National Guidelines for the Management of Traumatic Brain Injury

Neurotrauma Society of India
(An NTSI-NSI Initiative)

Editors
Mathew Joseph
Sumit Sinha
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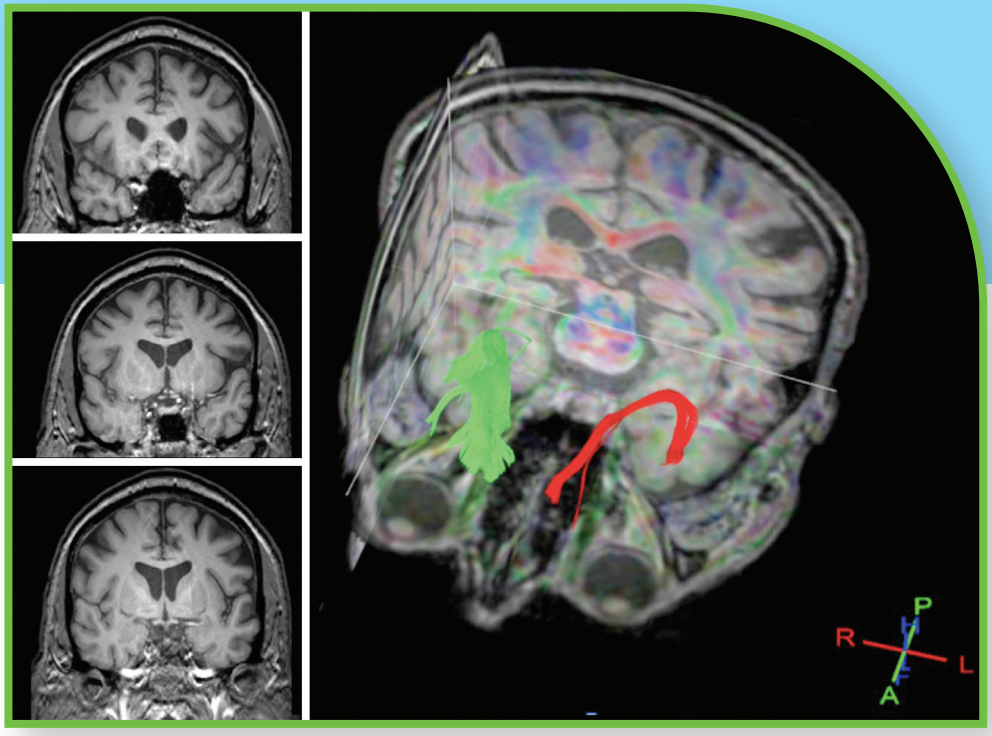

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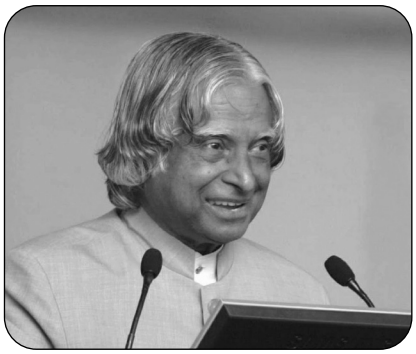
Dedicated to the millions of patients
who have suffered from traumatic brain injury and
to their loved ones who have shared the pain.

SPECIAL THANKS



Late Dr. A. P. J. Abdul Kalam
Former President of India
Who saw the need for these guidelines and encouraged their creation.
Without his guidance this project would not have seen the light of day.

Contents

"*In general the document is very useful and if used specially by surgeons in district hospitals and local governments adopt it, it will bring a qualitative change in the management and hence the outcome of head injury.*

My best wishes for success of this wonderful effort."

Prof. P.N. Tandon

From the Editor's Desk

A great majority of patients who suffer head injury are not seen in centers that have established neurosurgical services, and therefore receive less than optimal care or sometimes none at all. This is often the case even when the hospital has many of the facilities to adequately manage the patient due to the fact that most available protocols advise only the ideal treatment, which is perceived as complex and intimidating. The truth is very far from this because most of the treatment required by a patient with head injury, especially in the early stages, is well within the capabilities of a general medical setup. For example, one of the most important factors that influence the outcome of a patient with head injury is the blood pressure, and it is disappointing to see a patient arrive in the emergency room from another hospital in shock from scalp bleeding that could have been easily controlled before referral. This document is intended to encourage even the smallest hospital to perform life-saving interventions within its capabilities rather than stating, "We can't manage head injuries."

These guidelines are not purely evidence based but contain a large proportion of expert opinions gathered from doctors in academic and other fields to provide what we hope is the best possible advice to all doctors who encounter head injury in their practice.

They have been created for an environment where ideal treatment is not universally available. Each section describes optimal treatment, but more importantly emphasizes the importance of doing what is possible with the facilities and training available in a step-wise reduction of the complexity of the intervention. This approach can be criticized as accepting a lower quality of treatment rather than bringing up the level of care, but we feel that given the vast size of the problem, it is important to provide patients with whatever care is possible in the current scenario until the overall infrastructure is improved. In addition, it must be emphasized again that the "simple" interventions of stabilizing blood pressure and breathing have at least as much (or even more) influence on the outcome of head injury as neurosurgical interventions in the vast majority of cases. It is our earnest hope that this document will save lives and improve outcomes in head injury patients.

Mathew Joseph, M.Ch.
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Foreword

We are delighted that the guidelines for management of traumatic brain injury (TBI) in the Indian setting are being released. We applaud the many doctors who have worked on this document which represents a very important step forward in the growth of trauma services in India. These guidelines are the result of a multiyear effort that has culminated in a practical and usable tool for those who manage TBI. This is especially important as trauma and head injuries are extremely common problems in India, resulting in a lot of death and disability.

The guidelines that we helped to develop in the United States over 30 years ago have become widely adopted and have demonstrably improved outcomes. However, it was recognized that those guidelines were not directly applicable in the Indian setting due to different conditions, resources, and infrastructure. Therefore, a team of Indian doctors in collaboration with international experts took on the challenge of creating India-centric recommendations. No document is perfect and indeed such guidelines are by their very nature living documents that need to be corrected, updated, and constantly improved upon. The US version is now in its 4th edition and will no doubt continue to evolve.

We hope that these guidelines will prove useful to the Indian medical and surgical communities and congratulate all the individuals who worked tirelessly to make this a reality. We especially thank the many organizations that contributed money and talent toward this goal. May these efforts help many TBI patients and our colleagues who labor around the clock to care for them.

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The Guidelines Development Committee would like to thank the following special people without whom this project would not have been possible.

- We thank and recognize the Brain Trauma Foundation, USA, since their work served as a reference for these India-centric guidelines.
- American Association of Physicians of Indian Origin (AAPI), its office bearers, and its members including Presidents Dr. Ravi Jahagirdar and Dr. Seema Jain for their unfailing support and encouragement.
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- The Late Mr. Anwar Feroz Siddiqi for his relentless focused efforts in coordination and collaboration across the multiple stakeholders.

1 Introduction

India has unfortunately become the traumatic brain injury (TBI) capital of the world, and countless patients suffer such an injury each year. While some severely injured victims succumb, many survive with varying degrees of disability, representing a tremendous burden on the affected families and the country. We do not yet have a nation-wide organized trauma care system. As a first step toward this goal, we trust that this document will serve as a useful guide. This template might also be useful for other developing countries in a similar situation. The Indian neurosurgical community is keenly aware of the current statistics and is focusing its energy and abilities on improving this tragic situation.

Several years ago, Indian neurosurgeons joined various organizations including the American Association of Physicians of Indian Origin (AAPI) to improve TBI management in India. This was a monumental task and required a coordinated effort with support from many individuals and numerous organizations. The initial task force included representatives from the central government, epidemiologists, the general public, media, ambulance service groups, nongovernmental organizations, educational institutions, and neurosurgeons.

Some of our team members had helped to establish the original TBI Management Guidelines in the United States that resulted in substantial improvement in outcomes. However, due to infrastructure differences, these USA-based guidelines were not thought to be immediately applicable to the Indian situation. We therefore embarked on developing India-centric head injury guidelines that could be used to educate and train physicians, first responders, and trauma care providers, and this document is the culmination of such efforts. These guidelines are a "living document" that will be modified and improved with new knowledge and ongoing experience. Furthermore, while every effort has been made to make these recommendations as "evidence based" as possible, there is limited Class 1 or 2 evidence for many aspects of trauma care. Therefore, many of the recommendations are based on Class 3 evidence and expert consensus opinions.

Background

The purpose of these India-centric guidelines is to improve the entire spectrum of TBI care—from awareness and prevention, to prehospital care, in-hospital care, and finally rehabilitation. In the 1980s, the Brain Trauma Foundation, in collaboration with the American Association of Neurological Surgeons (AANS)

and the Congress of Neurological Surgeons (CNS) developed evidence-based management guidelines for severe TBI.[1] These guidelines have become widely used in the United States and are now in their 4th Edition. Modified versions of these guidelines, as well as the Advanced Trauma Life Support (ATLS) course, have been developed in other countries and have resulted in great improvements in the organization and treatment of trauma and specifically brain injury. Since trauma has become a major public health epidemic in India, and since the management of the injured patient remains quite variable, the need to create a document aimed at the Indian situation became apparent.

Basic Principles of TBI

The initial injury to brain (primary Injury) initiates several secondary processes (secondary Injury) that often lead to worse outcomes. Some of these secondary processes can be mitigated with timely interventions, and these guidelines aim to reduce such complications following TBI. This document will hopefully provide information for prompt treatment and appropriate care as to reduce secondary brain injury and optimize outcomes.

In most countries, TBI occurs most commonly in young males, and usually a major cause of death and disability below age 44 years. Since most patients with mild and moderate head injuries survive, as well as at least 50% of those with severe TBI, several thousands of patients with disabilities are added to the population every year. Due to increasing longevity, a second wave in TBI incidence is now also being seen in the elderly (**Fig. 1**). The increasingly frequent use of anticoagulants in the elderly population can complicate their management and sometimes result in a disastrous outcome even after a relatively trivial injury.

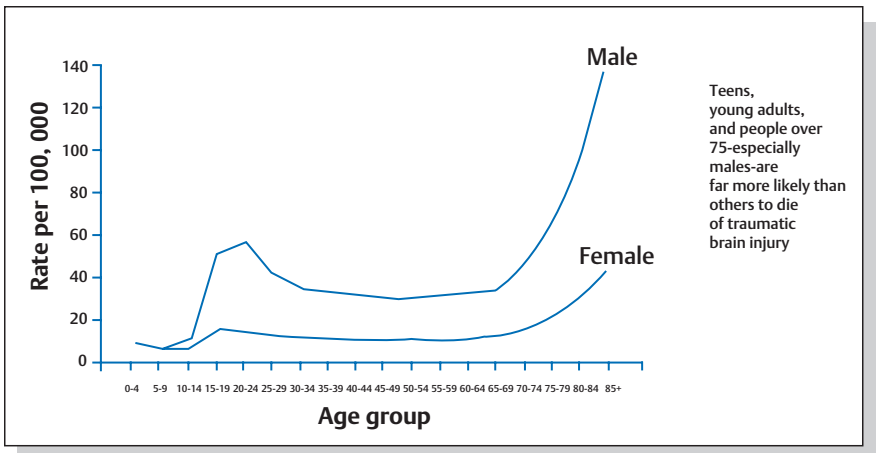

Fig. 1 Age distribution of traumatic brain injury.

For practical reasons, TBI is classified as mild, moderate, and severe. The vast majority of TBI is mild (80%), often seen in patients with brief loss of consciousness or temporary neurological dysfunction. Moderately injured patients have an altered level of consciousness and perhaps an asymmetric motor exam, but are usually able to follow simple commands. Severely injured patients are unresponsive and do not follow simple commands even after cardiopulmonary resuscitation. Severe hypotension or hypoxia can substantially impair the neurological examination. Furthermore, paralytic and sedative drugs can obviously obscure the exam. These confounding factors must therefore be kept in mind while assessing patients in the acute phase.

The Glasgow Coma Scale (GCS) is the most commonly used tool to classify TBI. It describes a patient's ability to open eyes, speak, and move limbs as per simple commands[2,3] (**Table 1**). A score of 15 is the maximum score and 3 is the minimum. Generally, a score of 14 to 15 is regarded as "mild," 9 to 13 as "moderate," and 3 to 8 as severe head injury. TBI can also be classified as closed (>90%) or penetrating, which occur due to gunshots, stabbing, shrapnel injuries, and so on.

Table 1 Glasgow Coma Scale to assess the severity of TBI in adults

Adult scale	
Eyes open	
Spontaneously	4
To speech	3
To pain	2
None	1
Best verbal response	
Oriented	5
Confused	4
Inappropriate words	3
Incomprehensible sounds	2
None	1
Best motor response	
Obeys commands	6
Localizes pain	5
Withdrawal from pain	4
Flexion to pain	3
Extension to pain	2
No motor response	1

Abbreviation: TBI, traumatic brain injury.

Importance of Guidelines

Emergency Medicine and Trauma Surgery are relatively new disciplines in India, with inconsistent prehospital care and trained ambulance services available only in a few urban settings. Even when personnel and infrastructure are available, most emergency medical personnel and physicians are not trained in trauma care, and often find it difficult to keep up with the literature and current recommendations.

The creation and implementation of evidence-based management guidelines in developed countries have resulted in a significant decrease in associated mortality and disability. The mortality from severe TBI in the United States has decreased from 51% in 1977 to around 20 to 30% currently. Contrary to the reasonable concern that some more patients would be saved only to survive in a vegetative state, recent data suggests that most of the survivors are categorized as good outcomes or moderately disabled.

Interestingly, not a single drug has been proven to have a beneficial effect during this period when mortality from severe TBI has been reduced by almost 50%! Certainly, more than any medication, this significant improvement has been realized by education, verified trauma systems and centers with full-time specialists, immediate access to CT scanning, emergency surgery when needed, specialized intensive care units and better monitoring of critically ill patients, and TBI rehabilitation. Our understanding regarding the cascade of events that follow TBI has also improved, resulting in more appropriate and targeted interventions.[4]

Although the dramatic decline in mortality and morbidity from TBI over the past three decades indicates improved care delivery, it is much harder to scientifically prove a direct cause-and-effect relationship. Nevertheless, there is some compelling evidence that the establishment of management guidelines and their implementation is very effective in reducing mortality and improving outcomes[5,6] (**Fig. 2**). For example, with the support of the Soros Foundation, the Brain Trauma Foundation was able to introduce surgeons in Croatia, Hungary, Slovakia, and Slovenia to TBI guidelines. This initiative resulted in a documented improvement in mortality.

The Indian TBI Initiative

We have taken a comprehensive approach to this major public health problem and separated our narrative into four phases:

- Awareness and Prevention: There is a need to improve public awareness regarding the seriousness and high incidence of TBI and increase commonsense preventive measures. As widely accepted, prevention is far more effective than the best treatments that can be offered. Despite this understanding, basic preventive measures such as helmets, seat belts, and air bags are only sporadically used across the country.
- Prehospital Care: This concept is in its nascent stages in India. Rescue squads have to be created and personnel appropriately trained.

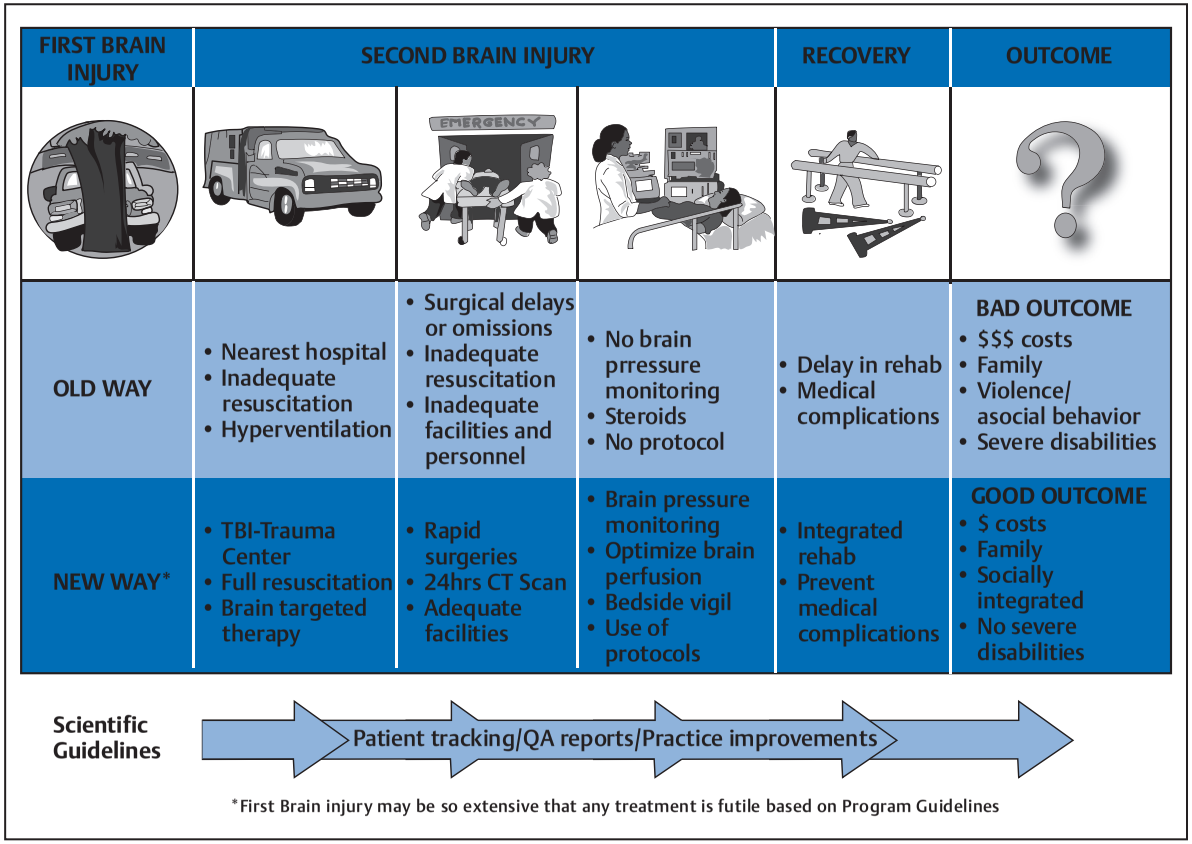

Fig. 2 Scientific guidelines: effective in reducing mortality and improving outcomes.

A systematic approach is essential, with designated trauma centers that are regularly inspected and their quality of care verified.

- Hospital Care: This requires Emergency Rooms that are adequately equipped and staffed doctors and nurses who are trained in trauma care. Level 1 and 2 trauma centers need adequate intensive care units, preferably staffed by Trauma and Neuro critical care specialists.
- Rehabilitation and Community Reintegration: Specialized TBI rehab programs that can assist TBI patients after hospitalization are greatly needed in India. Structured therapy to reintegrate the patient back into society is crucial and will be discussed.

The health care infrastructure in India has been making good progress in recent years. However, trauma care facilities are almost exclusively confined to large urban areas, and the vast majority of districts and rural areas do not have easy access to quality care. Furthermore, trauma care in the private sector is expensive and often not affordable and at present health insurance coverage is limited.

Need for TBI Guidelines

The level of care that patients with TBI receive in India is extremely variable. While a few urban centers of excellence meet international standards, others have trouble administering even first aid. A plausible reason is the lack of established standards or verification of trauma care hospitals or systems. The development of guidelines for trauma care delivery in other countries has resulted in marked improvements in outcomes.[7–14] It is essential that trauma centers be verified and designated by a reliable government or statutory agency.

There are no established protocols for prehospital care, patient triage, and treatment at different levels of hospitals or continuing care. Nationally accepted guidelines on management of TBI will help improve many of these shortcomings.

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2
Epidemiology of TBI

G. Gururaj

Traumatic Brain Injury in India

Traumatic injuries have emerged as a major public health problem in India in recent years. The rapid urbanization, unprecedented motorization, growing industrialization, and increasing impact of media along with changing lifestyles and values of people in the absence of safety policies and programs have contributed to this scenario. Even as India has made significant strides in the 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 have become a major cause of mortality, morbidity, and disability in India.

Among the various types of injuries, traumatic brain injury (TBI) is at the forefront, resulting in a significant number of deaths, hospitalizations, disabilities, and socio-economic losses. TBIs have a huge impact on individuals and families that represent an increasing burden on society at large. TBIs often affect young and productive members of society, and since most of them survive, they not only become unable to care for their families, but rather become a burden on them. The government is simply unable to deal adequately with this growing epidemic.

The importance of the magnitude of the problem due to TBI in India, has always been underestimated due to lack of proper research and good quality data. The development of robust epidemiological data helps in planning preventive strategies. The knowledge of the incidence, severity and the mechanism of injury, allow us to design appropriate health care services from subacute and emergency medicine to neurorehabilitation and also determines the training needs of the healthcare workforce. It also gives us an estimate about future socioeconomic needs to minimize the burden on wider society and governments.

Incidence and Mortality

The current assessment of the frequency of TBIs in India is limited due to lack of good quality population-based information in this area. There have been no large-scale epidemiological studies in the country. Apart from absence of community-based epidemiological studies, trauma registries as seen in high-income countries (HICs) do not currently exist in India. Further, the available data from the existing national sources of health and police sectors have inherent limitations due to inconsistent reporting. A small number of studies

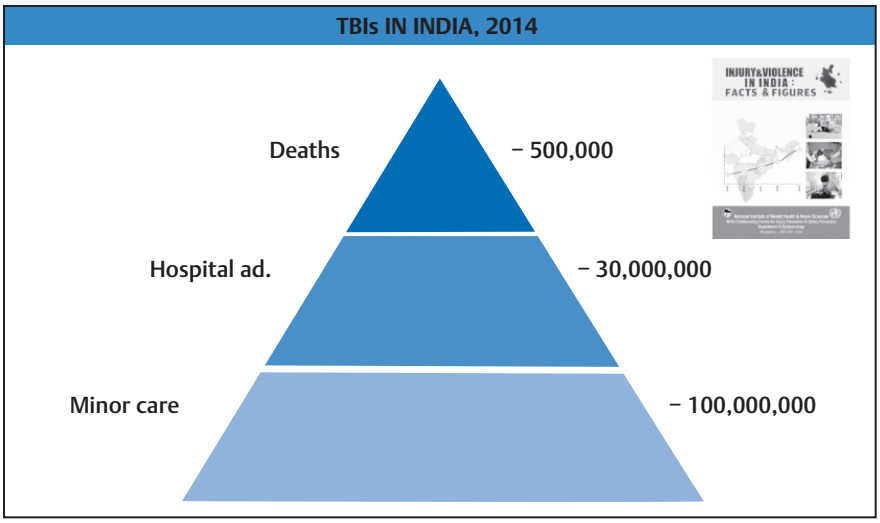

Fig. 3 Data (2014) from National Mortality Survey for traumatic brain injury (TBI) in India.

from individual medical centers provide a limited snapshot of the problem but cannot be accurately generalized in this vast and diverse country.

- Estimates from the Global Burden of Disease, World Health Organization, and few independent estimates confirm these observations by reporting more than a million deaths and nearly 50% of them being TBIs.[1,2] 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 500,000 deaths every year due to TBIs in India (**Fig. 3**).
- Interestingly, the case fatality rates of TBIs, especially in apex institutions and advanced trauma care centers, seem 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.

Nonfatal TBIs

Several hospital-based studies indicate that nearly half of the injury deaths and hospitalizations have an injury to the brain or spine at admission time, and consequently, it is estimated that about 500,000 TBI-related deaths occur every year in India. Furthermore, for every death nearly 30 to 50 people are hospitalized and consequently it is estimated that a minimum of 15 million moderate-to-severe TBIs are seen in India.[3] A recent national review of road safety in India, based on data from the 5-year Bangalore Road Safety and Injury

Prevention Program, has indicated that nearly 20% of ER Registrations, 10% of admissions, and one-third of hospital deaths are due to injuries and more than half of them have a TBI.[4] The prevalence of TBIs is not clearly known and a population-based study undertaken in Bangalore reported a prevalence of 94/100,000 population in rural Bangalore.

External Causes of TBIs

Among the various external causes, road traffic injuries, falls, workplace injuries (industrial/agricultural), violence, sports injuries, and those resulting during disasters account for the majority of TBIs. The problem, profile, and pattern of TBIs due to these external causes vary and are influenced by several macro and micro factors.

Epidemiological studies of neurotrauma indicate that road traffic injuries account for 60% of TBIs with falls and assault making up most of the rest. 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 miscellaneous causes. With road deaths increasing at an annual rate of 5 to 8% a year, the number of TBIs is also likely to increase at a corresponding pace in the coming years. As per the WHO, road crashes will be the fifth leading cause of death in India by 2030.

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

Most significantly data indicate that in India pedestrians, two-wheeler riders and pillions, and bicyclists constitute the majority of road traffic victims in India, as compared to high-income countries where motor vehicle occupants make up a much larger proportion.

The precise causes for the high incidence of road traffic accidents in India are still to be fully delineated. However, available research indicates that some of the risk factors include road design and operating factors, safety features of the vehicles, nonuse of helmets, seat belts, and child restraints, drinking and driving, driving at excessive speeds, poor visibility, the lack of pedestrian sidewalks, and discipline.

Patterns of TBIs

Limited data from India indicate that as seen in other parts of world, cerebral concussions, contusions, skull fractures, and traumatic intracranial hemorrhages (epidural, subdural, and intracerebral) are the usual injuries seen.[5] The severity distribution indicates that at least 60% of TBIs are classified as mild, 20% are moderate, and 15 to 20% are severe in nature. This proportion of mild TBIs is usually reported as 80% in western studies—perhaps because milder injuries do not always make it to tertiary centers in India.

Studies have also indicated that nearly a quarter of the injured persons are likely to have polytrauma and require prompt and intensive management.

Disability

It is well acknowledged that nearly all patients with severe TBI, 50% with moderate TBI, and 10 to 20% of those with mild TBI need rehabilitation services including physical, psychosocial, vocational, and economic rehabilitation. Based on available limited data, it is estimated that nearly 5 million Indians with a TBI require rehabilitation services.[6]

Trauma care services in India are evolving in India, even though distinct differences exist in availability, accessibility, and affordability between urban and rural areas. Apart from a major focus on primary prevention of RTIs, trauma care services that integrate emergency, in-hospital, and postdischarge care built on a combination of required human resources, facilities, and services that provide evidence-based care can significantly reduce deaths and disabilities.[7] The high burden of injuries and TBIs in India needs the urgent attention of policy makers, professionals, and political leaders, as global evidence has clearly demonstrated that these are eminently predictable and preventable.

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3
Prehospital Care Guidelines

V. D. Sinha and Amit Chakrabarty

Brain resuscitation should be started at the earliest as the traumatized brain is very susceptible to hypoxia and ischemia, and this makes prehospital care a crucial link in the chain of trauma care. Prehospital and emergency care has been a major issue in India, and it has been estimated that up to 20% of injured patients die after accidents because of inadequate treatment prior to hospitalization. The first 60 minutes after the trauma have been identified as the critical period for transporting patients from the scene of accident to a health-care center, preferably a trauma center and has been called as the "golden hour". The benefits of providing definitive resuscitative care within this early window have been widely acclaimed worldwide. Several studies in trauma literature have found reduced odds of dying with reduced prehospital times and first-aid care. The 'Golden hour concept' is now being fortunately getting accepted, at least in some metropolitan cities in India. The morbidity and mortality of severe head injury could be remarkably reduced by simply securing and maintaining the airway and stopping any external bleeding before arrival at the hospital. In the Indian setting, the prehospital guidelines are meant for any personnel involved in the prehospital response team such as the retrieval individuals, transporters, emergency room staff, medical personnel, specialists and health care workers. The training of the prehospital emergency personnel is often limited, and this can make a tremendous difference, especially when transfer times are long. There is a significant need to increase basic life support (BLS) emergency medical service (EMS) on site, and improved use of advanced life support (ALS) EMS systems.

Ideal Circumstances

In an ideal situation three critical tasks must be rapidly performed by prehospital providers caring for trauma victims:

- Examination with recognition of severe injuries and injuries with potential to cause rapid decompensation.
- Stabilization and transport to a hospital capable of addressing the identified injuries.
- Performance of an efficient triage with multiple victims.

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. Performing full spinal immobilization is prudent; prolonging scene time to initiate intravenous lines, bandage nonhemorrhaging wounds, or splint minor fractures is unnecessary and potentially deleterious.

Airway and Breathing

The airway must be assessed first in all trauma patients:

- If the patient can talk then the airway does not need immediate intervention.
- Noisy breathing is a sign of airway compromise requiring immediate intervention: Use a jaw thrust, remove foreign bodies from the mouth, perform an oral suction, and then insert an oral airway.

It is important in the prehospital setting to protect the airway of head-injured patients in the least invasive manner possible. An oral or nasal airway (with oral suction) is often sufficient if the airway is compromised, and the patient is breathing adequately. If the breathing is inadequate, then a definitive airway is indicated. If transport time is brief, often bag-mask ventilation (BMV) alone is sufficient, but in most cases with inadequate breathing either a laryngeal mask airway (LMA) or endotracheal intubation will be required. At all times care must be taken to maintain cervical immobilization as best as possible.

High-flow oxygen must be supplied to all trauma patients as soon as the airway and breathing are secured. Oxygen saturation should be continuously monitored with a pulse oximeter and the saturation maintained >90%.

Blood Pressure

All efforts must be made to keep the systolic blood pressure >90 mmHg in adult trauma patients.

- Control external hemorrhage with compression and bandaging.
- Splint long bone fractures, especially in the lower limbs.
- The decision to start IV fluids on the scene depends on the severity of hypotension and the estimated time to hospital. Fluids should be isotonic and not contain dextrose and administered at the maximum possible rate. If there is no hypotension, patient transfer should not be delayed by starting IV lines.

The blood pressure should be monitored frequently during resuscitation and transport.

Cardiac Arrest

If there is no palpable pulse, then basic life support must be started and continued without interruptions until the patient is taken over by the hospital team.

Glasgow Coma Scale Score

Prehospital measurement of the Glasgow Coma Scale (GCS) is a reliable indicator of the severity of TBI but should not be assessed until oxygenation and blood pressure have been normalized. Repeated assessment should be performed to identify improvement or deterioration over time. The adult protocol for standard GCS measurement can be followed for children over 2 years of age. In preverbal children, the pediatric GCS should be employed, with a full verbal score of 5 assigned to infants cooing or babbling.

Pupil Examination

Pupils should be assessed in the field for use in diagnosis, treatment, and prognosis. Pupillary examination should be done only after primary resuscitation, and the size and reaction of the pupils must be assessed. Left and right pupillary findings must be recorded separately, and asymmetry is defined as >0.4 mm difference in diameter.

Limited Resources

In many locations in India, the personnel available for retrieval of trauma patients do not have the training or the equipment to provide the interventions described above. It is important that these personnel are made aware of what they can do, besides just transporting the patient. These basic interventions for airway and blood pressure can be performed with no/minimal equipment and will result in significant improvements in the outcome of the patient.

Protocols

It is important that each area formulate realistic protocols for the situation on the ground in that region. For example, having a protocol that requires intubation as the intervention for a compromised airway when the majority of personnel do not have the necessary training will only result in no intervention being carried out and the airway remaining compromised during the entire transport. If they are taught that the minimal intervention is still better than none it is more likely that the patient will benefit. This is often not done because the organization will feel that accepting these lesser interventions is compromising their standards, but this will actually improve patient outcomes and must be seen as necessary.

Protocols are necessary regarding patient transport to appropriate facilities depending on the patient's clinical status; this is a regional decision and cannot be prescribed from a central organization.

Airway and Breathing

The process of assessment does not change—if the patient is not talking then the airway is at risk.

- If there is no noisy breathing and the chest is moving adequately no intervention is required, but this should be regularly checked during transport.
- If the breathing is noisy, clear out the mouth with a jaw thrust, perform an oral suction, and insert an oral airway. Repeat suction as often as necessary.
- If suction or artificial airway are not available and the breathing remains noisy, turn the patient semiprone—this will move the tongue away from the back of the throat and allow secretions or blood to flow out of the mouth.
- If the breathing is inadequate after clearing the airway and a definitive airway is not possible, attempt bag-mask ventilation and transport the patient as rapidly as possible to the nearest hospital where a definitive airway can be placed.

In all cases high-flow oxygen must be started soon after these interventions.

Blood Pressure

If blood pressure measurement is not possible, the retrieval personnel can be taught to assess pulse rate and volume.

- Control all external hemorrhage with compression and bandaging.
- If the expertise to start IV lines is not available and the blood pressure is low the patient must be transported to the nearest medical facility for this purpose before further transport to a trauma center.

4
Hospital Care Guidelines

Sumit Sinha and Mathew Joseph

Levels of Care

Traumatic brain injury (TBI) patients are treated in both government facilities and private hospitals. Government hospitals are generally overburdened, with inadequate manpower, resources, and equipment for the patient load. Available personnel and their skills often do not match the needs of the patients, and the concept of a dedicated trauma team has generally not been established. Small hospitals mushrooming across India label themselves as trauma centers but provide inadequate care with high mortality rates. Privately provided high-level care is expensive and therefore unaffordable to a majority of trauma patients.

Hospitals need to be categorized by the resources they have, to ensure that patients are appropriately managed at the level of care they need. Patients with significant injuries should not be retained at smaller hospitals, and at the same time there should not be unnecessary referrals and overcrowding of the higher-level hospitals.

- *Level 1 hospitals*: should have round-the-clock computed tomography (CT) scan facilities, neurosurgical and neurocritical care, and the ability to manage major trauma of other systems. They should be able to handle head injuries of any severity.
- *Level 2 hospitals*: should have round-the-clock CT scan facilities and a neurosurgeon on call available within an hour. These hospitals usually have limited ICU facilities and full-fledged neurocritical care is not possible. These hospitals should treat moderate head injuries, as well as minor head injuries requiring neurosurgery.
- *Level 3 hospitals*: are hospitals where round-the-clock CT scan and most other trauma services are available, but no neurosurgery is available. There should be an established method of obtaining a remote neurosurgical consultation. Patients with moderate and mild head injuries can be managed here depending on the CT findings after consultation with the remote neurosurgeon.
  - Any abnormal CT scan should be referred to a higher level if transfer time to neurosurgical care is more than 2 hours.
  - Liability issues for the consulting neurosurgeon need to be sorted out.
- *Level 4 hospitals*: do not have CT scan facilities but are able to stabilize airway, breathing, and circulation (ABC) and might have other trauma services. Patients with TBI who do not require CT scans can be treated at these hospitals.

Emergency Management

At arrival in the hospital the immediate focus must be on the ABC, and any assessment of the TBI must begin only after the necessary interventions for the ABC have been initiated.

Monitoring

Airway

Judging the patency of airway in a nonintubated 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.

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

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 SpO_2 on a pulse oximeter (normal SpO_2 while on supplementary oxygen does NOT indicate adequate breathing).

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.

- Noninvasive blood pressure.
- Invasive blood pressure—if significant instability present or on vasoactive drugs.

Intervention

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, 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.

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).

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 caliber 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—FAST and urgent surgical consultation if positive.
  - Pelvis—apply binder.
  - Femur—splint.

- Continue to administer crystalloids rapidly and monitor pulse and blood pressure.
- After more than one liter 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.

The treating personnel should examine and make every effort to exclude, especially in an unconscious patient, the easily overlooked causes of hypotension such as cervical spine injury, abdominal injury, pelvic fractures or fractures of long bones.

Limited Facilities

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 ABC remains unchanged and should be documented for the benefit of subsequent management.

Airway

If a definitive airway (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 semiprone so that oral secretions/blood flow out of the mouth.
- If an oral airway is not available, turn the patient semiprone.

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.

- 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 en-route.

Management of TBI

The principal focus of treatment in TBI is to limit secondary brain injury. This treatment is therefore aimed at optimizing oxygenation, blood pressure, intracranial pressure, and maintenance of adequate cerebral perfusion. It is also important to manage temperature, glucose, seizures, and other causes of potential secondary brain insults. All personnel involved in monitoring a head injury patient *must* be trained to assess the Glasgow Coma Scale and pupils. The following sections deal with the treatment of TBI in a hospital that has the necessary personnel and equipment for the purpose.

Criteria for Admission

The decision on where to admit the patient (emergency ward, regular ward, or ICU) will depend on the availability of facilities for monitoring and treatment at each institution, and these policies should be clearly defined to avoid any confusion. The following are the criteria for admitting a patient with TBI:

- History of loss of consciousness or amnesia.
- Age >65.
- Glasgow Coma Scale (GCS) score <15.
- Deteriorating GCS score.
- Focal neurological deficits.
- Posttraumatic seizure.
- Suspected skull fracture or penetrating injury.
- Drug or alcohol intoxication.
- Patient on antiplatelet drugs or anticoagulants.
- History of coagulopathy.
- Other significant injuries.
- Cerebrospinal fluid leak.
- No responsible caregiver after discharge.
- Persistent headache, photophobia, nausea, or vomiting.

Criteria for Performing a CT Scan

A CT scan should be performed when breathing and hemodynamic status allows transport.

- GCS score less than 13 on initial assessment.

- GCS score less than 15 at 2 hours after the injury.
- Amnesia for the event.
- Suspected penetrating or depressed fracture.
- Suspected base of skull fracture (hemotympanum, "panda" eyes, cerebrospinal fluid leakage from the ear or nose, Battle sign).
- Posttraumatic seizure.
- Focal neurological deficit.
- Two or more episodes of vomiting.
- Patient on antiplatelet drugs or anticoagulants.
- History of coagulopathy.
- Persistent headache, nausea, giddiness, restlessness.
- Before clearance for anesthesia for other injuries (do not delay emergency surgery to control hemorrhagic shock).
- Tense anterior fontanelle (in infants).

Indications for a Repeat CT Scan

- Deterioration of GCS score.
- New onset or worsening focal neurological deficit.
- Persistent headache, vomiting, or restlessness.
- Bradycardia, hypertension.
- Abnormal initial CT scan (repeat at 24 hours or earlier if indicated).

Note: There is evidence that the radiation exposure from a CT scan can damage the brain of children <5 years old. Modern CT scanners have pediatric settings to decrease this exposure—make sure they are used.

The NTSI does not at this time recommend MRI scans for children with acute TBI.

Monitoring

Parameters to be monitored outside the ICU:

- Pulse.
- Blood pressure.
- Clinical assessment of airway and breathing.
- Temperature.
- GCS 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 monitoring:

- Monitoring depends on severity of injury and capabilities of the system. For a patient who is being ventilated, EKG, invasive blood pressure (or frequent automatic noninvasive), pulse oximetry, and end-tidal carbon dioxide measurements should be monitored.
- If intracranial pressure (ICP) monitoring is possible then it should be done for:
  - All salvageable patients with GCS of 3 to 8 and abnormal CT.
  - In patients with GCS of 3 to 8 with normal CT if two or more of the following are present:
    - Age > 40 years.
    - Unilateral or bilateral motor posturing.
    - SBP < 90 mmHg.

The gold standard monitoring technique is an intraventricular catheter connected to an external strain gauge. Current intraparenchymal monitors are also accurate, but other techniques such as subarachnoid bolts are no longer accurate enough to recommend. There is intense research into noninvasive monitoring, but it is not yet in general use.

Fluid–Electrolyte Management

- Patient must be well hydrated, initially with isotonic fluids that do not contain dextrose.
- Hydration monitored by:
  - Pulse, BP.
  - Urine output and color.
  - Intake/output chart if possible.
- Hyperosmolar agents should be administered via a central lined.
- Adjustments must be made for increased temperature/motor activity.
- Enteral feeds must be established as early as possible.

Monitoring electrolytes:

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

Anticonvulsants in TBI

A loading dose of anticonvulsant should be administered to all patients who require admission. The commonly used drugs are phenytoin, fosphenytoin, and levetiracetam. There is no evidence that administration of anticonvulsants for more than a week is beneficial, and the medication generally should not be continued after discharge unless the patient had seizures during the admission.

Seizures Prophylaxis: In patients with seizures, phenytoin is recommended in order to decrease the incidence of early posttraumatic seizures (PTS) generally within 7 days of injury, when the overall benefit is thought to outweigh the complications associated with such treatment.[1]

Ventilation in TBI

Ventilation in TBI should be adjusted to maintain a pO_2 of at least 100 mmHg and a pCO_2 of around 35 mmHg. The pCO_2 should not be lowered below 30 mmHg except in very specific circumstances.

Treatment of Raised ICP

The basic treatment of potentially raised ICP is very important in all patients and is unfortunately often neglected.

- Head must be elevated above heart level.
- Neck must be in neutral position.
- Cervical collar must be removed as soon as the spine has been cleared.
- Airway and breathing must be normal.
- Blood pressure must be adequate.
- Temperature must be controlled.
- Seizures must be prevented.
- Sodium must be maintained.

When ICP is not monitored:

- Therapy for raised ICP should not automatically be started for all head injury patients. There must be some radiological or clinical evidence of possible raised ICP.
- Treatment should include measures to lower ICP and also to maintain an adequate blood pressure and thereby an adequate cerebral perfusion pressure (CPP).
- Osmotherapy: hypertonic saline, mannitol, or both in combination may be used. Mannitol is more effective in intermittent doses (1–2 g/kg/d) not more than 6 hours apart. Hypertonic saline may be administered either

continuously or as bolus doses to raise serum sodium up to 150 mEq/L (up to 160 mEq/L in children).

When ICP is monitored:

- ICP elevation above 22 mmHg requires intervention.
- CPP must be maintained above 60 mmHg, using vasoactive drugs if necessary.
- Response to elevated ICP:
  - Confirm accuracy of reading.
  - Ensure all systemic factors listed at the beginning of this section are controlled.
  - Vent CSF if an intraventricular catheter is in place.
  - Increase sedation and analgesia.
  - Osmotherapy.
  - Administer muscle relaxants.
  - Hyperventilate to a pCO_2 of 30 mmHg while preparing definitive intervention.
  - At some stage, especially before hyperventilation a CT scan must be repeated.
  - If ICP is not controlled with all medical measures and there is no lesion that can be surgically removed, then the options for treatment are:
    - Barbiturate coma (possible only in high-level ICUs).
    - Decompressive craniectomy.
  - Steroids should NOT be used for treatment of raised ICP.

Analgesia

Adequate analgesia is mandatory in all trauma patients and should be titrated to the severity of the soft tissue and skeletal injuries.

Sedation

Sedation should be used by experienced personnel. Short-acting medications are preferred.

- Emergency room:
  - Agitation.
  - For procedure.
  - Securing airway.
  - Splinting, lines.
- ICU:
  - Ventilation (as an infusion).
  - Procedures.

- Non-ICU areas:
  - Extreme caution because of decreased intensity of monitoring.
  - Drugs—quetiapine/risperidone/haloperidol/midazolam.

Infection Prophylaxis

There is no indication for administering prophylactic antibiotics in TBI. Antibiotics should not be administered for CSF rhinorrhea/otorrhea, insertion of ICP monitoring device, or for ventilation unless there are other indications of an active infection. Antibiotics can be given for scalp lacerations and compound depressed fractures that do not require surgery.

Operative Therapy (Timing, Indications)

Decisions regarding the need, timing, and type of surgery are left to the individual neurosurgeon managing the patient. Uncontrolled rise in ICP or clinical signs of herniation are indications for immediate surgery.

Discharge and Follow-Up

It is important that all patients after a TBI are sent home with a responsible caregiver who understands the symptoms for which the patient may need to return to the hospital.

From the emergency room:

- If there is no indication for admission or CT scan by the criteria mentioned above the patient can be sent home after any necessary first aid and treatment of other injuries.
- If the CT brain is normal, the patient has a normal sensorium and there are no other indications for admission.

Discharge after observation/treatment:

- This decision has to be made by the treating team. In an ideal situation all patients should return to independent function before being sent home either from the acute care ward or from a rehabilitation facility. In actual practice this is often not possible due to the pressure to admit new cases of acute TBI, and therefore patients are often discharged early. In this situation an assessment must be made on whether the patient requires in-patient treatment at a lower-level hospital or if the family can be trained to take care of the patient at home. Level 1 and level 2 hospitals should reach out to lower-level hospitals to establish systems by which patients can continue to receive medical (nonneurosurgical) care in a hub and spoke model.

Discharge advice:

- In all cases it is important to give verbal and printed discharge advice to patients with any degree of head injury and their families and caretakers. This advice should include:

- Details of the nature and severity of the injury.
- Details about the recovery process including the possibilities of later difficulties or complications. Symptoms that require a return for neurosurgical investigation should be emphasized.
- Information on when to return for follow-up and further treatment.
- Information about return to everyday activities including school, work, sports, and driving.

Reference

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5
Neurorehabilitation after Traumatic Brain Injury

Dhaval Shukla

Rehabilitation is the combined and coordinated efforts of a physician supervised multidisciplinary 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. About 10 to 15% of patients following mild TBI, 40 to 50% after moderate, and almost 100% after severe TBI have one or the other disability, requiring rehabilitation.

Evaluation

- 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.
- Any patient with TBI who has persistent and stable neurological deficit, and who requires medical monitoring and has impairment in two or more key domains should be transferred to an in-patient neurorehabilitation facility.

Recommendations for Neurorehabilitation Facilities

- There should be provision for inpatient rehabilitation beds, manpower, equipment, and space to provide optimum care in proportion to acute care.
- Each Level I center managing traumatic brain injury must have integrated multidisciplinary in-patient rehabilitation services.
- It is recommended for Level II center managing TBI to have integrated multidisciplinary inpatient rehabilitation services.
- If in-house rehabilitation facilities are not available then a referral to a rehabilitation physician (physiatrist) should be done, and treatment plan should be obtained for rehabilitation in nursing home or at home.

Rehabilitation Team

1. Rehabilitation physician (Physiatrist).
2. Neuropsychologist.
3. Speech and language pathologist.

4. Physical therapist.
5. Occupational therapist.
6. Rehabilitation nurse.
7. Orthotist.
8. Social worker.
9. Access to other medical specialties as best available in the setting.

Recommendations for Nursing Homes Where Rehabilitation Facilities Are Not Available

In-Patient Management

Disorders of Consciousness

- Prognosis is not universally poor in patients with disorder of consciousness.
- No patient should be labeled as "vegetative state (VS)" during acute care.
- Periodic assessment using Coma Recovery Scale-Revised should be done to know whether the patient is in unresponsive wakefulness syndrome (UWS), minimally consciousness state (MCS), or emerging from MCS.
- Prescribe amantadine (100–200 mg bid) for adults with traumatic VS/UWS or MCS (4–16 wk postinjury) to hasten functional recovery and reduce disability early in recovery.
- Predicting a timeline for coma recovery is difficult, as it mainly depends on the severity of the person's brain injury.
- The general time periods of recovery are following; however, these may vary from individual to individual:
  - Patients who reach an MCS within 3 months have a high likelihood of regaining full consciousness.
  - Recovery after TBI is fastest between 3 and 6 months after injury.
  - The speech and mobility improve between 6 months and 2 years.
  - Recovery slows down or plateaus 2 years after injury.
- Patient should be re-evaluated with imaging when the recovery halts or there is regression of recovery process.
- Decision to discontinue care should not be made for at least 3 months after injury.
- Decision to discontinue care should be made after repeated consultation with neurosurgeon, social worker, psychologist, and family.

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 to 3 hours (during day and night), always checking the skin for red marks that occur with prolonged focal pressure.

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.

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 bowel motility.
- Encourage water intake several times a day.
- Isabgol is a good stimulant for having regular bowel movements.
- Use Vaseline in anus to assist in removing impacted feces.
- A temporary catheter may be necessary for urinary retention.
- If used, keep the catheter clean.
- Urinary catheter tube should not be in between legs.
- Regularly check urine for color and smell.
- Dark brown urine is a sign of dehydration, and foul-smelling urine may need further evaluation for possible infection.

Reducing the Risk of Limb Deformity

- Change patient's position regularly; avoid same position for long duration.
- Regularly move both lower and upper extremities.
- Mobilize joints to full range passively (or actively if possible).
- If splints are used to prevent deformities 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 is 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.
- Baclofen appears to improve lower extremity spasticity, and its starting dose is 5 mg tid to maximum dose 80 mg/d.
- Tizanidine is effective for improving upper and lower extremity spasticity, and its starting dose 4 mg to maximum dose 36 mg/d.

Eating and Drinking

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 eating or drinking.
- Start with baby food, e.g., *halwa, khichdi, banana, ganjee*, etc.
- A caregiver 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.

Sleep and Rest

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

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 to stand and get balance before taking any step forward.
- Specific sit-to-stand training results in improved abilities.
- Conventional gait training with walker or handheld assistance under supervision, with verbal and tactile cues should be done.
- Aerobic exercise helps to reduce fatigue and improves social integration, physical independence, levels of spasticity, and overall mental health.

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 or shout very vigorously and be unable to control this very unpleasant behavior. The person may hit, pinch, 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.
- Move the patient to a quiet room and remain in that environment, away from other people, until they become calm.
- Avoid benzodiazepines (diazepam, lorazepam, etc.).
- Oral risperidone 1-2 mg/d or quetiapine (after ECG to rule out QTc prolongation) beginning at 25 mg twice a day may be given.

Out Patient Management

The following issues can be addressed at outpatient level:

- Speech and language.
- Headache.
- Vertigo.
- Cognitive rehabilitation.
- Psychiatric symptoms.
- Continuation of rehabilitation for motor impairments in ambulatory patient.

Indications for Referral to a Specialist

Neurosurgeon:

- Craniotomy site persistent pus discharge (maybe bone flap osteomyelitis).
- Cranioplasty for patients who have undergone decompressive craniectomy.
  - Usually 3 to 6 months after injury.
  - May consider early if patient has recovered and ready to go for work, scalp is sunken, and local headache.
- Posttraumatic hydrocephalus:
  - Suspect when recovery 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).
- Posttraumatic headache not responding to NSAIDs or amitriptyline.

Rehabilitation specialist:

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

Orthopedic surgeon:

- Heterotopic ossification:
  - 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 UWS/MCS.

Psychiatrist:

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

Outcome Assessment

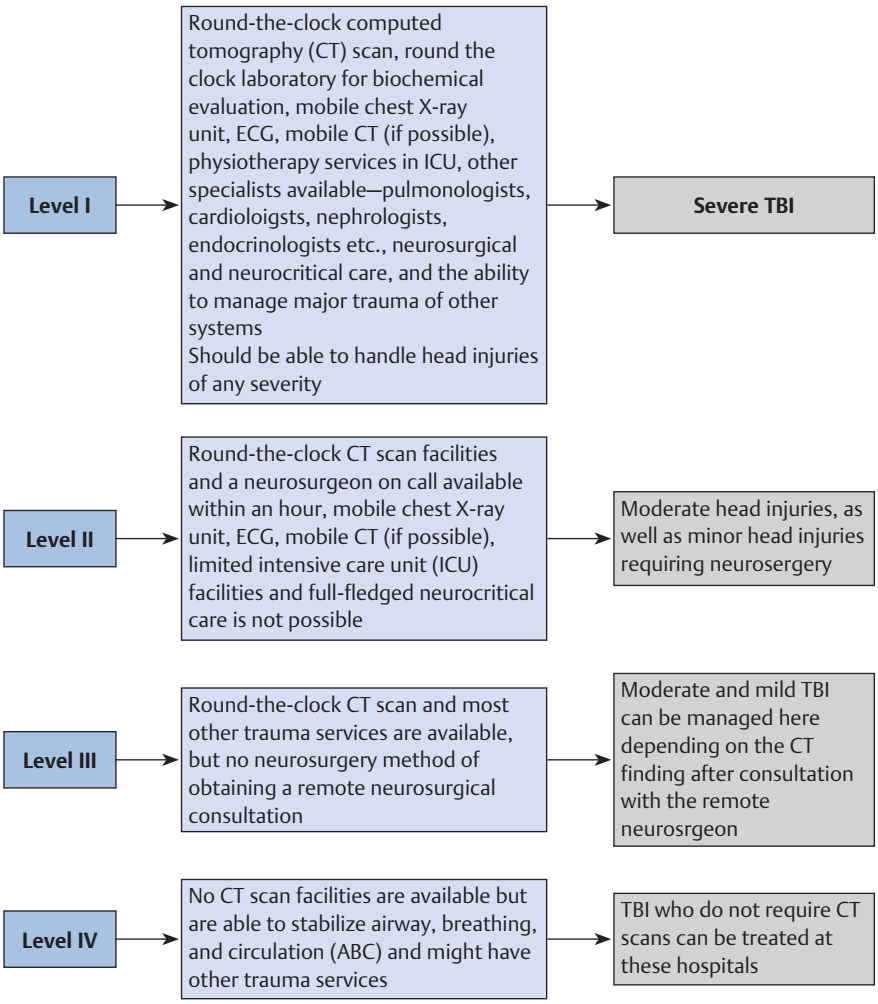
- Glasgow Coma Scale during acute care, and at time of discharge.
- Disability Rating Scale (DRS) at time of discharge from acute care.
- DRS at time of admission and discharge from in-patient rehabilitation.
- Glasgow Outcome Scale Extended (GOSE) at 6 months.

An app for GOSE is available on Google Play.

6
Summary and Conclusions

Sumit Sinha

IN-HOSPITAL CARE IN TRAUMATIC BRAIN INJURY (TBI)



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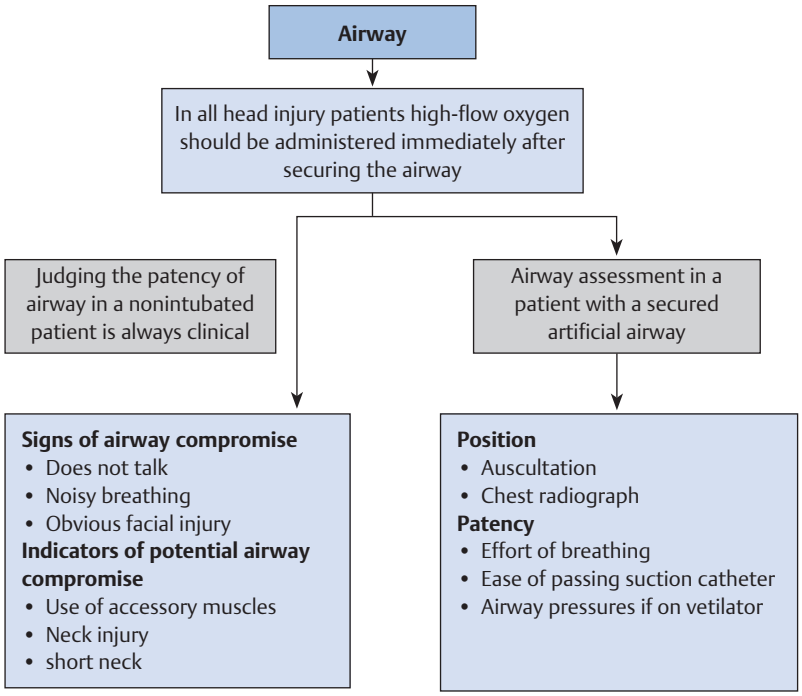

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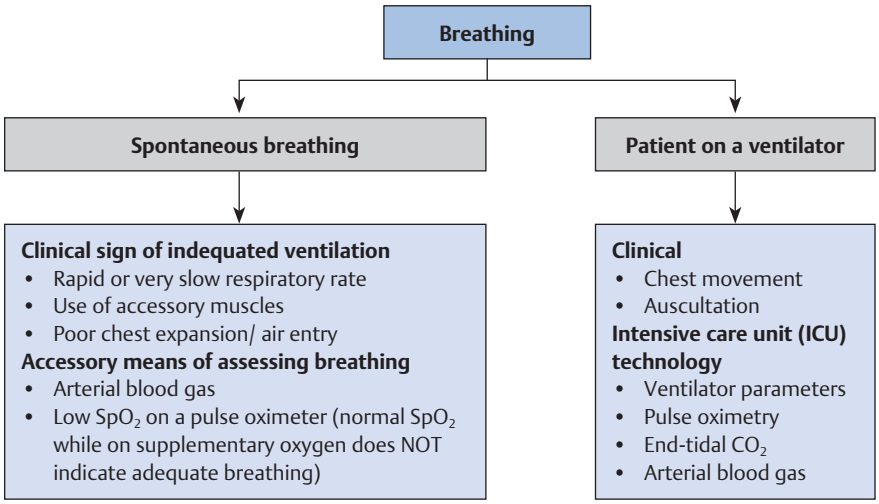

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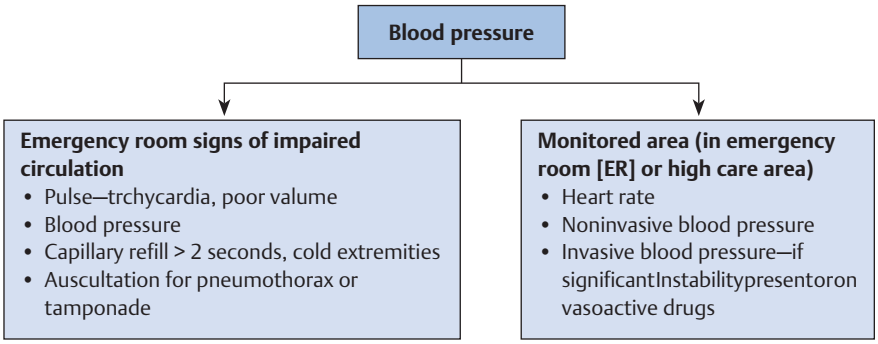

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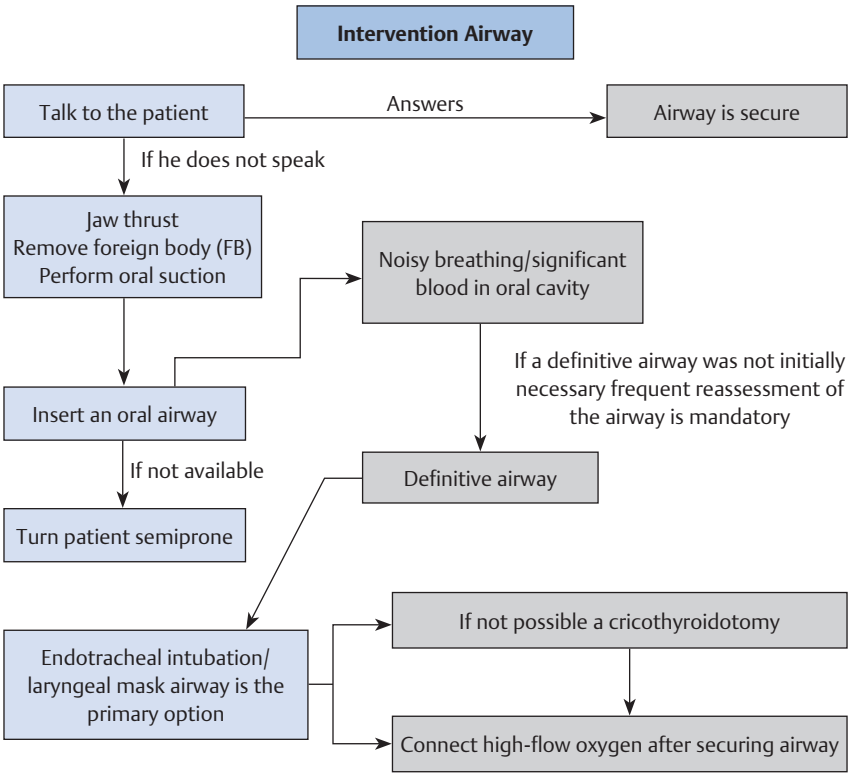

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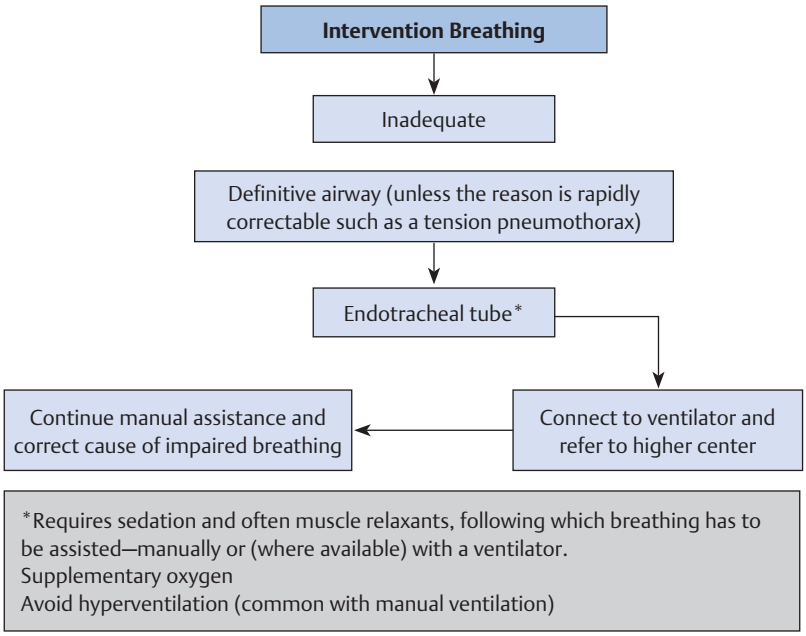

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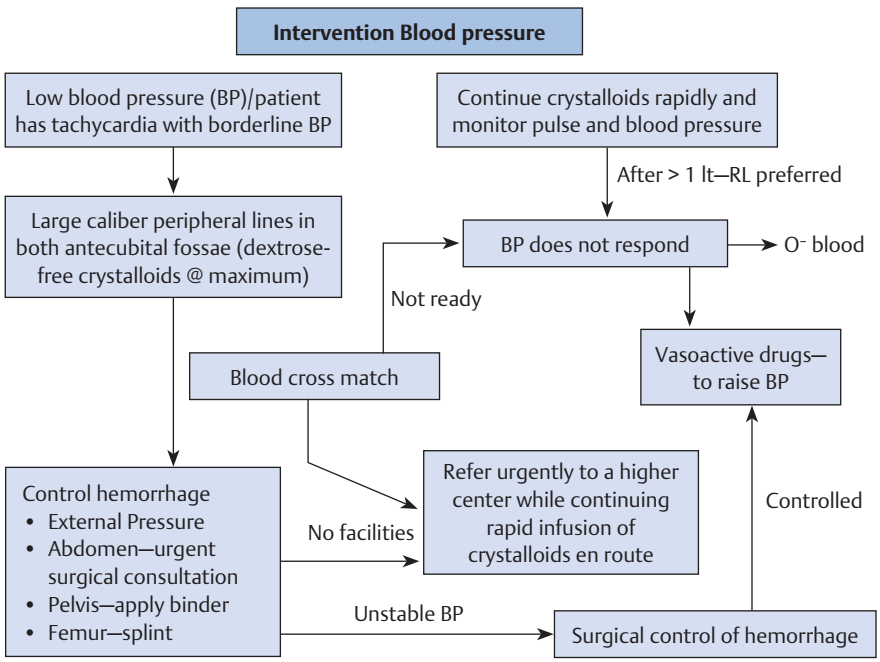


Head Injury—Gasgow Coma Scale (GCS)

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
• Inappropr words	3
• Incompr 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

Algorithm for Mx of mild head injury

- History
- G/E
- Neurological examination
- Skull X-Ray
- Cervical spine X-Ray
- Blood Alcohol levels

↓

Computed tomography (CT) head—ideally in all but completely asymptomatic patients

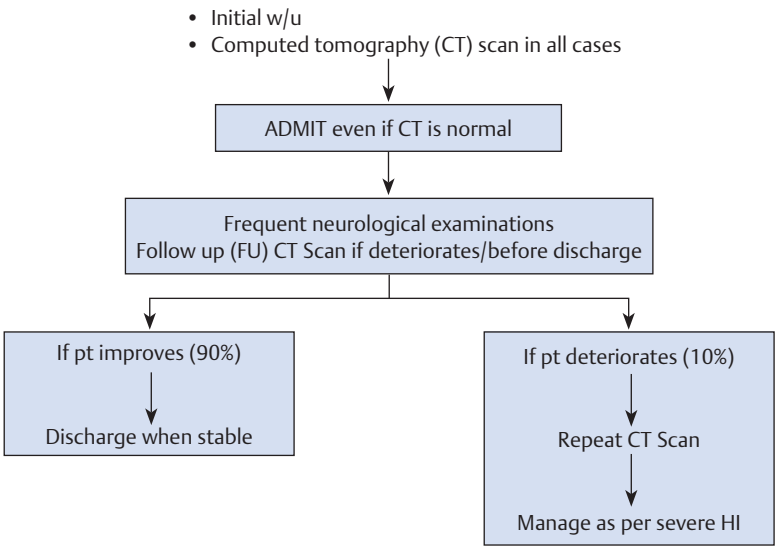
Admit

- Amnesia
- H/o loss of consciousness (LOC)
- Deteriorating conciousness
- Moderate-to-severe headache
- Alcohol/drug intoxication
- Skull fracture
- Cerebrospinal fluid (CSF) leak
- Significant ass injuries
- Abnormal CT scan

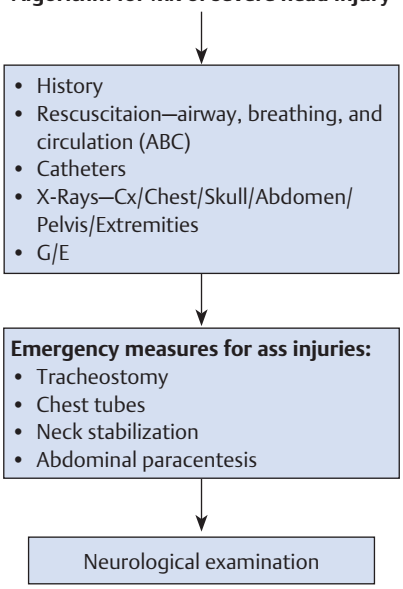
Discharge

- Does not meet criterion for admission
- Discuss need to return if problem

Algorithm for Mx of moderate head injury



Algorithm for Mx of severe head injury



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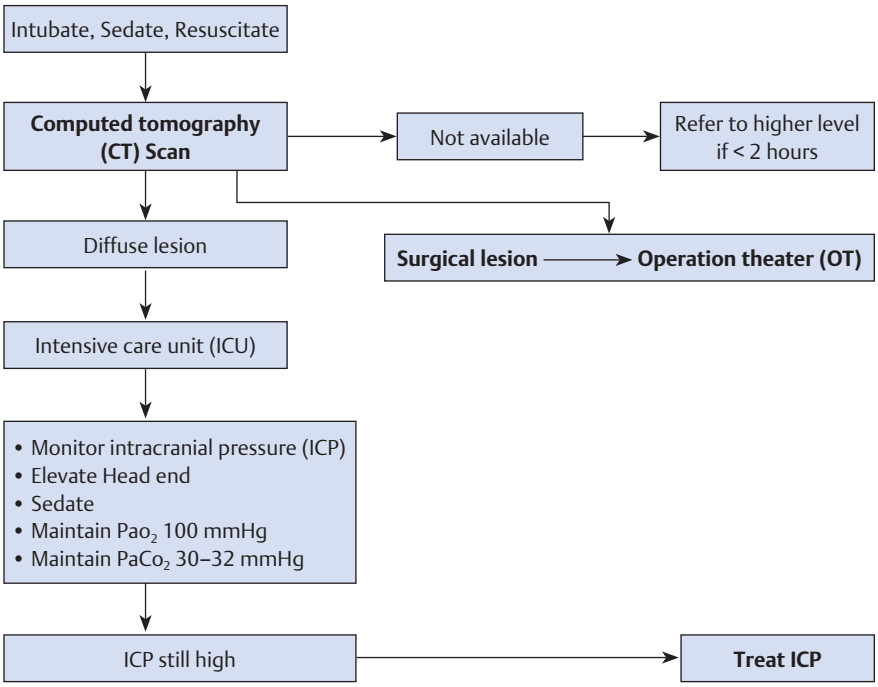

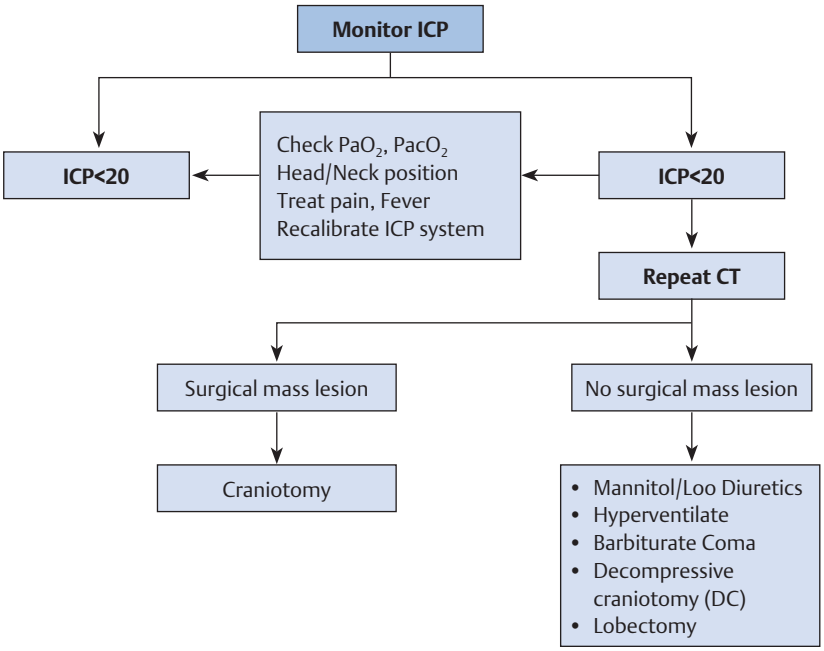

IN-HOSPITAL CARE IN TRAUMATIC BRAIN INJURY (TBI)

Criteria for performing a computed tomography (CT) head scan

Adults	Children
• Glasgow Coma Scale (GCS) < 13 on initial assessment in emergency department (ED) • GCS <15 at 2 hours after the injury in ED • Suspected open/depressed skull fracture • Any sign of basal skull fracture (hemotympanum, “panda” eyes, cerebrospinal fluid leakage from the ear or nose, Battle sign) • Posttraumatic seizure • Focal neurological deficit • > 1 episode of vomiting	• Posttraumatic 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 (hemotympanum, “panda” eyes, cerebrospinal fluid leakage from the ear or nose, Battle 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 m, high-speed injury from a projectile or other object) • Amnesia (antegrade/retrograde) > 5 minutes

The need for the development of guidelines for the management of traumatic brain injury (TBI) has long been a matter of concern to the treating medical personnel, and its importance has been recognized ever since improvements in TBI outcomes have been reported after the adoption of similar guidelines by the more developed nations across the globe. The Neurotrauma Society of India (NTSI) in collaboration with the Neurological Society of India (NSI) took up the mammoth responsibility of bringing forth these India-centric guidelines in a concise and comprehensive manner. A logical effort has been made to make these guidelines as practical as possible, depending upon the resources available at the treating hospital, rather than keeping them "ideal" but impractical to follow. These guidelines are expected to bring about an enormous change in the management of TBI across the country, especially if followed by the treating doctors, thereby improving the outcomes of TBI.

—Neurotrauma Society of India (NTSI)

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