as optimizing oxygenation and blood pressure and managing temperature, glucose, seizures, and other potential secondary brain insults. The prevention of deep venous thrombosis (DVT) is a difficult management issue in TBI. Nutritional support should not be neglected in patients with TBI. Use of dextrose-free crystalloids especially to stabilize blood pressure. TBI patients are at risk for other complications (eg, infection, gastrointestinal stress ulceration), which can be reduced by appropriate interventions.



MONITORING ABC

Airway

1. Judging the patency of airway in a non-intubated patient is always clinical

- Causes of airway compromise in HI
  - ↗ Altered consciousness – tongue fall back
  - ↗ Vomitus
  - ↗ Blood, facial injuries
- Signs of airway compromise
  - ↗ Does not talk
  - ↗ Noisy breathing
  - ↗ Obvious facial injury
- Indicators of potential airway compromise
  - ↗ Use of accessory muscles
  - ↗ Neck injury
  - ↗ Short neck

2. Airway assessment in a patient with a secured artificial airway

- Position
  - ↗ Auscultation
  - ↗ Chest radiograph
- Patency
  - ↗ Effort of breathing
  - ↗ Ease of passing suction catheter
  - ↗ Airway pressures if on ventilator

In all head injury patients high flow oxygen should be administered immediately after securing the airway.



Breathing

1. The adequacy of spontaneous breathing is again primarily clinical, with laboratory assistance

- Causes of inadequate breathing
  - Obstructed airway
  - Impaired effort
    - ↗ Severe neurological injury
    - ↗ Drug induced (sedation, muscle relaxants)
  - Chest pathology
    - ↗ Aspiration
    - ↗ Chest trauma
- Clinical signs of inadequate ventilation
  - ↗ Rapid or very slow respiratory rate
  - ↗ Use of accessory muscles
  - ↗ Poor chest expansion/ air entry
- Accessory means of assessing breathing
  - ↗ Arterial blood gas
  - ↗ Low SpO2 on a pulse oximeter (normal SpO2 while on supplementary oxygen does NOT indicate adequate breathing).



2. Breathing in a patient on a ventilator is assessed clinically and with assistive technology

- Clinical
  - ↳ Chest movement
  - ↳ Auscultation
- ICU technology
  - ↳ Ventilator parameters
  - ↳ Pulse oximetry
  - ↳ End-tidal CO2
  - ↳ Arterial blood gas

Blood pressure

Assessment of adequacy of circulation will depend on where the assessment is being done:

- Causes of hypotension
  - ↳ Blood loss – external or internal
  - ↳ Chest trauma
    - ◆ Tension pneumothorax
    - ◆ Cardiac injury or tamponade
  - ↳ Cervical spine injury (hypotension without tachycardia)
  - ↳ Patient almost brain dead



Emergency room signs of impaired circulation

- Pulse – tachycardia, poor volume
- Blood pressure
- Capillary refill >2 seconds, cold extremities
- Other evaluation
  - ↳ Auscultation for pneumothorax or tamponade

Monitored area (in ER or high care area)

- Heart rate
- Non-invasive blood pressure
- Invasive blood pressure – if significant instability present or on vasoactive drugs

Rapid infusion of dextrose-free cyrstalloids with constant monitoring of blood pressure and heart rate.



# RECOMMENDATIONS



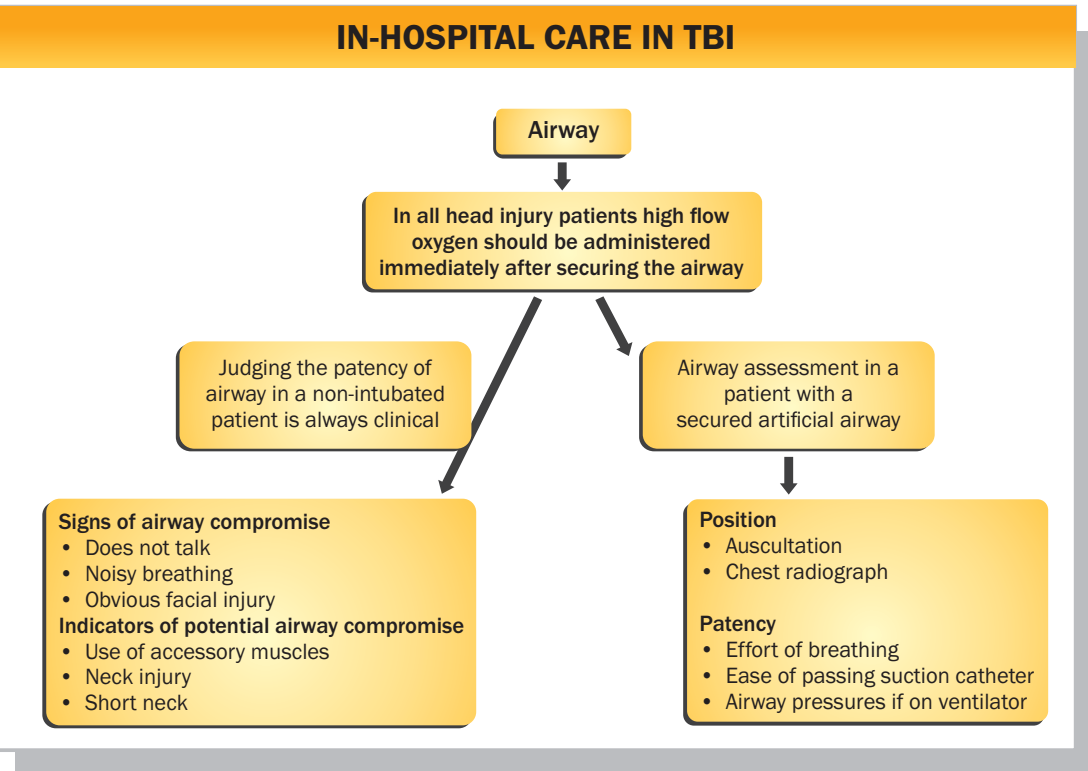
## INTERVENTION ABC

### Airway

Assessment and intervention should ideally be done as follows:

- Talk to the patient – if he answers, airway is secure.
- If he does not speak, perform a jaw thrust, remove foreign bodies from the mouth and perform an oral suction, and then insert an oral airway.
- If even after this breathing is noisy, or there is significant blood in the oral cavity the patient needs a definitive airway.
  - ↳ Endotracheal intubation / laryngeal mask airway is the primary option.
  - ↳ If not possible a cricothyroidotomy should be done (a tracheostomy is not an emergency surgical intervention).
- Connect high flow oxygen after securing airway.
- If a definitive airway was not initially necessary frequent reassessment of the airway is mandatory.

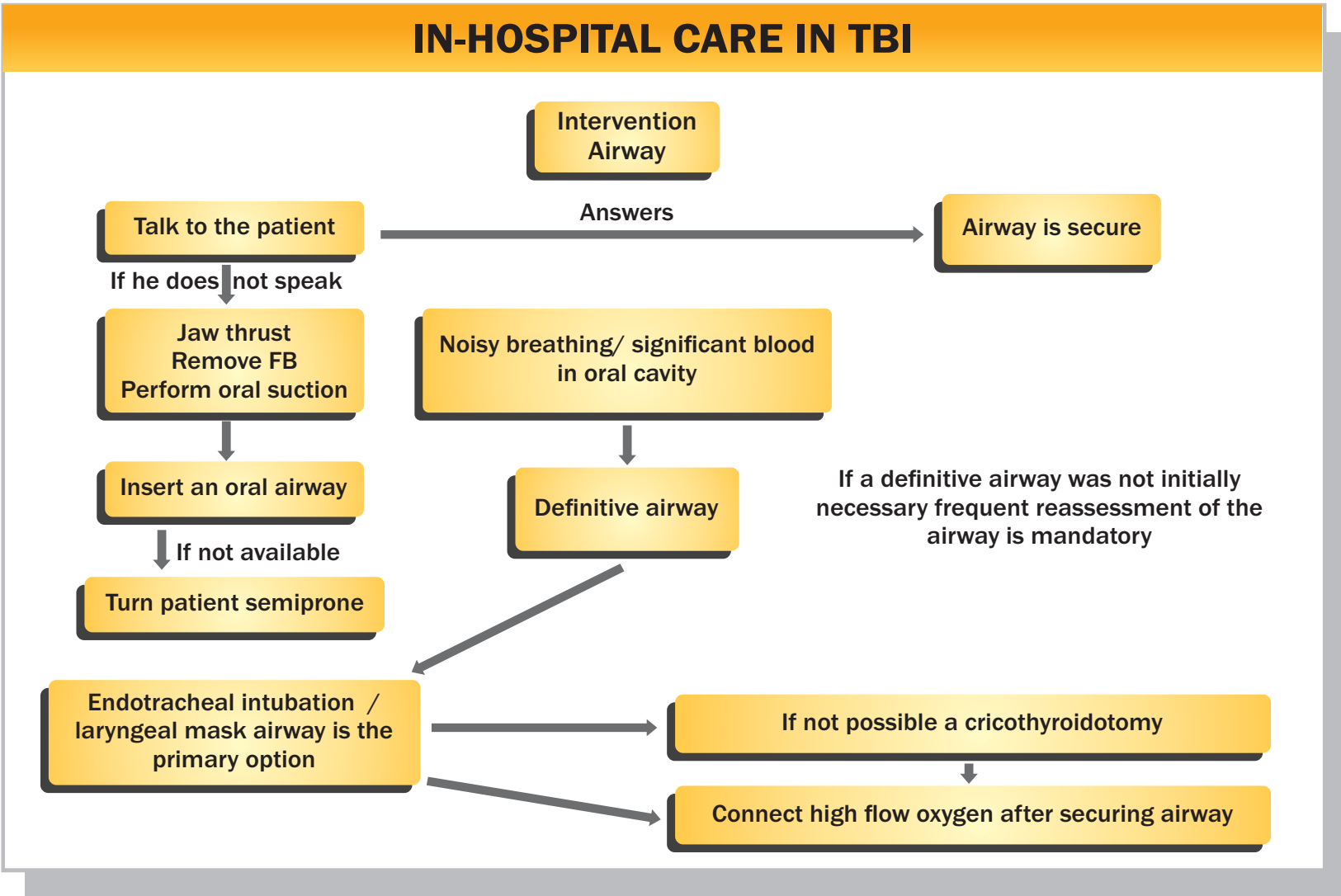
### IN-HOSPITAL CARE IN TBI



## III.C. IN-HOSPITAL CARE IN TRAUMATIC BRAIN INJURY



### IN-HOSPITAL CARE IN TBI



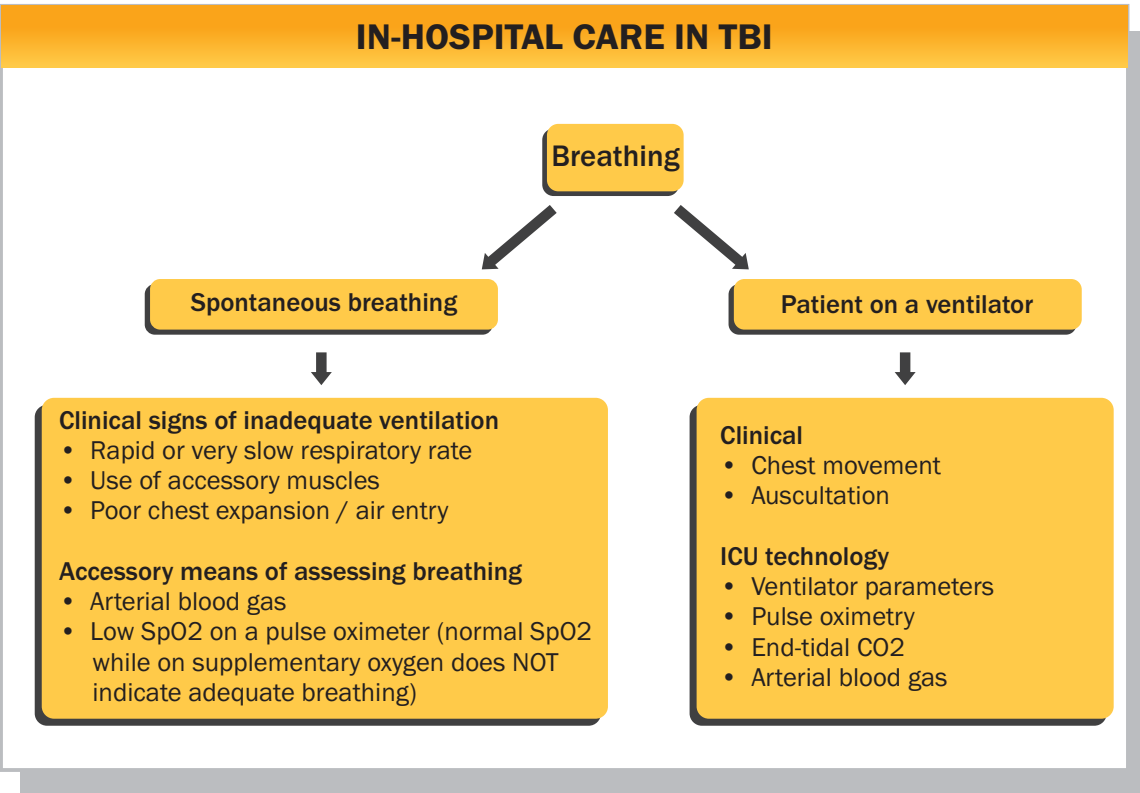
# RECOMMENDATIONS



## Breathing

If breathing is inadequate, the patient will need a definitive airway (unless the reason is rapidly correctable such as a tension pneumothorax). Inserting an endotracheal tube will usually require sedation and often muscle relaxants, following which breathing has to be assisted. This can be done manually or (where available) with a ventilator. Care must be taken to

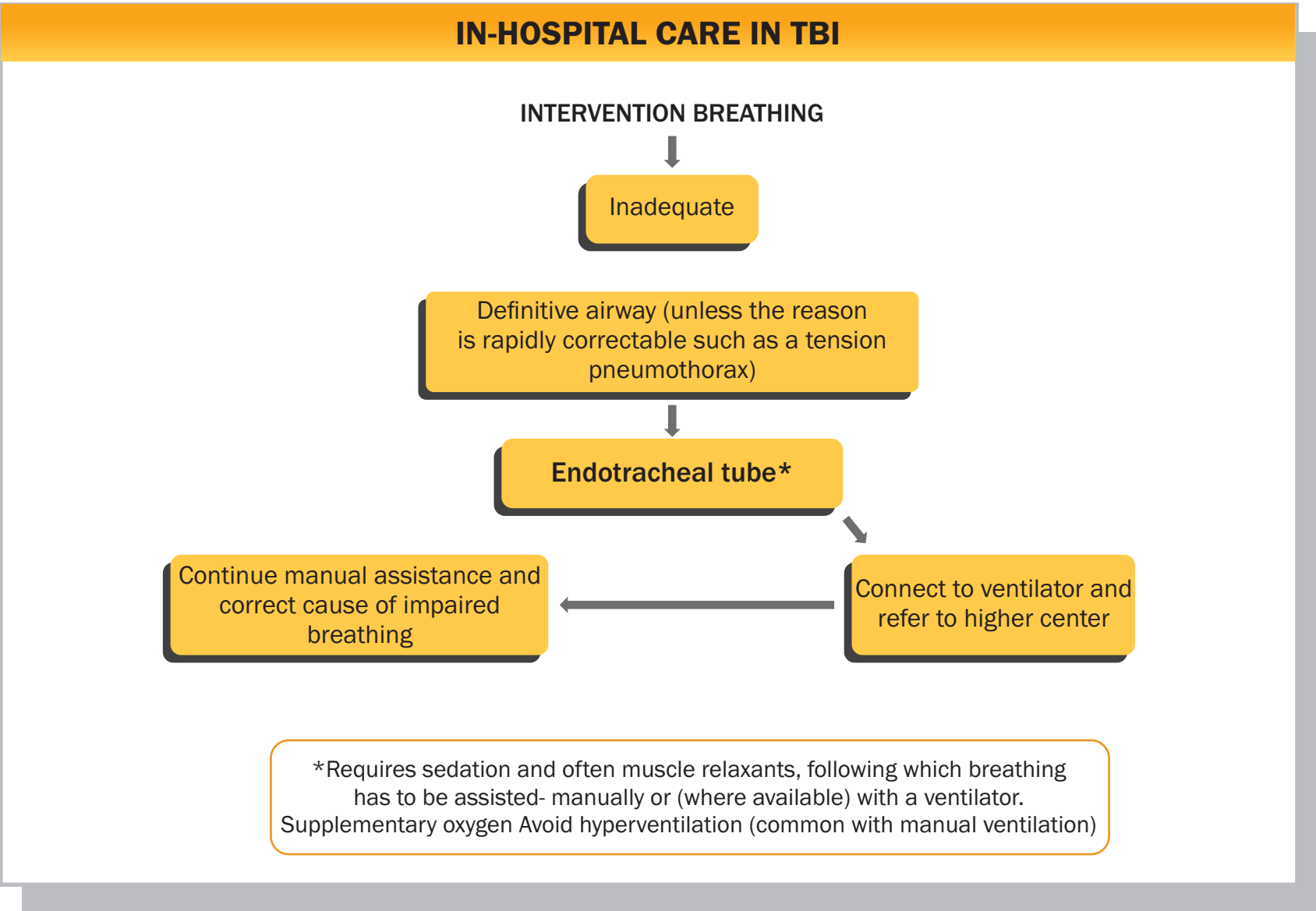
- Supply supplementary oxygen.
- Avoid hyperventilation (common with manual ventilation).



# III.C. IN-HOSPITAL CARE IN TRAUMATIC BRAIN INJURY



## IN-HOSPITAL CARE IN TBI



# RECOMMENDATIONS



## Blood pressure

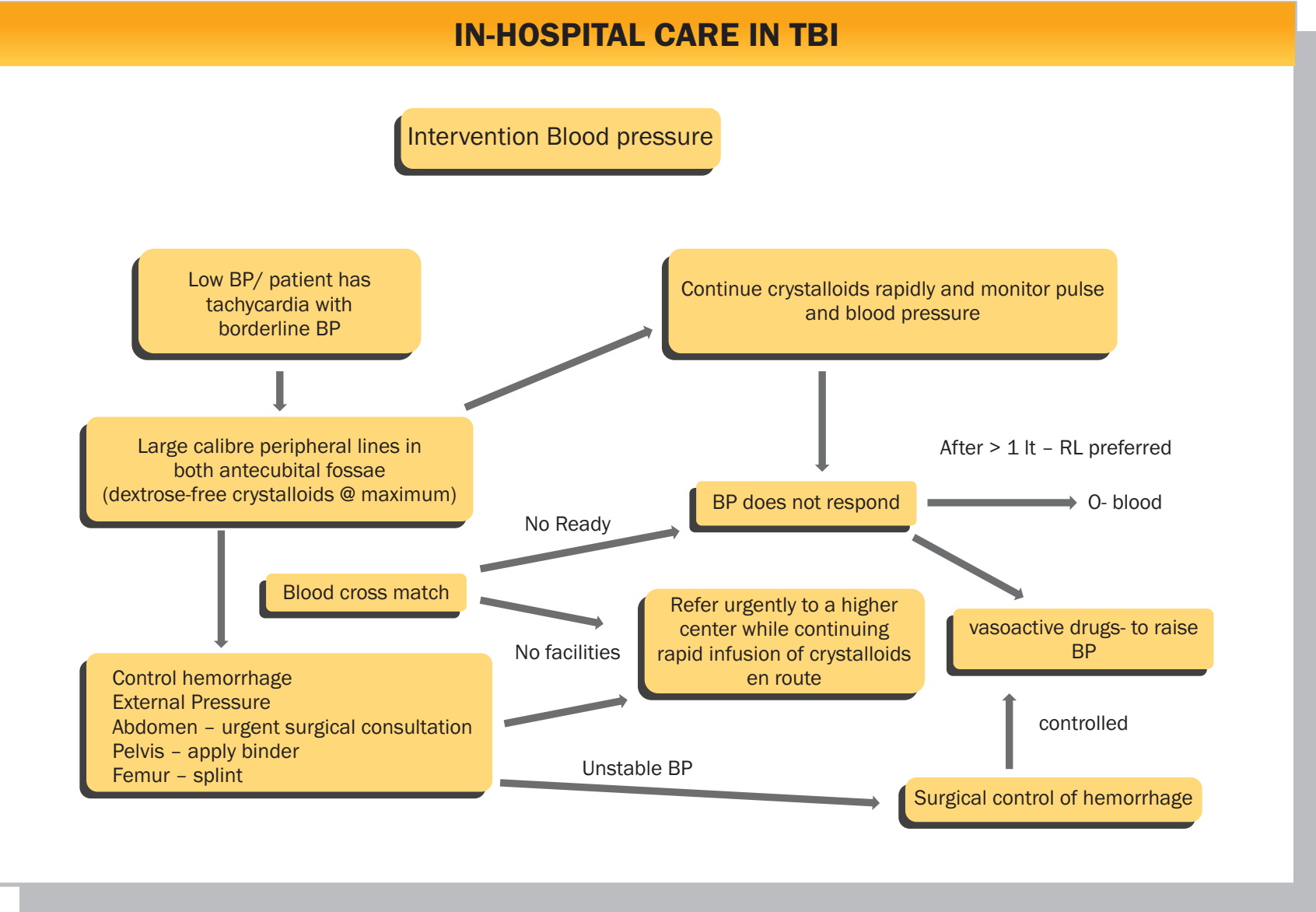
Hypotension is extremely damaging in head injury, and prevention / rapid correction is very important.

- If blood pressure is low or patient has tachycardia with borderline blood pressure- start large calibre peripheral lines in both antecubital fossae and administer dextrose-free crystalloids at maximum rate.
- Send a cross match for emergency blood transfusions.
- Control hemorrhage
  - ↳ External
  - ↳ Abdomen – urgent surgical consultation
  - ↳ Pelvis – apply binder
  - ↳ Femur – splint
- Continue to administer crystalloids like dextrose-free rapidly and monitor pulse and blood pressure.
- After more than one litre of fluid is administered- ringer lactate is preferred.
- If the blood pressure does not respond to crystalloids alone and cross matched blood is not ready- O negative blood may be transfused.
- Surgical control of hemorrhage may be needed if the circulation can still not be stabilized.
- Once hemorrhage is controlled vasoactive drugs may be used to raise the blood pressure if suitable monitoring is available.

# III.C. IN-HOSPITAL CARE IN TRAUMATIC BRAIN INJURY

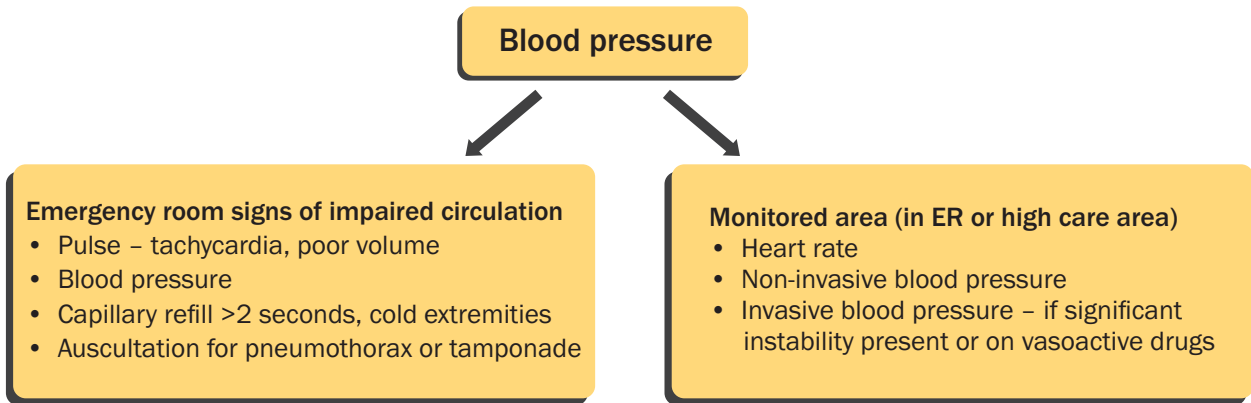


## IN-HOSPITAL CARE IN TBI





IN-HOSPITAL CARE IN TBI



INADEQUATE FACILITIES FOR ABC INTERVENTION

If the sequence of interventions described above cannot be performed due to lack of facilities then the following steps should be taken before referring the patient to a higher center:

**Assessment of airway, breathing and circulation remains unchanged and should be documented for the benefit of subsequent management.**

Airway

If endotracheal intubation / LMA / surgical airway is not possible then

- Insert an oral airway and perform suction.
- If frequent suction is needed or breathing is still noisy after inserting the airway, turn the patient semi-prone so that oral secretions/ blood flows out of the mouth.
- If an oral airway is not available turn the patient semi-prone.



Breathing

- If a definitive airway is possible and breathing inadequate.
  - ↳ Connect to ventilator.
  - ↳ If ventilator not available refer to a higher center.
  - ↳ If this is not possible continue manual assistance and correct cause of impaired breathing until breathing stabilizes.
- If a definitive airway is not possible then secure airway as best possible, treat any easily treatable cause of impaired breathing and refer urgently.

Circulation

- If blood pressure is low start rapid infusion of crystalloids like dextrose-free.
- If facilities for transfusion / treatment of extracranial injuries are not available.
  - ↳ Control hemorrhage as well as possible.
  - ↳ Refer urgently to a higher center while continuing rapid infusion of crystalloids like dextrose-free en route.



CLINICAL MONITORING

All personnel involved in monitoring a head injury patient must be trained to assess the Glasgow Coma Scale and pupils.

Non-ICU setting

Parameters to be monitored

- Pulse
- Blood pressure
- Clinical assessment of airway and breathing
- Temperature
- Glasgow Coma Scale score
- Pupils
- Other significant injuries/ problems of that patient

Frequency of systemic monitoring

- If no instability at admission then once an hour for 6 hours
- If stable then continue once every 2 hours

Frequency of neurological monitoring (ABC stabilized)

- Every half an hour till some sign of neurological improvement
- Then every hour till 12 hours
- Subsequently reduce frequency to every 2 hours if there has been some improvement since admission



Response to deterioration

- Report immediately
- Rapid decision to be made on the need for
  - ↳ Repeat investigation
  - ↳ Referral
  - ↳ Transfer to ICU/ OR

ICU / monitored area: Monitoring would depend on severity of injury and capabilities of the system.

Head Injury-GCS

Score in normal adults is 15

A Eye opening

- |                 |   |
|-----------------|---|
| • Spontaneously | 4 |
| • To speech     | 3 |
| • To pain       | 2 |
| • None          | 1 |

B. Best verbal response

- |                           |   |
|---------------------------|---|
| • Orientated              | 5 |
| • Confused                | 4 |
| • Inappropriate words     | 3 |
| • Incomprehensible sounds | 2 |
| • None                    | 1 |

C. Best motor response

- |                           |   |
|---------------------------|---|
| • Obeys commands          | 6 |
| • Localization to pain    | 5 |
| • Withdrawal to pain      | 4 |
| • Spastic flexion to pain | 3 |
| • Extension to pain       | 2 |
| • None                    | 1 |





Fluid – electrolyte

Resuscitation

For patients with TBI, the immediate goal of resuscitation is restoration and maintenance of adequate tissue metabolism by ensuring sufficient delivery of fuel, typically oxygen and glucose, to meet cellular metabolic demands. Fluid administration in shock is discussed under the section on blood pressure and oxygenation.

Maintenance

- Dextrose free isotonic fluids in adults (children may require dextrose)
- Patient must be well hydrated
- Hydration monitored by
  - ↳ Pulse, BP
  - ↳ Urine output and colour
  - ↳ Intake / output chart if possible
- Hyperosmolar agents should be administered via a central line
- All patients being administered hyperosmolar therapy must be catheterized
- Adjustments must be made for increased temperature / motor activity

Monitoring electrolytes

- Daily measurement of Na / K is ideal
- Mandatory if hyperosmolar therapy is being administered



Criteria for admitting patients to hospital following a head injury

- Deteriorating GCS.
- Focal or abnormal neurological signs.
- Early post-traumatic seizure.
- Skull fracture.
- High-risk mechanism of injury.
- Patients whose GCS has not returned to 15 after imaging, regardless of the imaging results.
- When a patient has indications for CT scanning but this cannot be done within the appropriate period, either because CT is not available or because the patient is not sufficiently cooperative to allow scanning.
- Continuing worrying signs (persistent vomiting, severe headaches, amnesia) of concern to the clinician.
- Drug or alcohol intoxication, other injuries, shock, suspected non-accidental injury, meningism, cerebrospinal fluid leak where a scalp laceration overlies a fracture, or the person's age).
- When there is no responsible family member, caregiver or close friend under whose care the person could be discharged.
- 'Mild' head injuries with symptoms such as headache, photophobia, nausea and vomiting, or amnesia requiring management.

Criteria for performing a head CT scan

Adults

CT scan should be performed within 1 hour of any of the following factors being identified:

- GCS less than 13 on initial assessment in the emergency department.
- GCS less than 15 at 2 hours after the injury on assessment in the emergency department.
- Suspected open or depressed skull fracture.
- Any sign of basal skull fracture (haemotympanum, 'panda' eyes, cerebrospinal fluid leakage from the ear or nose, Battle's sign).
- Post-traumatic seizure.
- Focal neurological deficit.
- > 1 episode of vomiting.

RECOMMENDATIONS



Children

With any of the following risk factors, perform a CT head scan within 1 hour of the risk factor being identified:

- Post-traumatic seizure but no history of epilepsy.
- On initial emergency department assessment, GCS less than 14, or for children under 1 year, GCS (pediatric) less than 15.
- At 2 hours after the injury, GCS less than 15.
- Suspected open or depressed skull fracture or tense fontanelle.
- Any sign of basal skull fracture (haemotympanum, 'panda' eyes, cerebrospinal fluid leakage from the ear or nose, Battle's sign).
- Focal neurological deficit.
- Loss of consciousness lasting more than 5 minutes (witnessed).
- Abnormal drowsiness or irritability.
- Three or more discrete episodes of vomiting.
- Dangerous mechanism of injury (high-speed road traffic accident either as pedestrian, cyclist or vehicle occupant, fall from a height of greater than 3 meters, high-speed injury from a projectile or other object).
- Amnesia (antegrade or retrograde) lasting more than 5 minutes.

Children who have sustained a head injury and have none of the above-mentioned risk factors, should be observed for a minimum of 4 hours after the head injury. If during observation any of the risk factors below are identified, perform a CT head scan within 1 hour. If none of these risk factors occur during observation, use clinical judgement to determine whether a longer period of observation is needed.

III.C. IN-HOSPITAL CARE IN TRAUMATIC BRAIN INJURY



Infants

For patients (adults and children) who have sustained a head injury with no other indications for a CT head scan but who are on anticoagulant or antiplatelet therapy, perform a CT head scan within 8 hours of the injury.

IN-HOSPITAL CARE IN TBI  
Criteria for performing a CT head scan

ADULT

- GCS < 13 on initial assessment in ED
- GCS < 15 at 2 hours after the injury in ED
- Suspected open/depressed skull fracture.
- Any sign of basal skull fracture (haemotympanum, 'panda' eyes, cerebrospinal fluid leakage from the ear or nose, Battle's sign).
- Post-traumatic seizure.
- Focal neurological deficit.
- > 1 episode of vomiting.

CHILDREN

- Post-traumatic seizure but no history of epilepsy.
- GCS <14, or for children < 1 year- GCS (pediatric) < 15.
- At 2 hours after the injury, GCS < 15.
- Suspected open/depressed skull fracture or tense fontanelle.
- Any sign of basal skull fracture (haemotympanum, 'panda' eyes, cerebrospinal fluid leakage from the ear or nose, Battle's sign).
- Focal neurological deficit.
- Loss of consciousness > 5 minutes (witnessed).
- Abnormal drowsiness or irritability
- 3/> e/o vomiting.
- Dangerous mechanism of injury (high-speed road traffic accident either as pedestrian, cyclist or vehicle occupant, fall from a height of > 3 mt, high-speed injury from a projectile or other object).
- Amnesia (antegrade/retrograde) > 5 minutes.

# RECOMMENDATIONS

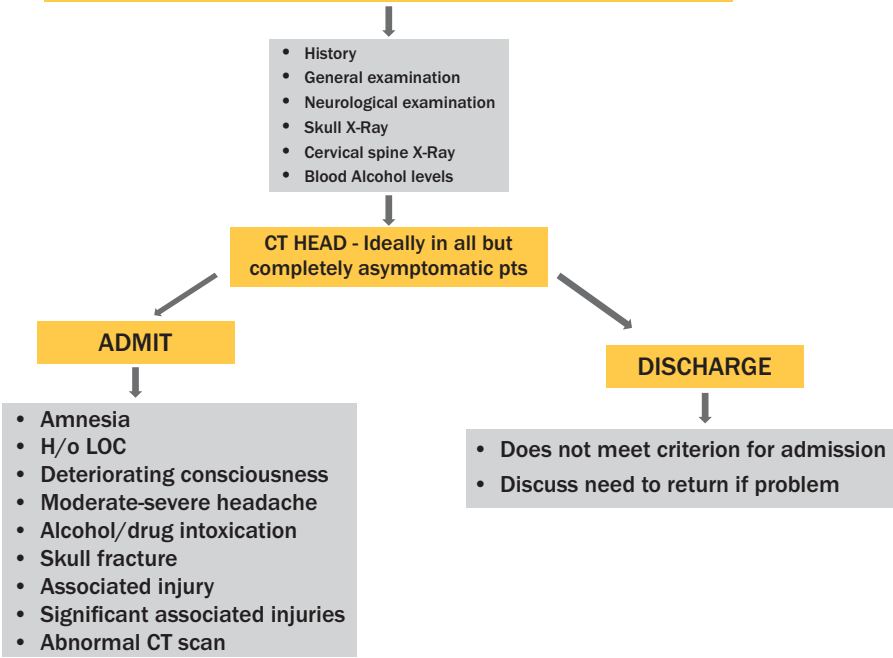
# III.C. IN-HOSPITAL CARE IN TRAUMATIC BRAIN INJURY



## Consider repeating the CT scan:

- If the initial scan shows an abnormality and there is clinical deterioration.
- To check that an original small lesion has not progressed (next day).
- To check that an initial small lesion has resolved spontaneously (in a week or two).

### ALGORITHM FOR MANAGEMENT OF MILD HEAD INJURY



## Discharge and follow-up

*The patient can be discharged with the follow up advice, if, any of the following are present-*

- If CT is not indicated on the basis of history and examination, as long as no other factors that would warrant a hospital admission are present (drug or alcohol intoxication, concomitant injuries, shock, suspected non-accidental injury, meningism, cerebrospinal fluid leak) and there are appropriate support structures for safe transfer to the community and for subsequent care (competent supervision at home).
- After normal imaging of the head and the patient has returned to GCS equal to 15, as long as no other factors that would warrant a hospital admission are present and there are appropriate support structures for safe transfer to the community and for subsequent care (competent supervision at home).
- After normal imaging of the cervical spine and as long as the patient has returned to GCS equal to 15 and their clinical examination is normal, and no other factors that would warrant a hospital admission are present and there are appropriate support structures for safe transfer to the community and for subsequent care (competent supervision at home).
- Do not discharge patients presenting with head injury until they have achieved GCS equal to 15, or normal consciousness in infants and young children as assessed by the pediatric version of the GCS.

**All patients with any degree of head injury should only be transferred to their home if it is certain that there is somebody suitable at home to supervise the patient. Discharge patients with no caretaker at home only if suitable supervision arrangements have been organized, or when the risk of late complications is deemed negligible.**

# RECOMMENDATIONS



## Discharge after observation

Patients admitted after a head injury may be discharged after resolution of all significant symptoms and signs providing they have suitable supervision arrangements at home.

### Discharge advice

Give verbal and printed discharge advice to patients with any degree of head injury who are discharged from an emergency department or observation ward, and their families and caretakers.

**Printed advice for patients, families and caretakers should be age-appropriate and include:**

- Details of the nature and severity of the injury.
- Risk factors indicating the need to return to the emergency department.
- Details about the recovery process, including the fact that some patients may appear to make a quick recovery but later experience difficulties or complications.
- Contact details of community and hospital services in case of delayed complications.
- Information about return to everyday activities including school, work, sports and driving.
- Details of the support organizations.
- Offer information and advice on alcohol or drug misuse to patients who presented to the emergency department with drug or alcohol intoxication when they are fit for discharge.
- Inform patients and their families and caretakers about the possibility of persistent or delayed symptoms following head injury and whom to contact if they experience ongoing problems.

### Patients who do not improve:

Criteria need to be formulated for decisions on discharge for patients who do not improve satisfactorily, as well as those patients for whom the family requests termination of care.

# III.C. IN-HOSPITAL CARE IN TRAUMATIC BRAIN INJURY



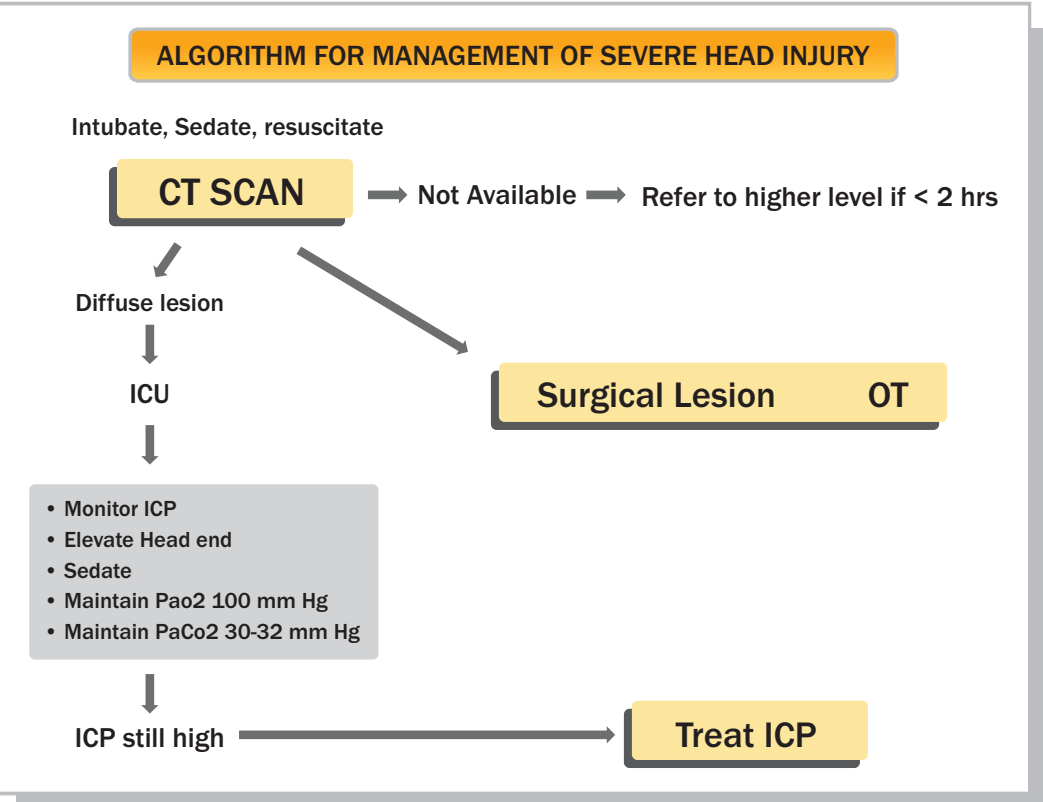
## Futility guidelines

It is very important to know which patient is salvageable and which is not, as there can be optimization of the resource allocation depending on the predicted outcome, but unfortunately no system is 100% perfect for prediction. Usually outcome prediction cannot be perfect in first 24 hours, and the confidence of prediction increases as days pass by after the injury. In the Indian setting it is probably acceptable to have 10-15% error either with pessimistic or optimistic outcomes to avoid utilizing scarce resources on patients unlikely to survive. This topic was not adequately discussed and there are no recommendations or conclusions at present.

## Management of CPP and ICP

### Indications for ICP monitoring

- All salvageable patients with GCS of 3–8 and abnormal CT
- In patients with GCS of 3-8 with normal CT if 2 or more criteria is present:
  - ↳ Age > 40 years
  - ↳ Unilateral or bilateral motor posturing
  - ↳ SBP < 90 mm Hg



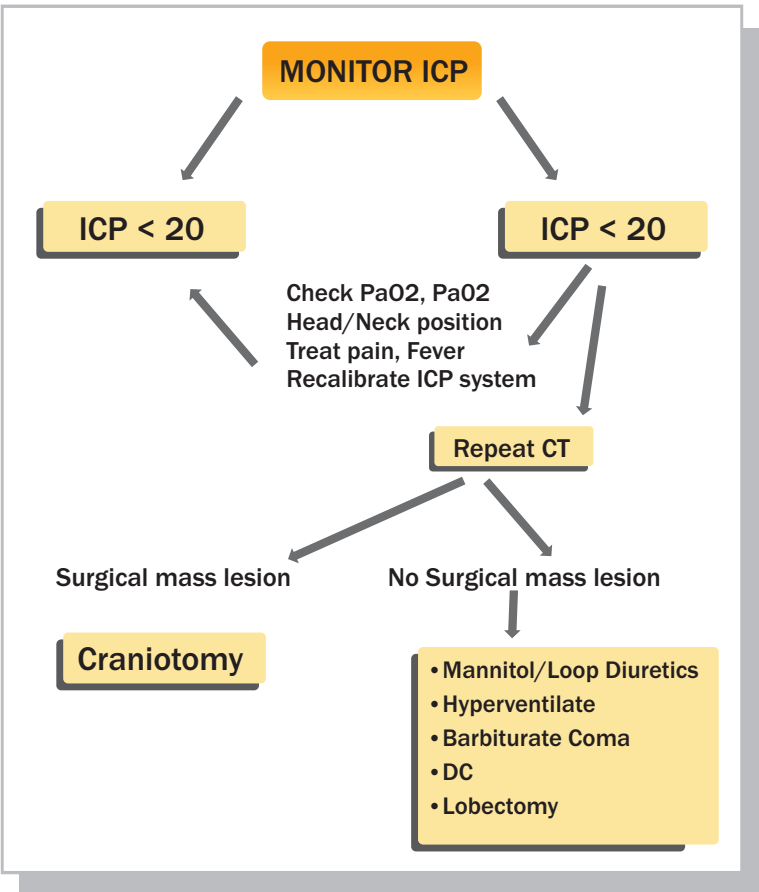
# RECOMMENDATIONS



- ICP therapy is only definitely indicated if raised ICP has been demonstrated by monitoring, if there is CT evidence of increased ICP (e.g., absent/compressed basal cisterns) or clinical signs of developing intracranial herniation.
- Treatment should not only be aimed at reducing ICP, but especially at restoring CPP to appropriate levels (60–70 mmHg).
- ICP elevations above 20–25 mmHg should be treated.
- Before initiating treatment directed at ICP, check for monitor malfunction, remediable extracranial disorders (PaCO<sub>2</sub>, BP etc.)

## Accepted methods of management of ICP and CPP are:

- Sedation, analgesia and mild to moderate hyperventilation (PaCO<sub>2</sub> 4–4.5 kPa or 30–35 mmHg).
- **Volume expansion** and inotropes or vasopressors when arterial blood pressure is insufficient to maintain CPP in a normovolaemic patient.
- **Osmotic therapy:** preferably mannitol. The effective dose range of mannitol is 0.25–1.00 g/kg intravenously. Intermittent boluses may be more effective than a continuous infusion, and the serum osmolality should not exceed 320 mmol/L. If the intracranial pressure falls below 20 mm Hg, these therapies can be carefully withdrawn. However, if intracranial hypertension persists, repeat head CT scan is recommended to assess for the presence of a new or expanding mass lesion.
- **Other agents**, such as Glycerol or Sorbitol are not advocated. If osmotherapy has insufficient effect, Furosemide (Lasix) can be given additionally.



# III.C. IN-HOSPITAL CARE IN TRAUMATIC BRAIN INJURY



- If intracranial hypertension is refractory to the strongest medical and surgical treatments, **high-dose barbiturates therapy** (along with intensive cardiac monitoring and blood-pressure support) can be used in patients who are haemodynamically stable, with injuries compatible with recovery. The loading dose of pentobarbital is 10 mg/kg over 30 min or 5 g/kg per h for 3 h, and the maintenance dose is 1 mg/kg per h.
- Another second-tier therapy is **hyperventilation** to a PaCO<sub>2</sub> of less than 30 mm Hg. With this approach, assessment of jugular venous oxygenation or cerebral blood flow is recommended to monitor ischemia, at level I trauma center.
- A final effort includes **decompressive craniotomy** for progressive, therapy-resistant intracranial hypertension with associated pupillary dilatation or decerebrate posturing.
- Other ICP therapy such as hypothermia, is considered to be experimental and should not be instituted in patients.
- There is no established indication for steroids in the management of acute head injury. They should not be used in head injury.
- If the intracranial pressure exceeds 25 mm Hg, repeat computed tomography is recommended to ascertain expanding or new intracranial lesions.

## Hyperventilation

- Hyperventilation may be useful transiently if the patient shows any obvious signs of cerebral herniation after correction of hypoxemia or hypotension. (Signs of cerebral herniation include fixed, dilated, or asymmetric pupils and motor responses of extensor posturing or no movement when an unpleasant stimulus is applied).
- When these signs are present in a comatose patient with traumatic brain injury, hyperventilation (about 20 breaths per min for adults, 30 breaths per min for children, and 35 breaths per min for infants) may be used with arterial blood-gas analysis guiding the rate of ventilation.





Operative Therapy (Timing, Indications)

Asurgically significant epidural hematoma, or acute subdural hematoma should be evacuated immediately upon detection.

For small hemorrhagic contusions or other small intracerebral lesion: a conservative approach is generally adopted; but operation should be considered urgent for large intracerebral lesions with high or mixed density on CT scan.

Specific indications for operation include:

- Clinical deterioration
- Size
  - >1 cm thickness extracerebral clot
  - >25–30 ml intracerebral hematoma
- Midline shift > 5 mm
- Enlargement of contra lateral ventricle or temporal horn
- Obliteration of basal cisterns/third ventricle
- Raised or increasing ICP
- **Depressed skull fracture:** operation is definitely indicated only if it is a compound (open) fracture (not over sagittal sinus) or if the fracture is so extensive that it causes mass effect. Closed depressed skull fractures are usually treated conservatively, but operation may be appropriate in selected cases to reduce mass effect or correct disfigurement.
- Decompressive craniotomy is required when other means of controlling ICP fail.



Antiepileptic drugs

A single antiepileptic drug- phenytoin/ valproic acid or carbamazepine should be started on the day of admission in all the cases for a short period of 1 week to 3 months after injury, if no relapse of seizure activity occurs, in patients with one or more of the following risk factors-

- Compound depressed skull fracture.
- Penetrating injuries.
- Intraparenchymal hematoma/ contusion.
- Known c/o seizure disorder.
- Focal neurological deficits.
- GCS = 3-8.
- Loss of consciousness >24 hours.
- Amnesia > 24 hours.
- Immediate or Early seizure <24 hours.
- Cortical/ subcortical or frontal site of the lesion.
- Extremes of age.
- Alcohol abuse.

In the absence of the above-mentioned risk factors, there is no recommendation to treat patients with AED.



Infection prophylaxis

- No prophylaxis for intubation / ventilation / ICP monitoring.
- Prophylaxis for lacerations acceptable.
- Treatment of other injuries / aspiration acceptable.

In severe traumatic brain injury (TBI) patients, the incidence of infection is increased with mechanical ventilation and invasive monitoring techniques. Infections contribute to morbidity, mortality and increased hospital length of stay. For example, as many as 70% of mechanically ventilated patients can develop pneumonia and ICP monitoring infection rates can be as high as 27%. Infection prophylaxis for TBI can be divided into several aspects of care, including external ventricular drainage (EVD) and other ICP monitoring devices, and prophylaxis to prevent nosocomial systemic infection.

Analgesics & Sedatives

Adequate analgesics mandatory for trauma.

Sedation use by experienced personnel.

- Danger of losing airway / neurological exam. Drugs available for sedation and analgesia need to be standardized to create guidelines

Indications and location

- **Emergency room**
  - ♦ Agitation
  - ♦ For procedure
    - ↳ Securing airway
    - ↳ Splinting, lines
- **ICU**
  - ♦ Ventilation
  - ♦ Procedures



• Non ICU areas

- ♦ Extreme caution because of decreased intensity of monitoring.
- ♦ Drugs – quetiapine / risperidone / haloperidol / midazolam.

Glucose Management

A strict glycemic control is not recommended, especially with intensive insulin therapy. However, blood sugar levels should not be allowed to rise above 150 mg/dl in any patient with traumatic brain injury.

Deep venous thrombosis prophylaxis

Graduated compression stockings or intermittent pneumatic compression stockings are recommended unless lower extremity injuries preclude their usage in all the bedridden patients with severe traumatic brain injury, immediately after stabilization. Their use should be continued until patients are ambulatory.

Nutrition

All the patients should be started on full caloric replacement starting as early as feasible (24 hours) after Traumatic brain injury. Patients who can be fed via the enteral route should receive EN- Total parenteral nutrition should be started in patients who fail to tolerate at least 50% of their goal rate of entral nutrition.

The calculated energy and nutritional requirements are as follows-

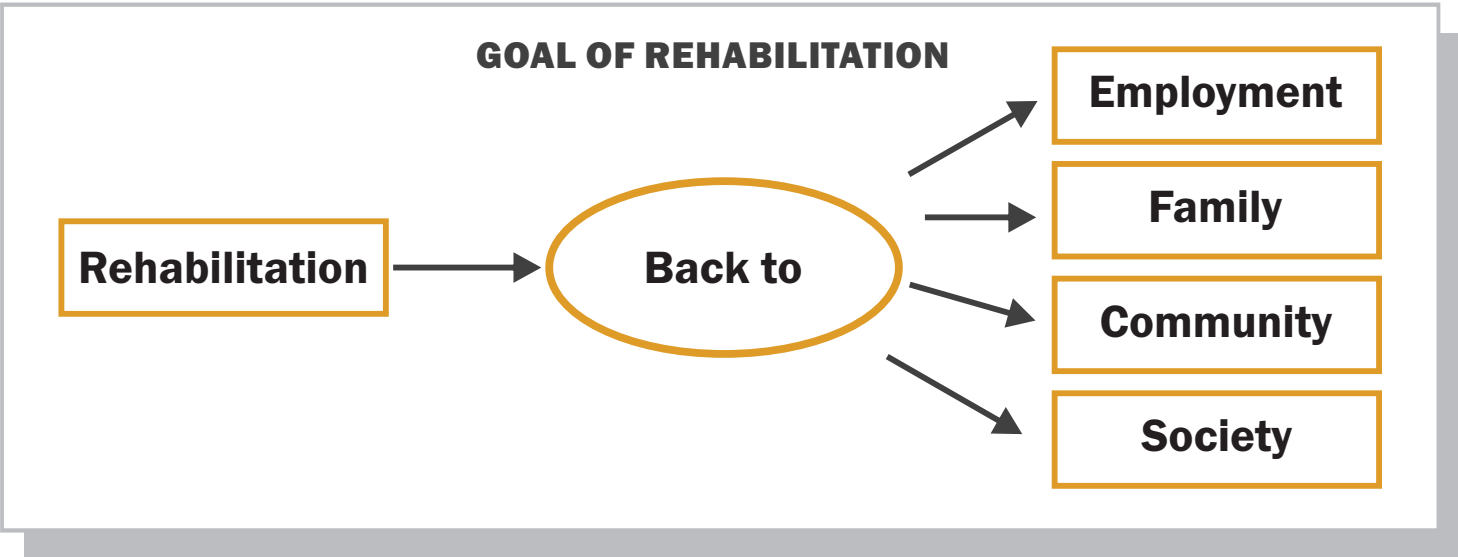
- Mod- severely injured (ISS of 25 – 30)- 25 to 30 kcal/kg/d or 120% to 140% of predicted BEE.
- Severe TBI- 30 total kcal/kg/d (140% of MREE).
- 1.25 g of protein/kg/d- sufficient for most injured patients.
- 2 g of protein/kg/d appropriate for severely burned patients.
- Carbohydrate- <5 mg/ kg/min (25 kcal/kg/d) for burn patients, and even less for nonburn trauma patients.
- IV lipid intake <30% of total calories.



III.D. NEUROREHABILITATION

REHABILITATION:

Rehabilitation is the combined & co-ordinated efforts of a physician supervised multi-disciplinary team in helping a diseased person to reach maximum physical, psychological, social, vocational and educational potential, consistent with his or her physiological or anatomical impairment, environmental limitations, desires and life plans.



Disability after TBI

Post-acute TBI patients who are conscious have following mixture of cognitive and physical impairment.

- Cognitive deficits
  - ↳ 37.5% moderate
  - ↳ 12.5% severe
- Motor deficits
  - ↳ 30% hemiplegia/ hemiparesis
  - ↳ 17% quadriparesis
  - ↳ 15% incoordination
  - ↳ 37.5% extra-pyramidal features
  - ↳ 90% spasticity
- Other deficits
  - ↳ 77.5% cranial nerve paresis
  - ↳ 10% neurogenic bladder
- Psychiatric illness
  - ↳ 22.5% on antidepressants
  - ↳ 5% on antipsychotics

# RECOMMENDATIONS



Patients who are at home after TBI have following health related problems

Type of disability	%
Locomotor activities	15
Headache	14
Decreased power and strength in limbs	9.8
Memory and information processing deficits	7.6
Visual difficulties	5.3
Speech and communication problems	4.3
Generalized pains	8.3
Anxiety features	5.2
Giddiness and loss of balance	5.5
Hearing problems	2.4
Phobias	3.8
Behavior problems	13
Epilepsy	6.5
Total number	581
	100

## Need for rehabilitation in Traumatic Brain Injury (TBI)

- Patients who need rehabilitation: 1.5 million / year.
- Less than 10 integrated multidisciplinary inpatient neuro-rehabilitation facilities in country.
- Although long term neuro rehabilitation services are available, there are not enough to provide optimum care and to all those who need it.
- Any patient with TBI who has persistent and stable neurological deficit, who requires medical monitoring and has impairment in at least two key domains should be transferred to in patient neuro-rehabilitation facility.
- A person with TBI should be evaluated and treated for impairments in cognition, vision speech and language, behavior, swallowing, sensory motor system, and bowel and bladder function.

# III.D. NEUROREHABILITATION

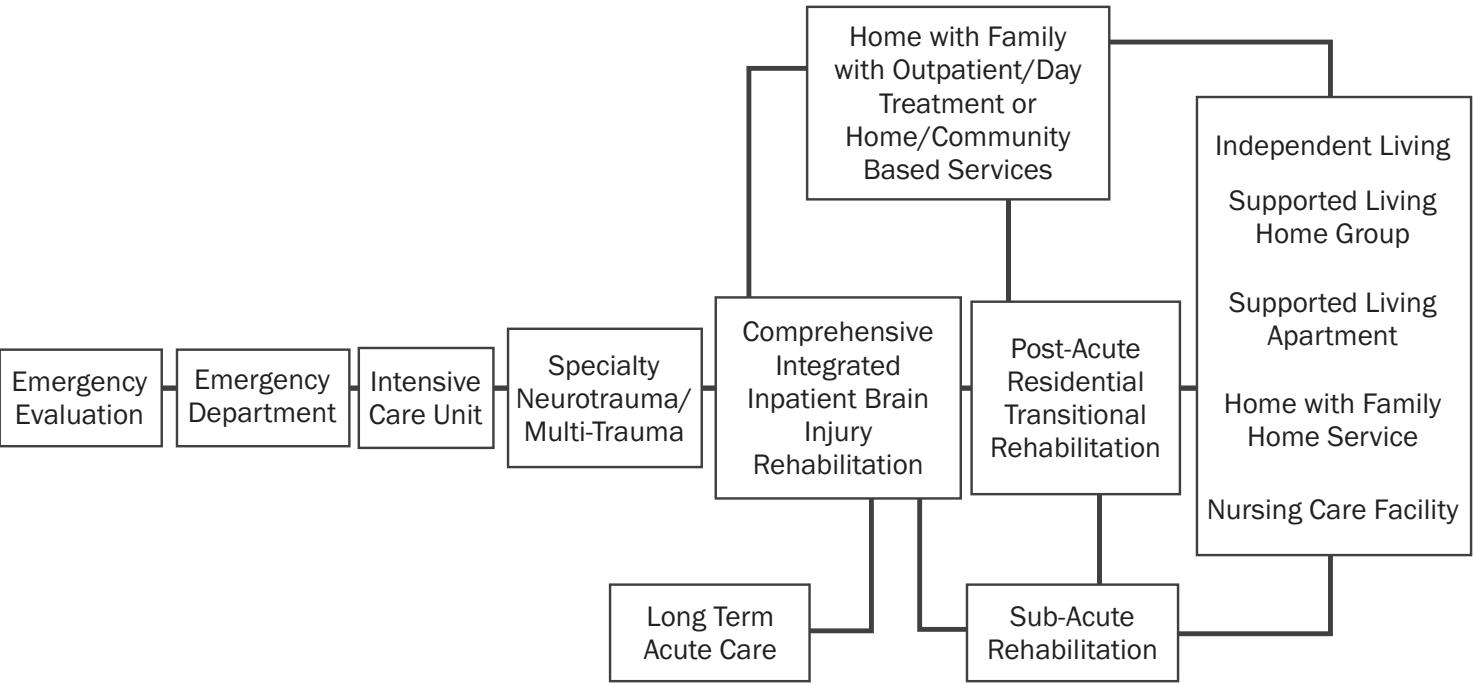


## Benefits of post-acute brain injury rehabilitation

- An improvement in behavior and everyday activities following rehabilitation.
- Increased independent living.
- Higher rate of return to independent work, training or home-making.
- Lower level of unemployment.

## TRAUMATIC BRAIN INJURY CONTINUUM OF CARE

Adapted from the Rocky Mountain Regional Brain Injury System to depict the continuum of care for individuals with moderate and severe TBI





Indications for referral:

Neurosurgeon:

- Craniotomy site persistent pus discharge (may be bone flap osteomyelitis).
- Cranioplasty for patients who have undergone decompressive craniectomy.
  - ↳ Usually 3 - 6 months after injury.
  - ↳ May consider early if patient has recovered and ready to go for work, scalp is sunken, and local headache.
- Post-traumatic Hydrocephalus.
  - ↳ Suspect when recover halts or when patient starts deteriorating after initial recovery.
- Chronic Subdural Hematoma (CSDH).
  - ↳ Suspect when new onset headache days after injury.
  - ↳ New onset neurological deficits days after injury.
  - ↳ Suspect when patient starts deteriorating after initial recovery.

Neurologist:

- Seizure while on antiepileptic drug.
  - ↳ Consider cognitive side effects of AEDs before adding new drug.
- Post-traumatic headache not responding to NSAIDs or amitriptyline.



Rehabilitation specialist:

- Spasticity.
- For pressure sores not responding to dressings and position change.

Orthopedic surgeon:

- Heterotopic ossificans.
  - Suspect when painful restriction of joints with swelling.

Chest physician:

- Pneumonia.
- Venous thromboembolism.

Urologist:

- Recurrent urinary tract infection.
- Complication of neurogenic bladder (urinary stone, pyelonephritis).

Gastroenterologist:

- For percutaneous endoscopic gastrostomy (PEG) if patient cannot be fed orally for many days/ or in vegetative/ minimally conscious state.

Psychiatrist:

- Depression.
- Psychosis.
- Substance abuse prior to or after injury.

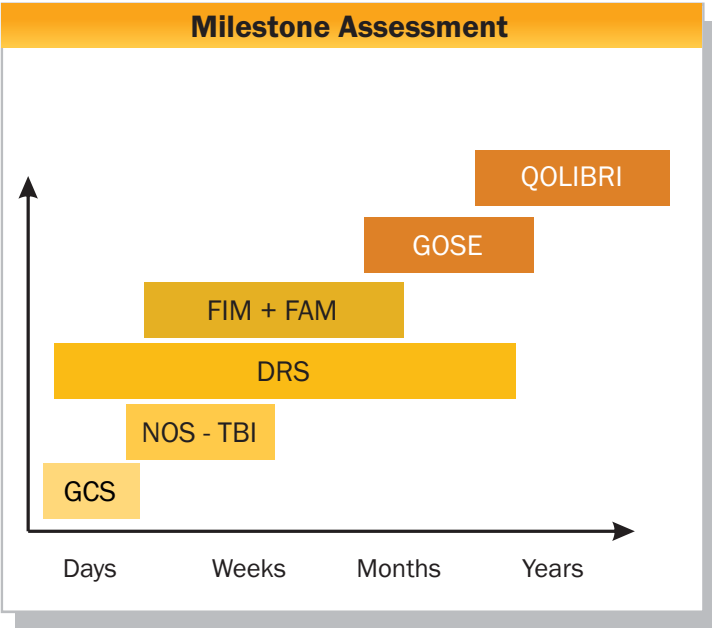




Outcome Assessment:

- Disability Rating Scale (DRS) at time of discharge from acute care.
- DRS at time of admission and discharge from inpatient rehabilitation.
- Glasgow Outcome Scale Extended at 6 months.
- Brief neuropsychological (ABIC does not require a trained neuropsychologist) assessment at 6 months.

American Brain Injury Consortium (ABIC)	
Test	Area Addressed
Rey Complex Figure	Visuoconstruction & memory
Controlled Oral Word Association	Oral fluency
Symbol Digit Modalities (oral)	Sustained attention
Grooved Pegboard	Fine motor dexterity
Neurobehavioral Functioning	Behavior/QOI
Inventory	



Recommendations for Lack of facilities: Addressing the Gap

- **Formulation of neuro-rehabilitation facilities**
  - ↳ Each Level I center managing traumatic brain injury must have integrated multidisciplinary inpatient rehabilitation services.
  - ↳ It is recommended to have integrated multidisciplinary inpatient rehabilitation services for Level II centers.
  - ↳ There should be provision for inpatient rehabilitation beds, manpower, equipments, and space to provide optimum care in proportion to acute care.
- **The rehabilitation process involves “Team efforts”. The integrated neurorehabilitation team should consist of:**
  - ↳ Rehabilitation Physician (Physiatrist).
  - ↳ Neuropsychologist.
  - ↳ Speech & language pathologist.
  - ↳ Physical therapist.
  - ↳ Occupational therapist.
  - ↳ Rehabilitation nurse.
  - ↳ Orthotist.
  - ↳ Social worker.
  - ↳ Access to other medical specialties as best available in the setting.

## Tips for Care Takers

### General Principles

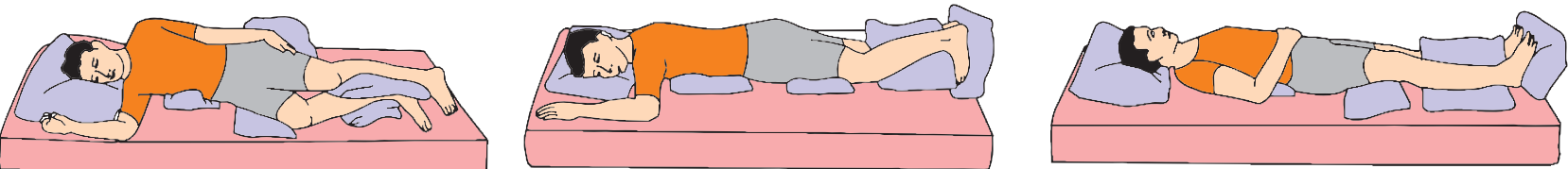
- All patients admitted to hospital should have an initial assessment, conducted by rehabilitation professionals, as soon as possible after admission.
- The core rehabilitation professional team should include physiatrists, other physicians with expertise/core training in neuro rehabilitation, occupational therapists, physical therapists, speech-language pathologists, nurses, social workers, family members and dietitians.
- All team members should be trained in supported conversation to be able to interact with patients with communication limitations such as aphasia.
- Patient, family and caregiver education is provided both formally and informally, with consideration given to individual and group settings as appropriate.
- Patients should engage in training that is meaningful, engaging, progressively adapted, task-specific and goal-oriented in an effort to enhance motor control and restore sensorimotor function.
- Training should encourage the use of patients' involved affected limb during functional tasks and be designed to simulate partial or whole skills required in activities of daily living (e.g. folding, buttoning, pouring, and lifting)
- Therapists should provide supplementary training programs aimed at increasing the active movement and functional use of the affected arm between therapy sessions, e.g. Graded Repetitive Arm Supplementary Program (GRASP) suitable for use during hospitalization and at home
- The Grasp Program should include: strengthening exercises for the arm and hand (using small wrist weight, putty, hand gripper), range of motion exercises (stretching, active exercises), and exercises that improve gross and fine motor skills (e.g., blocks)
- The need for special equipment (e.g., wheelchairs, safety devices) should be evaluated on an individual basis. Once provided, patients should be reassessed, as appropriate, to determine if changes are required or equipment can be discontinued with the aim of achieving normal unassisted function.
- Spasticity and contractures can be prevented or treated by antispastic pattern positioning, range-of-motion exercises, and/or stretching.
- Joint protection strategies should be used during the early or flaccid stage of recovery to prevent or minimize pain.

## Recommendations for Caretakers

### Skin care to treat or help prevent pressure sores

- Evaluate the person's skin daily for pressure sores or evidence of breakdown.
- Wash all open sores daily with boiled water and cover wounds with sterile gauze or clean cloths. Topical agents may be used if wounds are infected or there is pus draining or the area is warm to touch with signs of inflammation.
- It is important to clean wet or soiled skin immediately after urination or bowel movements. Prolonged contact with urine or feces can cause skin breakdown.
- Consider using a pad or pillow stuffed with cotton. The cotton can be thrown away if soiled and the pad or pillow can be reused.
- It is important to turn the person in bed every 2-3 hours (during day and night), always checking the skin for red marks that occur with prolonged focal pressure.

### Position support options to decrease pressure ulcers





## Refer to specialist for following:

### Local Spasticity

- Botulinum toxin type A injections.
- Phenol blocks of the musculoskeletal nerve.
- Electrical stimulation.

### Generalized spasticity not responding to oral baclofen or patient cannot tolerate oral baclofen.

- Intrathecal baclofen.
  - ↳ Reduces upper and lower extremity spasticity.
  - ↳ Improvements in walking performance..

### Sleep and Rest

- Ensure that patient gets a quiet but monitored environment to ensure good sleep.

### Care to prevent choking and facilitate breathing

Persons who cannot move spontaneously should lie in a position that helps easy breathing.

Move pillows and blankets away from face (potential suffocation hazard).

Use rolled blankets to raise the head and chest if lying flat.

Use the sitting position for feeding/drinking, and keep the patient upright for an hour after feeding.

If the patient vomits, quickly turn on side to avoid aspiration/choking.



### Care to prevent choking and facilitate breathing



### Management of Urine and Feces

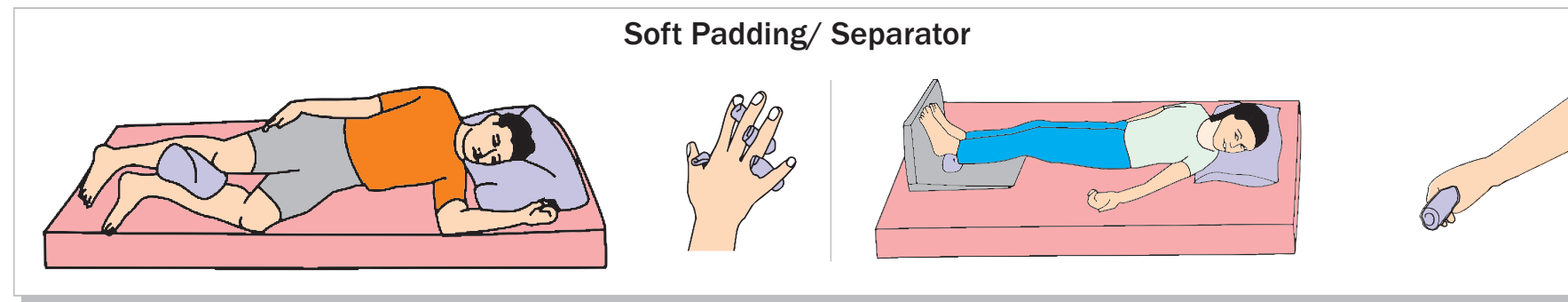
- Make certain that the patient is having regular urination and bowel movements.
- Fruits and grains are most helpful for stimulating bow motility.
- Encourage drinking water several times a day.
- Isabgol is a good stimulant for having regular bowel movements.
- Use Vaseline to assist in removing impacted feces.

**A temporary catheter tube may be necessary for urinary retention. If used, keep the catheter clean and free from infection. Regularly check urine for color and smell. Dark brown urine is a sign of dehydration, and foul-smelling urine may need to further evaluation for possible infection.**



## Reducing the Risk of Limb Deformity

- Change patients position regularly, avoid same position for long duration.
- Regularly move his both lower and upper extremities, avoid same position for long.
- Mobilize his joints passively or actively as possible.
- If splints are used to ensure that there is a soft padding to avoid injuries due to splint itself.
- Keep a soft padding or a separator in between the limbs, both upper and lower, fingers, to avoid frictional injuries.



## Spasticity

- Spasticity a common symptom, which requires intervention, especially when it interferes with functional abilities such as mobility, positioning or hygiene, or when it is the cause of deformity or pain.

## Oral drugs:

**Baclofen** appears to improve lower extremity spasticity, and its starting dose is 5 mg tid to maximum dose 80 mg/ day.

**Tizanidine** is effective for improving upper and lower extremity spasticity, and its starting dose 4 mg to maximum dose 36 mg/ day



## Eating and Drinking

A brain injury can cause both physical and thinking difficulties that interfere with the ability to swallow.

## If the patient has difficulty swallowing:

- Make sure the patient is sitting upright. Support head if necessary.
- Encourage to take one sip/ bite at a time.
- Help the patient to lower chin down toward chest during swallowing.
- Try giving liquids by spoon or straw.
- Ask the patient to swallow two times for each sip/ bite.
- Ask the patient to take a breath and hold it, then swallow and breathe.
- Check between swallows and after the meal to make sure there is no food left in the mouth.
- Offer one item of food at a time.
- Do not talk while or drinking
- Start with baby food, eg. Halwa, khichdi, banana, ganjee, etc.
- A helping person should remain with patient to assure that patient eats and drinks safely.
- Assist patient to sit upright for 30 to 60 minutes after eating.
- Patients with cognitive difficulty in feeding may require instruction as given to small children with modification of utensils.



Washing and Bathing

- Daily washing is essential for hygiene.
- Surgical site needs to be washed daily to prevent infections.
- Patient with poor balance should sit on a chair with a cut out opening in the seat, and a back strap to bathe.
- Water should be just warm as patients may not distinguish between hot and cold water.

Walking

- Initial walking can be very tiring.
- Walk short distances at first and allow the person to rest often.
- Allow him to stand and get his balance before taking any steps forward.
- Specific sit-to-stand training results in improved abilities.
- Conventional gait training with walker or hand held assistance under supervision, with verbal and tactile cues should be done.
- Body weight-supported treadmill training is not required.
- A specific balance and coordination training program is effective if patient has significant balance problems.
- Aerobic exercise helps to reduce fatigue and improves social integration, physical independence, levels of spasticity and overall mental health.



Speaking

Strategies to help patient understand

- Make sure you have the person's attention before speaking.
- Say name and make sure patient is looking at you.
- Speak slowly.
- Try to use the simplest words that can communicate your message.
- Use short sentences. Repeat your sentence if necessary.
- Use pictures, gestures and demonstrations to help her to understand your words.

Strategies to help the person with aphasia to speak the correct words

- Help to practice words by naming objects around the house.
- Encourage to use gestures.
- Ask to describe what an object looks like or what it is used for.
- Even if patient leaves out words in a sentence, patient may be able to communicate her message. Repeat the full sentence back to so person can hear the words that he/ she did not include in the sentence.
- If person is unable to say a word that patient wants to say, ask to watch and listen to you as you say the word. Then ask to repeat the word.
- Ask to practice words and phrases that are most often needed. For example, "I have pain." "I want water".





**Problems in Speaking Clearly**

- Slurred speech sounds.
- Speak too fast, too slow or too softly.
- The voice may have a weak, strained or hoarse quality
- If the patients talks too fast, ask them to say one word at a time. You may ask the patients to tap fingers for each word that they want to say. Tapping helps to create a slow rhythm.
- If a patient talks too slowly, give time to talk. This may be the only way person can make herself understood.
- If voice is very soft or weak, ask to take a deep breath before starting to talk.
- Following exercise may help person to speak clearly: Smile Exercise, Kissing Exercise, and Tongue Exercise.

**Reading**

- Check if the patient is able to read, comprehend and answer written commands/directions/signs accurately.
- Ascertain that patient doesnot complains of headache or double vision when reading.



**Strategies to help the person with reading and writing**

- Ask the patient to read single words or short phrases and gradually increase the number of words to be read.
- Instruct the patient to take the finger and move it from one word to the next.
- If the patient has double vision, cover one eye with a patch.
- If the patient has difficulty concentrating, provide a quiet place for reading.

**Writing**

Observe if the patient can write his name, address, simple numbers, simple words or notes and make them practice. Relearning is a slow process and would require patience, and one step at a time approach.

**The following guides can increase safe participation in homemaking tasks:**

- If a patient has poor balance or uses a walker, remove all small floor rugs that could cause her to trip and fall.
- If the patient has poor balance, should perform tasks from a sitting position. Items that the patients needs should be placed within their reach. For example, the patient may fold laundry or do food preparation while sitting.
- A patient who is weak or tires easily should take rest breaks during the task.



Problems with Agitation and Destructive Behavior

After brain injury, some persons easily become angry, restless or excited, or behave in a manner that is not socially acceptable. A person may swear, yell or scream very vigorously and be unable to control this very unpleasant behavior. The person may hit or fight, pinch and bite, or break things for no clear reason.

- It may be possible to calm the person simply by talking quietly and in a comforting and reassuring manner.
- Soft music can help an agitated person to relax.
- A quiet room and allowed to remain in that environment, away from other people, until they become calm.
- Avoid benzodiazepines (diazepam, lorazepam, etc)
- Oral risperidone 2 mg/ day may be given only under medical supervision.

**Vestibular Dysfunction** is commonly overlooked, vertigo, balance problems, visual complaints (double vision, blurriness) and nausea are possible symptoms. Vestibular rehabilitation following TBI is needed in order to promote vestibular adaptation and recovery. Medications are generally not useful.

Techniques used in vestibular rehabilitation.

- Gaze stability exercises.
- Vestibulo-ocular reflex gain adaptation.
- Substitution exercises.
- Habituation techniques.
- Static and dynamic balance and gait exercises.



Headache - Common after mild TBI.

- If headache is similar to that of any primary headache disorder, treat it accordingly.
- For chronic headache amitriptyline 25 mg every night may be given, only under medical supervision.
- New onset of acute headache days after injury requires a head CT scan.

Seizure and Epilepsy

- If patient never had history of seizures antiepileptic drugs (AED) are not required.
- If the patient is on AED, then it should be tapered and stopped.
  - ↳ Commonly prescribed AED phenytoin should be tapered at the rate of 100 mg every month.
- If patient gets new seizure days after injury, then treatment is similar to that of any new onset of seizures.

All medications only under medical supervision only.

Cognitive Rehabilitation Therapy (CRT)

- Graduates with job requiring high level of intelligence may have severe disability due to cognitive impairment.
  - ↳ Such patients should be referred for comprehensive neuropsychological assessment and cognitive retraining therapy at special centers.
- Hierarchy of CRT should address attention followed by memory then executive functions.
  - ↳ A mix of restoration and compensation approaches should be used. The therapy should be systematic, structured and repetitive according to the needs of each particular patient.



**Patients with poor education status and not so demanding job can be managed at home with following tasks:**

**Improving Mental Speed:**

- Sorting of grains/ beads of different colors and sizes.

**Improving Attention:**

- Letter cancellation/ Number cancellation/ Cancellation of shapes.
- Copywriting and Dictation.

**Executive functions and Working Memory:**

- Mental calculation.
- Reciting poetry.
- Reciting arithmetic table.
- Remembering shopping list.
- Remembering new routes.
- Categorization of household articles.
- Planning for social events.

**Visuospatial Functions:**

- Copying drawings.
- Learning rangoli.
- Comparing pictures.



**Recommendations for lack of human resources**

- Training of healthcare personnel for acute inpatient and long term care:
  - ✎ Manpower should be increased for neurorehabilitation .
  - ✎ Train existing Physical Medicine and Rehabilitation (PMR)/ specialists (Physiatrists) / Physical Therapist (PT) (Physiotherapist)/ Occupational Therapists (OT)/ Speech and Language Pathologists (SLP) (Speech Therapists)/ Clinical Psychologist (CP) in neurorehabilitation.
  - ✎ Create new more PMR/PT/OT/SLP/CP specialized in neurorehabilitation.
  - ✎ Modify existing curriculum for new PMR/PT/OT/SLP/CP in neurorehabilitation.
  - ✎ Start post MD/ DNB PMR fellowship program in neurorehabilitation.
  - ✎ Focus on TBI in post-graduate education program in OT/ PT/ SLP/ CP.
  - ✎ Train nurses to provide and supervise bedside therapy.
- Training of personnel for long term care.
  - ✎ Train currently available community based workers to provide long term care.
  - ✎ Identify and train primary caregiver in the family for homecare.
  - ✎ Tele rehabilitation for assessment and provision of home-based rehabilitation programs.

**Recommendation of lack of awareness**

- Awareness amongst healthcare providers about utility and knowledge of neurorehabilitation.
- Government requires greater awareness of need for neurorehabilitation, lack of facilities, and value (social and economic) of neuro rehabilitation and should provide necessary infrastructure and health care providers.

**Recommendation for lack of finances**

- Insurance (public/private) should cover inpatient and long term neurorehabilitation treatment, and adaptive equipments.
- Government should subsidize neuro rehabilitation services and adaptive devices.
- Disability benefits should improve so that persons with disability following TBI can live dignified life.