

# Traumatic Brain Injury in Mumbai: A Survey of Providers along the Care Continuum

## Abstract

**Introduction:** Traumatic brain injury (TBI) represents a significant burden of a global disease, especially in low- and middle-income countries (LMICs) such as India. Efforts to curb the impact of TBI require an appreciation of local factors related to this disease and its treatment. **Methods:** Semi-structured qualitative interviews were administered to paramedics, anesthesiologists, general surgeons, and neurosurgeons in locations throughout Mumbai from April to May 2018. A thematic analysis with an iterative coding was used to analyze the data. The primary objective was to identify provider-perceived themes related to TBI care in Mumbai. **Results:** A total of 50 participants were interviewed, including 17 paramedics, 15 anesthesiologists, 9 general surgeons, and 9 neurosurgeons who were involved in caring for TBI patients. The majority of physicians interviewed discussed their experiences in public sector hospitals (82%), while 12% discussed private sector hospitals and 6% discussed both. Four major themes emerged: Workforce, equipment, financing care, and the family and public role. These themes were often discussed in the context of their effects on increasing or decreasing complications and delays. Participants developed adaptations when managing shortcomings in these thematic areas. These adaptations included teamwork during workforce shortages and resource allocation when equipment was limited among others. **Conclusions:** Workforce, equipment, financing care, and the family and public role were identified as major themes in the care for TBI in Mumbai. These thematic elements provide a framework to evaluate and improve care along the care spectrum for TBI. Similar frameworks should be adapted to local contexts in urbanizing cities in LMICs.

**Keywords:** Barriers to care, low- and middle-income countries, mortality, traumatic brain injury, urbanization

## Introduction

Traumatic brain injury (TBI) is among the highest causes of morbidity and mortality worldwide, especially in low- and middle-income countries (LMICs) where TBI incidence has remained persistently high.<sup>[1-3]</sup> The most frequent causes of TBI in LMICs are road traffic accidents due to the rapid urbanization of LMIC cities and lack of corresponding protective roadway and helmet laws.<sup>[3]</sup>

The mortality associated with TBI has remained constant in the past two decades in India, and long-term neurological sequelae of TBI continue to present a major burden for individual families and the state of India.<sup>[4-6]</sup> Efforts are underway to profile and curb the burden of TBI, and solutions to decrease its incidence should be specific to each location. We focus on Mumbai, the

most population-dense city in India and the third densest megacity in the world, since it typifies the rapid urbanization seen in major cities in many LMICs.

In this study, we conduct interviews with providers of care for TBI patients from the time of injury to the time of hospital evaluation, procedures, and discharge. Our objective is to characterize strengths and limitations along the care continuum for TBI in Mumbai to help provide a consolidated framework in developing priorities to reduce its burden.

## Methods

### Contextual factors

In Mumbai, there are multiple ambulance services, including the statewide 108 emergency response service. Most ambulances are stationed at the sites

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of frequent trauma, such as train stations. Ambulances are staffed with a paramedic, who receives training on cardiopulmonary resuscitation, wound care, and medical stabilization, and driver, who is not formally trained as a physician or a paramedic, but may help with patient stabilization when asked.

There are four government-funded trauma centers that manage the majority of traumas within Mumbai. These include Lokmanya Tilak Municipal General Hospital (LTMGH) and King Edward Memorial Hospital (KEMH). In the trauma ward, anesthesia and general surgery residents generally perform the initial evaluation and management of trauma patients and consult the neurosurgical team when there is a concern for TBI. These four large public trauma centers have a dedicated trauma operation theater (OT). Private hospitals in Mumbai require out-of-pocket payment by patients or their families for admission.

### Objectives

The primary objective of this study was to identify provider-perceived themes – including strengths and weaknesses – related to care for TBI in Mumbai. The secondary objectives included identifying portions of TBI care – including medical, surgical, and process factors – that were perceived to be efficacious and contrasting public and private hospitals' approaches to TBI care.

These questions were framed around the Lancet Commission for Global Surgery's organizational framework around safe, affordable, and timely care.<sup>[7]</sup>

### Study design

This was a qualitative, semi-structured survey of care providers for TBI patients in Mumbai, India. Three categories of participants were selected: Surgeons (including neurosurgeons and general surgeons), anesthesiologists, and paramedics. These participant categories were selected to include the physicians most directly involved in TBI care from stabilization in the field to eventual evaluation, management, and discharge from the hospital. Semi-structured interview questionnaires were developed for each participant category to address the aforementioned research objectives [Supplementary Files 1-3]. Questionnaires underwent multiple reviews (by SG, MK, HS, and VK) prior to their finalization and were piloted in Mumbai prior to implementation.

Interviews were conducted by the same interviewer (SG) in English or Hindi depending on the preference of the interviewee and were audio-recorded with no identifying information included in the recordings. All interviews were conducted in person during the on-duty shifts of interviewees.

### Participant sample

Convenience sampling was used to select interviewees based on professional contacts of two coauthors (MK and VK) and contacts of these interviewees. Interviews were conducted at the offices or wards of surgeons and anesthesiologists and the locations throughout Mumbai where paramedics were stationed. After identifying potential interviewees, all interviews were approached and consented to participate. In total, 60 participants were invited to participate, and 50 ultimately consented to be interviewed. Interviews were conducted from March 6, 2018, to April 23, 2018.

The sample was enriched in participants from LTMGH, the largest of four full-service trauma centers in Mumbai, and KEMH, one of three other full-service public trauma centers in Mumbai. Recruitment was stopped when response saturation was reached. All survey responses were included in the analysis.

### Coding manual and thematic analysis

Audio recordings in Hindi and English were transcribed by SG. Thematic analysis was then utilized as previously described.<sup>[8]</sup> Audio recordings were analyzed by SG to derive coding manual inductively, which were iteratively refined to arrive at the final coding manual used for this thematic analysis.

### Ethics approval

This study was approved by the LTMGH Institutional Ethics Committee (IEC06/18) and the Harvard Medical School Institutional Review Board (IRB17-2034). All participants provided written informed consent to participate in this study.

### Results

A total of 50 participants were recruited including 9 neurosurgeons, 9 general surgeons, 15 anesthesiologists, and 17 paramedics [Table 1]. All participants completed interviews.

#### Theme 1: Workforce

The amount of care providers available, referred to as the workforce, featured prominently throughout most interviews [Table 2].

Paramedics are stationed with a driver and no additional medical support, which occasionally limits care during transport, such as when patients need multiple interventions simultaneously. Paramedics receive help from police and family members. Mumbai's Government Railway Police and citywide police force often accompany paramedics during transport to provide assistance during transport. Family members are occasionally called to assist paramedics during transport by assisting with basic first aid tasks when they were

**Table 1: Profile of interviewees**

	Surgeons (n=18)	Anesthesiologists (n=15)	Paramedics (n=17)
Sex, n (%)			
Male	14 (78)	7 (47)	13 (76)
Female	4 (22)	8 (53)	4 (24)
Institution type, n (%)			
LTMGH	12 (67)	8 (53)	-
Other public	4 (22)	3 (20)	-
Private	1 (6)	3 (20)	-
Both	1 (6)	1 (7)	-
Training level, n (%)			
Attending	12 (67)	11 (73)	-
Resident	6 (33)	4 (27)	-
Specialty, n (%)			
Neurosurgery	9 (50)	-	-
General surgery	9 (50)	-	-
Interview length, median (IQR)			
Minutes	14 (12-20)	14 (10-18)	14 (11-19)

LTMGH – Lokmanya Tilak Municipal General Hospital; IQR – Interquartile range

**Table 2: Summative table of themes and thematic elements raised during interviews**

	Thematic elements	
	Positives	Areas of improvement
Workforce	Family involvement in prehospital and hospital care Consultant physician/surgeon availability	On-site medical support for paramedics Overcrowding in trauma bays Ancillary staff (PT/OCT/nursing) availability Lack of dedicated TBI teams
Equipment	Well stocked ambulances Motorbike ambulances CT scanners in trauma wards	Lack of hospital gurneys Equipment shortages and malfunctioning in ICU Increasing ICU beds ICP monitors Trauma OT availability
Financing care	Heavily subsidized public hospitals Social workers	Private to public transfers for affordability Occasional shortage of certain supplies/medications
Family/public role	Informing and aiding paramedics Increasing public awareness about ambulances Family assistance with prehospital and hospital care Government providing heavily subsidized care	

PT – Physical therapist; OCT – Occupational therapist; TBI – Traumatic brain injury; ICU – Intensive care unit; CT – Computed tomography; ICP – Intracranial pressure monitor; OT – Operation theater

present on scene. Trauma bays at public hospitals can be overcrowded due to a lack of ample registrars to process the incoming patients:

*“If there are 4-5 patients already in queue [at the trauma ward], then after that, you will be attended by the doctor... They take time to admit that patient, 15-20 min, sometimes half an hour. The patient is having bleeding and if the doctor attends to the patient after half an hour, then the patient deteriorates”* (Paramedic).

This overcrowding raises concern for paramedics, who noted that patients’ clinical condition can worsen during this wait. Physicians who receive patients in these trauma bays often do not have a notification system that tells them which patients are in queue and how to triage

them. However, neurosurgical care and other specialty consultations are available at all times of the day and week at all sites where interviews were conducted.

While nurse-to-patient ratios are noted to be as low as 1:1 in private hospitals, they are higher in public hospitals. Most hospitals have physical therapists (PTs) and occupational therapists (OCTs) to create rehabilitation plans and teach the families how to administer these plans at home. Workforce limitations of nursing and PT/OCT staffing were noted by participants to contribute to potentially preventable medical complications such as bedsores and infections.

Clinical teams dedicated to trauma patients exclusively are present in some hospitals and facilitated evaluation

and management. Paramedics suggest that each hospital receiving trauma patients should have a process of trauma triage and evaluation and a dedicated team to ensure an efficient patient handover. Physicians believe that specialized teams and operating theatres could result in tailored and higher quality care for TBI patients.

*“[For] pure neurosurgical head injuries, they should have a dedicated ward [and] dedicated ICU where everything from the palliative care, treatment, occupational therapy, physiotherapy, diet, and supportive care are all taken care of under one roof and with a dedicated team who is very isolated to taking care of these specific needs”* (Surgery attending, public hospital).

Where personnel shortages exist, such as in ambulances and in the wards, complications and delays could arise. Providers utilize teamwork – including with nonmedical personnel such as the help of families for rehabilitation on the wards – to mitigate the consequences of personnel shortages.

## Theme 2: Equipment

All parties are aided in their evaluation and management of TBIs by equipment and technologies [Table 2]. Nearly all paramedics mention that the equipment stocked in their ambulances, including basic first-aid material, cervical collars, suction, and supplemental oxygen, are critical in managing TBIs and are consistently well stocked by their management. They also discussed their new innovative motorbike ambulances, which allow them to maneuver through urban congestion and reduce a potential delay in care.

*“(The bikes) help us a lot. There was even a case today from the center here. I went on bike and a transport ambulance went. I headed out faster than the ambulance. As soon as I got there, I began management, [evaluated the patient], [followed] the ABC rules of trauma. I could see if the patient’s situation was down trending, and immediately [started] managing oxygen for example... The bikes just get there quickly and [allow] for a faster response. Life can be saved with these bikes”* (Paramedic).

Upon their arrival to some public hospitals, paramedics note that lack of hospital gurneys can result in the reliance of trauma ward physicians on the ambulance’s stretcher to transport patients for testing and imaging, which can delay paramedics’ return to their stations.

Anesthesiologists and surgeons discussed that having computed tomography scanners within trauma wards significantly reduces delays in diagnosis and facilitates management. Anesthesiologists made frequent use of multiparameter vital sign monitors, ventilators, and blood work in the trauma wards and intensive care units (ICUs).

Sometimes, there are not enough devices for each TBI patient who requires one in public hospitals.

*“If the ABG [arterial blood gas] machine suddenly goes out of order, then the technician comes to repair it like six hours later. So, for six-seven hours if we have a bleeding patient coming in, I would not be able to do his ABG, would not know if there is (an) acidosis and then arbitrarily, I would give sodium bicarb... I think all the doctors here have a good clinical acumen because of working with lesser facilities. But yeah, I think in the end patient care, it must be getting affected”* (Anesthesia attending, public hospital).

Equipment shortages and malfunctions result in periods of time when patient monitoring or care may suffer. Clinicians who face these scenarios can adapt by developing strong clinical acumen to manage patients during these times.

There are similarly not always enough ICU beds in public hospitals for each critical patient, requiring some patients to stay in floor beds. These deficits result in physicians’ utilizing resource allocation by providing the sickest patients to the best devices and highest level of care to maximize lives saved.

Anesthesiologists and surgeons discussed that invasive intracranial pressure monitors (ICP) could be a useful adjunct in managing TBI patients, but these were not available in public hospitals and were variably available in private hospitals. Physicians have adapted by relying on clinical symptoms and signs, in conjunction with imaging, to arrive at estimations of ICP changes.

Surgeons emphasized the importance of having an OT readily available to prevent delays, but in the public sector, delays occasionally arose if another emergent case was ongoing in the trauma OT.

*“What we are having is [an] OT that is for general surgical cases and traumatic brain injury... So, most of the times, we get [the OT] quick, but...sometimes with [subdural hematoma] and contusion, these patients get delayed. And sometimes ... it has happened that patients have deteriorated over time ... and we had to intervene later than we wanted to”* (Neurosurgery resident, public hospital).

Equipment plays a significant role in the care of TBI patients. Providers in ambulances and in public hospitals discussed that their equipment is sufficient to manage patients; increasing the amount and quality of monitoring tools and specifying exclusive neurosurgical trauma OTs were raised as potential areas for improvement.

## Theme 3: Financing care

Underlying all interviews were issues related to financial access [Table 2]. Anesthesiologists and surgeons comment that when an uninsured patient presents to a private hospital

and was unable to pay out of pocket, the patient would be stabilized and transported to a public hospital in one of the private hospital's ambulances. Patients in private hospitals need to pay for their care daily, resulting in some patients' running out of funds after a few days in the hospital.

*“And it's really, really sad [that] just because they don't have money, they cannot take further treatment in this corporate setup and then they need to move, and I have seen a lot of number of patients who have done that”* (Anesthesiologist attending, private hospital).

In these scenarios, finances can limit a patients' continuity of care. When this happens, physicians facilitate transfers using their own hospitals' ambulances and communicating with a physician at the receiving hospital to discuss the patient.

Physicians at public hospitals uniformly state that the acute phase of care is not significantly impacted by the financial consideration. These hospitals are financed such that nearly all components of care are free, and even supplies and medicines that are not provided for free can usually be sanctioned for free by social workers.

*“They pay around 2500 [rupees]... so it was down to roughly 50 US dollars. So, you get a neurosurgery for 50 US dollars ...and forward stay, they have to pay 5 or 10 rupees... and even if they are not able to pay, we make [it] free. There's always options”* (Neurosurgeon attending, public hospital).

While public hospitals are usually able to fully subsidize care, situations do arise when certain supplies and expensive medications are not available in the hospital and must be procured by patients' families from pharmacies outside of the hospital. When families cannot do this or patients' families have not been identified, physicians can adapt by providing less expensive alternatives and drawing from previously stockpiled resources.

*“Somewhere down the line, we have to keep a stock for the patients who have nothing. Like sometimes, prescribe an additional drain [for one patient] and you keep one in stock for the next patient who may not have”* (General surgeon, public hospital).

Patients' finances can hinder their access to care at private institutions, thus limiting their choices. Public hospitals use all available resources to provide free care for these patients with the assistance of government programs, and in the uncommon circumstances when patients do need to pay for an element of care, physicians can adapt by providing whatever treatments are available.

#### **Theme 4: Family and public role**

The importance of the family of patients, the general public, and the government was frequently discussed by interviewees [Table 2].

Paramedics discussed that the public often alerts them about nearby accidents and even carries injured patients to them. This decreases the time to management by paramedics, but these helpers usually do not know about cervical spine protection during transport, which can worsen injury. During transport to the hospital, patients' family members can assist with basic first aid when they are available.

Patients' families play a key role in management in public hospitals by paying for supplies and medicine when able and by assisting with rehabilitation and nursing tasks when workforce is limited. Physicians, nurses, PTs, and OCTs teach family members how to perform these tasks, such as turning a patient to prevent bedsores and assisting with chest physiotherapy.

*“The relatives are given guidance, and then they take care of a lot of the nutritional needs, they help ... attach the nutrition for the patient, they take care of the rotation of the patient for the bed sores, they even take care of the hygiene of the patient. So, I believe the relatives are a lot more involved which may or may not be a great thing, but it is more than a professional help, I believe relatives take care of a lot [and] take a forefront in the management of these patients in the allied aspects”* (Surgery attending, public hospital).

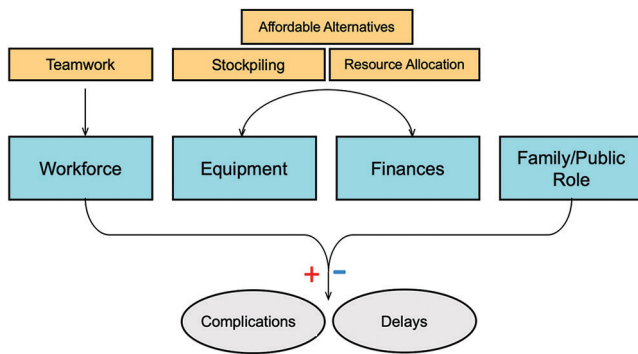
Physicians commended the government for funding largely free care for trauma patients at public hospitals who could not afford it at private hospitals. Physicians often stockpiled government resources that could be bought at pharmacies relatively cheaply (i.e., drains and sutures) and allocated these to patients who could not afford them. Expensive medications, such as certain narrow-spectrum antibiotics, were not always provided by the government, so when patients could not afford these, physicians relied on cheaper alternative medications.

While a minority of patients are brought to the trauma ward by trained paramedics, an increase in the amount of trained personnel in public prehospital care systems would aid in getting TBI patients to the hospital more quickly and safely.

*“[Having prehospital care] makes a difference because at least you would have evaluated a simple thing, like would have done some suctioning, some O2 mask, something at least-at least [giving] proper positioning... [to avoid] cervical trauma... Either the police [are] getting them or the people by the road [are] getting them”* (Anesthesiologist attending, public hospital).

## **Discussion**

This survey identified key themes related to care for TBI in Mumbai, including workforce, equipment, financing care, and the family/public role [Figure 1]. These themes were often discussed in the context of reducing or increasing complications and delays, which are the two critical



**Figure 1:** A diagrammatic representation of thematic elements and related subthemes raised by interviewees is presented. The four major themes (blue) were frequently raised in the context of promoting and preventing complications and delays (gray). Adaptations (orange) can mitigate shortcomings in workforce, equipment, and financial access when they arise

components in the final outcome of TBI patients.<sup>[9-12]</sup> When interviewees identified limitations in the major themes, they used teamwork to mitigate workforce shortages and resource allocation, affordable alternatives, and stockpiling to mitigate shortages in equipment and patient finances.

The workforce was consistently brought up as vital to managing TBI, from paramedics stabilizing patients to teams of anesthesiologists and surgeons evaluating them in trauma wards. Teamwork was especially important in the scenarios of workforce shortage, including such examples as paramedics receiving help from policemen during ambulance first aid and rehabilitation plans made after discussion between surgeons and PTs. Lapses in communication often exacerbated workforce shortages, such as during the handover process between paramedics and physicians in the trauma bay. Initiatives such as prehospital notification systems can help to alleviate this lack of communication and prepare trauma wards for critical incoming patients.<sup>[13]</sup> Building capacity through increasing trained members of the workforce remains a key priority in global health, especially as India and other middle-income countries are estimated to remain understaffed in the health-care sector for possibly over a decade.<sup>[14-16]</sup>

Equipment was vital to managing TBI patients in all phases of care – from the ambulance, the OT, and to the postoperative period. In public settings, equipment to monitor vital signs was sometimes faulty or in too low quantity, which led to the need for resource allocation. This may hamper TBI management by decreasing physicians' ability to know when patients' vital signs have changed. The lack of ICP monitors in most centers was also raised. ICP monitors have shown efficacy in increasing survival for severe TBI.<sup>[17]</sup>

Financial access played a significant role in TBI management. Patients who were initially brought to private hospitals but required transfer due to an inability to afford

care had delays in definitive management. Public hospitals financially covered nearly all aspects of care, including neurosurgical operations, for free for patients who could not afford it. The government of India aims to establish universal health care, which will continue to improve the care provided to TBI patients who cannot afford basic supplies.<sup>[18]</sup> The family plays a significant role alongside paramedics and physicians as allies in management, and their involvement may improve patient outcome since families will continue to interact with the patient after discharge daily but may also hurt the outcome because they do not have the formal education of health-care providers.

As exemplified by the interviewees in this study, local providers readily identify strengths and gaps in care and often create work-arounds to mitigate their effects.<sup>[19]</sup> Multi-institutional partnerships between the Indian hospitals, including trauma centers in Mumbai, and outside institutions have allowed for progress in understanding trends and gaps in trauma care within the city.<sup>[19-22]</sup> Further collaborative efforts between Mumbai health institutions and their local and international partners to address the barriers to care we identify will be crucial to preventing and managing TBI.

This study has pertinent limitations. Most interviews were conducted while providers were on-duty at work, which was purposefully done to provide convenience for participants, minimize recall bias, and facilitate convenience sampling. However, this method also resulted in occasional interruptions for patient care and the potential for decreased participant focus as they balanced answering questions and thinking about patients. All interviews were conducted by providers located at an urban site within Mumbai, which limits our generalizability to suburban and rural areas around the city. The sample of surgeons and anesthesiologists is enriched in two large trauma centers and may not reflect barriers specific to smaller tertiary hospitals or community centers. Further, given logistical constraints, we were unable to include opinions of all relevant providers, such as nurses in the trauma wards or general wards and PTs.

## Conclusions

Four themes related to the care of TBI patients emerged in this survey of paramedics, anesthesiologists, general surgeons, and neurosurgeons in Mumbai: workforce, equipment, financing care, and the family and public role. These themes have a major impact on both the minimization and promotion of complications and delays in treatment. Providers utilize a variety of adaptations and local innovations when shortcomings in these themes arise.

## Informed consent

Informed consent was obtained from all individual participants included in the study.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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