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Emergency management of traumatic brain injury patients and adherence to treatment guidelines in tertiary care hospitals of Lahore, Pakistan

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Abstract: The cross-sectional prospective study aimed to study the factors associated with traumatic brain injuries (TBIs) and acute management of patients presenting at emergency departments in two tertiary care hospitals in Lahore, Punjab, Pakistan, as well as compliance with international guidelines. Data was collected from 1,000 patients between February 2nd to August 2nd, 2022. Among TBI patients, 82.1% were male, and most TBIs resulted from road traffic accidents (62.6%). Headaches were experienced by 97.8% of patients, while 72.3% experienced vomiting. The diagnostic procedures included X-rays (98.9%) and CT scans (86.4%). The adherence to trauma guidelines at EDs showed blood pressure monitoring in 100% of patients, oxygen monitoring in 69.4% of patients, hyperosmolar therapy (59.2%) and infection prophylaxis (93.65%). Diagnostic procedures like X-ray (98.9%) lactulose (3.3%), anti-seizure prophylaxis (59.9%), steroid therapy (4%) and anesthetic and sedative administration were not in accordance with international guidelines. Intracranial pressure monitoring facility was not available in EDs. Deep vein thrombosis prophylaxis and nutrition were not provided in EDs. This study revealed that emergency management of TBI patients adhered to most of the international guidelines, with prompt diagnosis and therapeutic care provided in both tertiary care hospitals.

Keywords: Traumatic brain injury, emergency department, Guidelines, management, Road traffic accidents

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INTRODUCTION

Traumatic brain injury (TBI) is a disruption in the normal functioning of the brain caused by a blow, bump, or jolt to the head or when a sudden, external, physical assault damages the brain (Maas *et al.,* 2022). The injuries may be caused by falls, roadside accidents, traffic accidents, sports, assaults, etc. TBIs can result in mass lesions which are areas of localized injury such as concussions, hematomas, and contusions. TBI is a great challenge to any healthcare system because of the heterogenicity of the disease in terms of injury causes and patient outcomes (Gao *et al.*, 2020). Depending on the level of brain injury as described by the Glasgow Coma Scale, TBI can be classified as mild, moderate, or severe. Mild TBI mostly results in loss of consciousness that in most cases is not life-threatening, whereas severe TBI may cause serious brain injuries and loss of consciousness for longer period (Dams-O'Connor *et al.*, 2023).

TBIs are the leading cause of disability and death in the United States, with 2% prevalence in general population and an annual average of 53,014 deaths (Silverberg *et al.*, 2020). The epidemiological data, incidence rates and injury characteristics of TBI across the world vary and it is difficult to transfer the results of one country to another. The annual incidence of TBI in Pakistan was estimated to be 50 in 100,000 people. A systematic study in 2015 reported that Pakistan has highest death rates from road traffic incidents in the East Mediterranean region of WHO (Razzak *et al.*, 2015). Another study reported that every year more than 10 million people in Pakistan suffer from TBI, and almost 1.2 million lives are lost to road traffic accidents. The rising population, lack of resources and poor safety measures are leading causes of high TBI cases in Pakistan (Razzak *et al.,* 2008). Currently there is no national policy for the management of TBI. The tertiary care hospitals have adopted international guidelines for the emergency management of TBI (Adamson *et al.,* 2020). TBI management is based on the diagnosis and Glasgow Coma Scale. The AMC trauma practice management guidelines: traumatic brain injury (Silverberg *et al.,* 2020), French Society of Anesthesia (Geeraerts *et al.*, 2018), Intensive Care Medicine and Brain Trauma Foundation (BTF) Guidelines (Khormi *et al.*, 2018) for severe TBI address the in-hospital management of TBI patients with mild, moderate, and severe TBI. These include blood pressure monitoring, oxygenation, hyperosmolar therapy, prophylactic hypothermia, infection prophylaxis, intracranial pressure (ICP) monitoring, cerebral perfusion thresholds, brain oxygen monitoring and therapeutic management (anesthetics, analgesics, sedatives, nutrition, anti-seizure prophylaxis and steroids) (Wiles, 2022). Research studies conducted locally and city-wise are required to address or better characterize the causes of TBIs and treatment protocols that would assist in development of national policy for TBI management. Specific data on

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predisposing factors, diagnosis, and acute management of traumatic brain injury is lacking in many major cities of Pakistan. The current study was designed to demonstrate factors associated with TBI, management in emergency departments and adherence to international guidelines in tertiary care hospitals located in one of the largest cities of Pakistan.

MATERIALS AND METHODS

Study design participants

A cross-sectional prospective observational study was designed and conducted on patients brought to Emergency Departments (EDs) of tertiary care hospitals i.e., General and Jinnah Hospitals, Lahore on Monday, Tuesday, Wednesday, and Friday of every week (12 pm to 4 pm) for a period of six months i.e., 2nd February to 2nd August 2022. During this period 1000 patients diagnosed with TBI and assigned a Glasgow Coma Scale (GCS) score in EDs were included in the study by simple random sampling technique. The study was conducted in compliance with the Helsinki declaration and STROBE guidelines. The report was compiled according to STROBE cohort checklist (Ghaferi, Schwartz and Pawlik, 2021).

Inclusion and exclusion criteria

Patients irrespective of age and gender were included. The patients diagnosed with TBI and assigned a GCS score in the EDs were included in the study. Patients received dead from accident sites or expired before assigning GCS were excluded. Patients diagnosed with tumors, toxicities of drugs, and other neurological disorders were excluded.

Plan of work

The questionnaire tool was constructed in compliance with guidelines published by French Society of Anesthesia (Geeraerts *et al.,* 2018), Intensive Care Medicine and Brain Trauma Foundation (BTF) Guidelines (Khormi *et al.*, 2018) and AMC trauma practice management guidelines: traumatic brain injury and Brain Trauma Foundation Guidelines (Silverberg *et al.*, 2020). The tool was modified in consultation with the emergency medicine experts from both hospitals. The tool was standardized and validated by two experts after conducting a pilot study. The first part of the tool consisted of demographic information including age, gender, brought by/from and cause of injury. The second part of the questionnaire consisted of pre-hospital management which included types of injury, consciousness state, first aid, physicians' diagnosis. The last part of the questionnaire included the therapeutic management in EDs.

STATISTICAL ANALYSIS

The collected data was coded and analyzed by SPSS 24.0 with 0.05 as level of significance. Glasgow Coma Scale was employed to classify the patients as having mild (13-15), moderate (9-12), and severe (3-8) traumatic brain injuries. All the variables were classified according to Glasgow Coma Scale. A chi-square was used for statistical comparison of different variables with GCS score. The association of age, gender, cause, and type of injury with severity of TBI was analyzed in Loglinear model.

RESULTS

A total of 1000 patients, admitted to EDs of both hospitals and assigned a GCS immediately after admission were included in the study. Of 1000 patients 82.1% were male and 33.6% were aged between 21 and 30 years with median age 30 years (IQR=3-90). The median GCS score was 13 with 60.6% of patients assigned mild GCS score, 31.8% moderate and 7.1 % severe TBI. The major cause of TBI was road traffic accidents 62.6%, amongst which fall from motorbike (23.4%) was highest as presented in table 1. More than three-quarters (80.7%) were brought to EDs by ambulance. More than two-thirds (83.6%) were provided first aid before arriving at EDs.

The association between GCS score and cause of injury was significant ($p<0.05$). A significant relationship (P=0.045) was found between type of injury and severity of TBI (GCS score, 3-8) as presented in table 1. The cause of injuries was classified into various categories and significant association was observed between categories like falls from motorbike (P=0.041), motorbike and car accident (P=0.033), fall from stairs (P=0.002) and pedestrian hit by motorbike (P=0.005) with severity of TBI. A significant association of age (P=0.000) and gender (P=0.009) with the severity of TBI was also observed. The diagnostic tests and GCS score were not significantly correlated (P=0.074). The association between patients age, gender, and cause of TBI with TBI scale was found using loglinear model. A significant association of age (P=0.000) and gender (P=0.009) with TBI scale was found (table 1).

Most common clinical symptoms observed in patients arriving at EDs of the hospitals were headaches, loss of consciousness, ventilatory dysfunction, vomiting and seizures. 97.8% of patients suffered from headaches irrespective of the severity of TBI. The least common symptom was seizure, which was found to be significant (P=0.04) with TBI severity. Significant association was observed between TBI severity and consciousness (P=0.011, 43.4%), vomiting (P=0.002, 72.3%) and ventilatory dysfunction (P=0.000, 93.1%) as presented in table 1.

The emergency management provided to the TBI patients arriving in EDs constituted airway management, urinary catheterization, intraventricular catheterization, X-ray, tetanus shot and depending on TBI severity, patients were referred to ICU (4.2%) or surgery wards (12.3%).

CT scans were performed on 86.4% of patients. A significant relationship ($p<0.05$) was found between the GCS score and early management showing that the patients received early care immediately after they reached EDs of the hospitals. Airway management was provided immediately to 69.4% patients. X-rays were recommended to 98.9% patients with TBI and 4.8% were admitted to ICU. Surgery was recommended to 12.3% of patients and airway catheterization was done in 79.4% patients in EDs. Tetanus shot was given to 91.1% of patients. Intraventricular catheterization was done in only severe TBI patients (10.5%). Urinary catheterization was performed in 79.4% of patients (table 2).

The major classes of drugs prescribed to TBI patients constituted analgesics, anti-inflammatory, anticonvulsants, antibiotics and coagulant. The analgesics most prescribed were paracetamol (P=0.025) and ketorolac (P=0.008) as significant and positive association was found between these drugs and TBI classification. The anti-seizure drug valproic acid was prescribed to 59.9% patients and mannitol was prescribed to 59.2% patients to correct osmolarity (Table 2). The most common antibiotics administered were ceftriaxone (P=0.014) and amoxicillin (P=0.002). Several analgesics and anti-inflammatory drugs were also prescribed for several mild to severe cases. Paracetamol (P=0.001), ketorolac (P=0.008) and diazepam (P=0.024) showed significance in chi-square test. Anti-convulsant like valproic acid was administered to 59.9% patients (table 2).

Fourteen points were assembled from the international TBI guidelines and were compared with the observations recorded in the current study, for adherence and the results are presented in table 3.

DISCUSSION

During the past two decades, Lahore, located in North Punjab and Pakistan's second largest city, has faced massive increase in population of about 12 million due to urbanization and industrial growth. This has increased the load of traffic on the roads of the city (Karim *et al.*, 2024). To date no study has been conducted in Lahore assessing the adherence of acute management of TBI in ED's to international guidelines. Our study has demonstrated that one of the major causes of traumatic brain injury (TBI) is road traffic incidents (RTI) and the vehicle causing highest percentage (23.4%) of injuries is the motorbike. Regarding the age-gender distribution, our study goes along with another study conducted in Southern Punjab in 2022 (Rahman *et al.,*, 2022) and another large scale study conducted in 2015 (Bhatti *et al.,*, 2015). All studies found a pronounced incidence of TBI in young male (median age 30 yrs.) and similar cause of injury which was fall from motorbikes. WHO has reported, Pakistan as one of the country with highest road traffic mortalities (Organization, 2023). Our study showed a significant correlation between causes of injuries and GCS score (table 1). Pakistan is a low to middle income country therefore larger population can't afford cars and utilize motorbikes as vehicles. Our study reported the prevalence of mild TBIs suggesting that road safety awareness programs conducted by traffic police departments occasionally have increased awareness of adoption of safety precautions while driving various vehicles. However, to further decrease the RTIs and burden on health care in Lahore, more education and awareness of common people may be initiated by Traffic Police departments.

In this study a total of 807 of 1000 TBI patients arrived at the tertiary care hospitals by ambulances suggesting that Lahore city provides an adequate network of ambulance services. The previous study conducted in southern Punjab reported very low percentage of ambulance service (44.7%) (Rahman *et al.*, 2022). The study conducted in 2015 in seven large teaching hospitals of Pakistan also showed low percentage of patients (32%) arriving by ambulance (Bhatti *et al.*, 2015). First aid was provided to 83.6% of patients before they reached hospitals (Table 1). This suggests that the ambulatory service and personnel are adequately trained to manage the people suffering from accidents. Several studies have reported beneficial impact of prehospital emergency management on the patient's outcome. Previous study conducted in two selected districts of Pakistan, Faisalabad and Peshawar, showed suboptimal emergency management (Razzak *et al.*, 2008).

The management of TBIs in emergency departments of the hospitals was assessed according to the guidelines by French Society of Anesthesia, Intensive Care Medicine, AMC trauma practice management guidelines: traumatic brain injury and Brain Trauma Foundation Guidelines. After reaching the ED's early management included assigning a GCS score to TBI patients based on eye-verbal-motor response. Based on GSC score and emergency protocols of hospital the diagnostic procedures including X-rays (98.9%), CT scans (86.4%), MRI (2.1%) or both (CT scan & MRI, 11.5%) were recommended. The X-ray diagnostic recommendation was not according to the international guidelines as presented in Table 3, however these results were consistent with a previous large scale study conducted in 2015 (Bhatti *et al.*, 2015). In EDs the median GCS score was 13 (IQR 3-15) and 60.6% of patients were classified as having mild TBI. Major injuries included contusion (39.7%), extracranial injury (19.1%), hematomas (13.1%) and skull fracture (9.6%). The types of TBI identified included mild (60.6%), moderate (31.8%) and severe (7.6%). The acute management was provided immediately after the arrival of the patient. Blood pressure management was done in 100% patients and airway management was recommended to 69.4% patients. The patients were kept in supine position to prevent clot formation and in both hospitals DVT prophylaxis was managed by the same method in ED's.

Table 1: Demographics and Clinical characteristics of patients admitted to Emergency Departments of tertiary care hospitals in Lahore

	Glasgow Coma Scale of Traumatic Brain Injury n (%)				
	Mild TBI 13-15	Moderate TBI 9-12	Severe TBI 3-8	Total (% of 1000 pts)	p-value
Demographic Characteristics					
GCS score	606 (60.6)	318 (31.8)	76 (7.6)	1000 (100)	
Age					
<20	107 (61.8)	59 (34.1)	7 (4)	173 (17.3)	P=0.088
21-38	293 (61.9)	144 (30.4)	36 (7.6)	473 (47.3)	P=0.000[a]
39-55	156 (60.2)	84 (32.4)	19 (7.3)	259 (25.9)	
56-73	39 (54.2)	21 (29.2)	12 (16.7)	72 (7.2)	
>74	11 (47.8)	10 (43.5)	2 (8.7)	23 (2.3)	
Gender					
Male	473 (57.6)	278 (33.9)	70 (8.5)	821 (82.1)	P=0.000
Female	133 (74.3)	40 (22.3)	6 (3.4)	179 (17.9)	P=0.009[a]
Types of Road Traffic incidents					
Motorbike and car accident	52 (54.2)	34(35.4)	10 (10.4)	96 (9.6)	P=0.033
Fall from Motorbike	147 (62.8)	19(29.1)	68(8.1)	234 (23.4)	0.041 [a]
Motorbike hits Motorbike	61 (64.9)	27 (28.7)	6 (6.4)	94 (9.4)	0.225 [a]
Motorbike and auto rickshaw accident	35 (62.5)	14 (25)	7 (12.5)	56 (5.6)	0.865 [a]
Motorbike and Truck accident	32 (65.3)	13 (26.5)	4 (8.2)	49 (4.9)	-
Bicycle and Motorbike accident	16 (88.9)	1 (5.6)	1 (5.6)	18 (1.8)	-
Hit by car	47 (67.1)	20 (28.6)	3 (4.3)	70 (7)	-
Hit by Motorbike	47 (56.6)	30 (36.1)	6 (7.2)	83 (8.3)	0.005 [a]
Car crash	9 (42.9)	10 (47.6)	2 (9.5)	21 (2.1)	-
Auto Rickshaw hits Auto Rickshaw	14 (63.6)	7 (31.8)	1 (4.5)	22 (2.2)	-
Other types of Accidents					
Fall from height	52 (57.8)	32 (35.6)	6 (6.7)	90 (9)	0.264 [a]
Fall from stairs	43 (65.2)	22 (33.3)	1 (15)	66 (6.6)	0.002[a]
Hit by stone	9 (56.3)	7 (43.8)	0 (0)	16 (1.6)	-
Fall from unconsciousness	23 (51.1)	19 (42.2)	3 (6.7)	45 (4.5)	-
Fight	12 (57.1)	8 (38.1)	1 (4.8)	21 (2.1)	-
Unknown	7 (36.8)	6 (31.6)	6 (31.6)	21 (2.1)	0.055 [a]
Brought By					
Ambulance	489 (60.6)	256 (31.7)	62 (7.7)	807 (80.7)	P= 0.977
Local vehicles	117 (60.6)	62(32.1)	14 (7.3)	193 (19.3)	
Brought from					
Accident site	467 (61.6)	232 (30.6)	59 (7.8)	758 (75.8)	P=0.011
Home	104 (60.1)	63 (36.4)	6 (3.5)	173 (17.3)	
Other hospital	35 (50.7)	23 (33.3)	11 (15.9)	69 (6.9)	
First Aid	498 (59.6)	271 (32.4)	67 (8)	836 (83.6)	0.358
Types of Injuries identified by health care providers at Emergency departments					
Contusion	256 (64.5)	114 (28.7)	27 (6.8)	397 (39.7)	P=0.000
Concussion	39 (72.2)	11 (20.4)	4 (7.4)	54 (5.4)	
Hematoma	78 (59.5)	35 (26.7)	18 (13.7)	131 (13.1)	
Skull Fracture	52 (64.5)	34 (35.4)	10 (10.4)	96 (9.6)	
Diffuse Axonal injury (DAI)	12 (63.2)	7 (36.8)	0	19 (1.9)	
Hemorrhage	22 (47.8)	21 (45.7)	3 (6.5)	46 (4.6)	
Cystic Lesions	10 (62.5)	5 (31.3)	1 (6.3)	16 (1.6)	
Internal Bleeding	26 (56.5)	17 (37)	3 (100)	46 (4.6)	
Extracranial Injury	111 (58.1)	74 (38.7)	6 (6.5)	191 (19.1)	
Coma	0	0	4 (100)	4 (0.4)	
Clinical Presentation					
Headache	588 (60.1)	315(32.2)	75 (7.7)	978 (97.8)	P= 0.118
Consciousness	286 (65.9)	119 (27.4)	29 (6.7)	434 (43.4)	P=0.011
Vomiting	444 (61.4)	237 (23.8)	42 (5.8)	723 (72.3)	P=0.002
Ventilatory dysfunction	548 (58.9)	309 (33.2)	74 (7.9)	931 (93.1)	P=0.000
Seizures	65 (58.6)	31 (27.9)	15 (13.5)	111 (11.1)	P=0.04

*Represents significant difference between the variable and GCS score [a] represents loglinear analysis with severity of TBI The variables with number of patients less than 5 in any GCS score were not analyzed.

Table 2: Acute and Therapeutic management of TBI patients and association with severity of TBI

Management parameters	Glasgow Coma Scale of Traumatic Brain Injury n (%)				p- value
	Mild TBI 13-15	Moderate TBI 9-12	Severe TBI 3-8		
Acute Management in Eds					
Blood Pressure Monitoring	606 (60.6)	318 (31.8)	76 (7.6)	1000 (100)	-
Airway Management	404 (58.2)	229 (33)	61 (8.8)	694 (69.4)	P= 0.025*
Supine	603 (60.5)	318 (31.9)	76 (7.6)	997 (99.7)	-
Urinary Catheterization	455 (57.3)	268 (33.8)	71 (8.9)	794 (79.4)	P=0.080
Intraventricular Catheterization	0	0	8 (10.5)	8 (10.5)	-
X-Ray	598 (60.5)	317 (32.1)	74 (7.5)	989 (98.9)	P=0.156
CT scan	531 (61.5)	274 (31.7)	59 (6.8)	864 (86.4)	P=0.074
MRI	15 (71.4)	4 (19)	2 (9.5)	21 (2.1)	
Both	60 (52.2)	40 (34.8)	15 (13)	115 (11.5)	
Tetanus shot	543 (59.6)	295 (32.4)	73 (8)	911 (91.1)	P=0.080*
Therapeutic Management in EDs					
Analgesics, Anti-inflammatory and Anticonvulsants					
Paracetamol	229 (61.9)	100 (27)	41 (11.1)	370 (37)	P=0.001*
Diclofenac	27 (64.3)	14 (33.3)	1 (2.4)		-
Piroxicam	7 (53.8)	6 (46.2)	0	13 (1.3)	-
Naproxen	35 (64.8)	17 (31.5)	2 (3.7)		-
Ketorolac	344 (59.3)	179 (30.9)	57 (9.8)	580 (58)	P=0.008*
Dexamethasone	21 (52.5)	15 (37.5)	4 (10)	40 (4)	-
Diazepam	2 (20)	7 (70)	1 (10)	10 (1)	-
Valproic acid	353 (58.9)	187 (31.2)	59 (9.8)	599 (59.9)	P=0.005*
Carbamazepine	4 (100)	0	0	4 (1)	-
Phenytoin	4 (23.1)	6 (46.2)	3 (23.1)	13 (1.3)	-
Levetiracetam	75 (54.3)	44 (31.9)	19 (13.8)	138 (13.8)	P=0.011*
Haloperidol	10 (62.5)	4 (25)	2 (12.5)	16 (1.6)	-
Lactulose	20 (60.6)	12 (36.4)	1 (3)	33 (3.3)	-
Mannitol	347 (58.6)	183 (30.9)	62 (10.5)	592 (59.2)	P=0.000*
Antibiotics					
Ceftriaxone	275 (56.8)	162 (33.5)	47 (9.7)	484 (48.4)	P=0.014*
Amoxicillin	358 (65.1)	149 (27.1)	43 (7.8)	550 (55)	P=0.002*
Ciprofloxacin	27 (47.4)	25 (43.9)	5 (8.8)	57 (5.7)	P= 0.099
Metronidazole	48 (60)	26 (32.5)	6 (7.5)	80 (8)	P=0.990
Vancomycin	15 (57.7)	10 (38.5)	1 (3.8)	26 (2.6)	-
Others					
Tranexamic acid	41 (59.4)	24 (34.8)	4 (5.8)	69 (6.9)	-
Doxylamine	349 (61.7)	188 (33.2)	29 (5.1)	566 (56.6)	P=0.003*
Omeprazole	511 (64.2)	275 (32.3)	66 (7.7)	852 (85.2)	P= 0.624
Isosorbide dinitrate	182 (63.6)	75 (26.2)	29 (10.1)	286 (28.6)	P= 0.019*
Outcomes					
Referred to ICU	23 (47.9)	10 (20.8)	15 (31.3)	48 (4.8)	P=0.000*
Referred to OT for Surgery	73 (59.3)	34 (27.6)	16 (13)	123 (12.3)	P=0.045*
Referred to Neurology Units	10 (4.1)	177 (72.5)	57 (23.4)	244 (24.4)	P=0.000*

*Represents significant difference between the variable and GCS score. The variables with number of patients less than 5 in any GCS were not analyzed.

Table 3: Observations in EDs according to international guidelines

	Guideline recommendations	Observations according to guidelines n (%)	Observations noncompliant with guidelines
I	Assessment of TBI using Glasgow Coma Scale All guidelines recommend using GCS for TBI diagnosis	1000 (100%)	
II	Blood Pressure All guidelines recommend BP monitoring and maintaining systolic blood pressure above 90mmHg	1000 (100%)	
III	Oxygenation All guidelines recommend oxygen monitoring (oxygen saturation >90%)	Oxygen saturation was maintained either by oxygen cylinders or on ventilators 694 (69.4%)	
IV	Radiological Examination The French Society of Anaesthesia and Intensive Care Medicine guidelines recommend CT scans in patients with GCS from 3-13.	CT scan was performed in 86.4% and MRI in 2.1 % and both were performed in 11.5% patients	X-ray is not recommended but was performed in 98.9% patients
V	Transcranial doppler The French Society of Anaesthesia and Intensive Care Medicine guidelines recommend calculation of Pulsatility index by transcranial doppler		This facility was not available in both tertiary care hospitals
VI	Biomarker evaluation The French Society of Anaesthesia and Intensive Care Medicine guidelines don't recommend biomarker evaluation for assessment of TBI	No biomarkers were assessed in the ED to assess TBI	
VII	Hyperosmolar therapy BTF guidelines recommend use of hyperosmolar therapy for clinically observed raised ICP and restricting its use before ICP monitoring	Mannitol was administered 592 (59.2%)	Lactulose was administered 33 (3.35%)
VIII	Infection prophylaxis BTF guidelines recommend use of antibiotics prior to any surgical procedure however class of antibiotics are not mentioned	The antibiotics were administered in ED's Antibiotics= 936 (93.6%) Ceftriaxone 484 (48.4%) Amoxicillin 550 (55%)	
IX	Deep vein thrombosis prophylaxis BTF and AMC recommend sequential compression device to improve blood flow in the lower limbs	Not available in ED's	All patients were kept in supine positions to prevent development of clots
X	Intracranial Pressure monitoring & technology ICP is recommended in all patients after receiving abnormal CT scans. The technology to be used as stated by guidelines include ventricular catheters connected to external strain gauge	ICP monitoring facility was not available in ED's	Based on CT scans and patients' vitals, intraventricular catheterization was performed to decrease the intracranial pressure
XI	Anesthetics, analgesics and sedatives BTF guidelines recommend barbiturates and propofol	Barbiturates and propofol were not administered	Paracetamol 370 (37%) Ketorolac 580 (58%)
XII	Anti-epileptic prophylaxis All guidelines don't recommend use of anti-epileptic drugs to prevent post-traumatic seizures, however anticonvulsants are indicated to prevent PTS	The practice was not according to guidelines Diazepam was administered to 10 (1%) patients	Valproic acid 599 (59.9%) Levetriacetam 138(13.8%) Phenytoin 13 (1.3%) Haloperidol 16 (1.6%) Carbamazepine 4(1%) were administered in ED's
XIII	Steroids These drugs are not recommended by any guidelines		Dexamethasone 40 (4%) was administered in ED's
XIV	Nutrition Nutrition is generally recommended at least by fifth day post-injury to decrease mortality		Not administered in EDs

The international guidelines recommend sequential compression device to improve blood flow but in our study such practice was not observed (Rakhit *et al.,* 2021). All the guidelines recommend ICP monitoring in patients with abnormal CT scans. In our study, ICP monitoring was not observed in the ED's, however patients with abnormal CT scans and MRI were shifted to ICU for intraventricular catheterization to reduce intracranial pressure. The patients recommended intraventricular catheterization (10.5%) were diagnosed with severe TBI (3-6 GCS) and the international guidelines recommend intraventricular catheterization in patients with severe TBI (Santacruz *et al.*, 2022). Urinary catheterization was done in 79.4% patients in ED's before referring to the ICU, OT's or neurology wards.

The acute management of included administration of paracetamol (37%) and ketorolac (58%) in the ED's. The guidelines recommend barbiturates and propofol, but the use of these drugs was not observed in the ED's of both hospitals. Anti-epileptic prophylaxis is not recommended in any of the international guidelines. The patients assigned GCS score consisted of 11.1% patients with seizure presentation. Levetiracetam and valproic acid were administered to almost half of the patients included in the study (Table 2). The clinical practice observed was not according to the guidelines as all guidelines don't recommend anti-seizure prophylaxis (Khormi *et al.*, 2018, Wiles, 2022). Therefore, we suggest reconsideration of the tertiary hospital guidelines for prescribing anti-seizure prophylaxis. The osmolarity was corrected by the administration of mannitol (59.2%) and lactulose (3.3%) in patients whose CT scans presented some abnormality.

The prophylactic administration of antibiotics was preferred in TBI patients presenting with contaminated wounds, CSF leakage and multiple injuries. Most commonly ceftriaxone and amoxicillin were administered as empirical therapy (Table 2). The BTF guidelines recommend use of antibiotics prior to surgeries, however in the current study TBI due to road traffic accidents was highest so antibiotic prophylaxis (93.6%) and tetanus shots (91.1%) were administered to more than three quarter patients (Geeraerts *et al.,*, 2018). Other drugs administered to patients assigned GCS included tranexamic acid to prevent bleeding, doxylamine (56.6%) and omeprazole (85.2%) to prevent nausea and vomiting. Vomiting was observed in 72.3% of patients at the time of arrival in emergencies. Isosorbide dinitrate was recommended to 28.6% patients, mostly with previous history of cardiovascular disorders. According to our study most of the treatment provided to the patients in ED's were according to the guidelines of Brain Trauma Foundation, French Society of Anesthesia and Intensive Care Medicine and AMC trauma practice management guidelines: traumatic brain injury.

Limitations

The current study focused on two tertiary care hospitals in a city of about 12 million population for eighteen hours a week for six months. The time and selected institutions constrain the results of every guideline on health outcome. Another intrinsic limitation of the study was the documentation of patient outcomes in the ICUs, operating theaters, and neurology wards. We could not monitor the operational procedures conducted after transferring the patients to the operating theaters.

CONCLUSION

The study indicates that contusions were the predominant type of damage in patients with traumatic brain injuries. The male population was largely affected by traumatic brain injuries primarily resulting from road traffic incidents. Before arriving in EDs, adequate prehospital treatment was administered. The international criteria were predominantly followed in the emergency department's management of traumatic brain injury; nevertheless, full compliance was absent. Furthermore, the therapeutic treatments were delineated based on the cause of the traumatic brain injury.

Prospects

Attaining full adherence to international criteria poses a challenge in lower middle-income nations because of limited resource availability. The timely implementation of national health policy, aligned with available resources and international guidelines, is crucial to support physicians in clinical settings in promptly addressing the sustainable developmental goal 3 (SDG 3) and enhancing the well-being of individuals afflicted with traumatic brain injury.

Ethical approval

The study was conducted in compliance with Helsinki declaration and STROBE guidelines. The report was compiled according to STROBE cohort checklist. The Ethical approval was obtained from the Human Ethical Review Board (IRB no: ORIC/LCWU/22-327) of Lahore College for Women University. The IRB approvals of General and Jinnah Hospitals, Lahore, Pakistan were also taken to conduct the research.

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Conflict of interest

The authors have no conflict of interest.

The consent form included the statement that data will be published without declaring the identity of the patients.

Author contributions

SHK designed the study, obtained institutional approvals and applied statistics, AM carried out manuscript compilation, MK, RA, SM collected data from the hospitals and compiled the manuscript.

Data Availability statement

All data generated or analysed during this study are included in this published article.

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