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Evaluation of The Initial Management Of Severe Traumatic Brain Injuries Before Icu Admission

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Abstract :
Background: Severe traumatic brain injury (TBI) remains a major public health concern, with high incidence rates and serious consequences for affected patients. Prehospital care, including rapid and effective initial management, is a critical factor influencing patient outcomes . Objectives: This study aims to evaluate the initial pre-admission management of patients with severe TBI admitted to the intensive care unit (ICU B) at Hassan II Regional Hospital in Agadir, Morocco. Methods: We conducted a retrospective, descriptive, cross-sectional study over a two-year period (March 2021 to August 2023), including 65 patients admitted with severe TBI. Clinical, hemodynamic, respiratory, radiological, and interventional data were collected and analyzed from patient medical records.Results:
The majority of patients were male (93.15%) with a mean age of 33.5 years. Road traffic accidents accounted for 68.49% of cases. The average prehospital delay was 9.31 hours. Closed head trauma was present in 97.26% of patients, with 43.55% presenting with a Glasgow Coma Score (GCS) below 8. Most patients were hemodynamically stable (71.23%) and did not exhibit signs of respiratory distress (76.71%). Brain CT scans were performed in 95.89% of patients, with contusions being the most common finding (86.30%). Intubation was performed in 60.27% of cases. Initial management also included fluid resuscitation (80.82%), sedation (41.10%), and surgical referral when necessary (12.5%). Conclusion:
This study highlights the variability and complexity of severe TBI cases in the pre-admission phase and underlines the need for improved prehospital care systems, timely interventions, and multidisciplinary collaboration. Enhancing prehospital response time and protocols may improve outcomes for patients with severe TBI.

Keywords
- *Severe Traumatic Brain Injury*
- *Prehospital Care*
- *Emergency Medicine*
- *Neurotrauma*
- *Glasgow Coma Score*
- *Intensive Care Unit*
- *Initial Management*
- *Road Traffic Accidents*
- *Morocco*
- *Head Injury Evaluation*

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I. Introduction

Severe traumatic brain injury (TBI) remains a major concern in the field of emergency medicine and trauma care due to its high incidence and often catastrophic consequences for patients. In the pre-hospital setting, the speed and effectiveness of the initial assessment and management are crucial factors in improving patient outcomes.

Our detailed analysis of epidemiological data, neurological, hemodynamic, and respiratory clinical parameters, as well as pre-hospital interventions, provides valuable insights into the current state of severe TBI management.

The challenges associated with rapid assessment, transport, and early management—especially in the context of time and resource constraints—are thoroughly discussed. The objective of this work is to evaluate the initial management of patients with severe traumatic brain injuries prior to admission to the intensive care unit B of Hassan II Hospital in Agadir.

II. Materials and Methods

This is a retrospective cross-sectional descriptive study conducted in the ICU B of the regional hospital center Hassan II in Agadir over a 2-year period, from March 2021 to August 2023. Our study population consisted of 65 patients, all of whom were admitted to ICU B with a diagnosis of severe traumatic brain injury. Data were collected from patients' medical records and analyzed to gather information on the causes of trauma, injury severity, time interval between the accident and hospital admission, and other relevant parameters.

III. Results

In our study of patients who sustained severe traumatic brain injuries, it is evident that males were significantly more affected, accounting for 93.15% of cases. The mean age of the affected individuals was 33.5 years, indicating a marked vulnerability in this age group. The age range of patients, spanning from 0.5 to 68 years, highlights the need for tailored approaches for effective pre-hospital management across diverse age groups. The majority of severe TBI cases were caused by road traffic accidents, representing 68.49% of cases, followed by falls (24.66%) and assaults (6.85%).

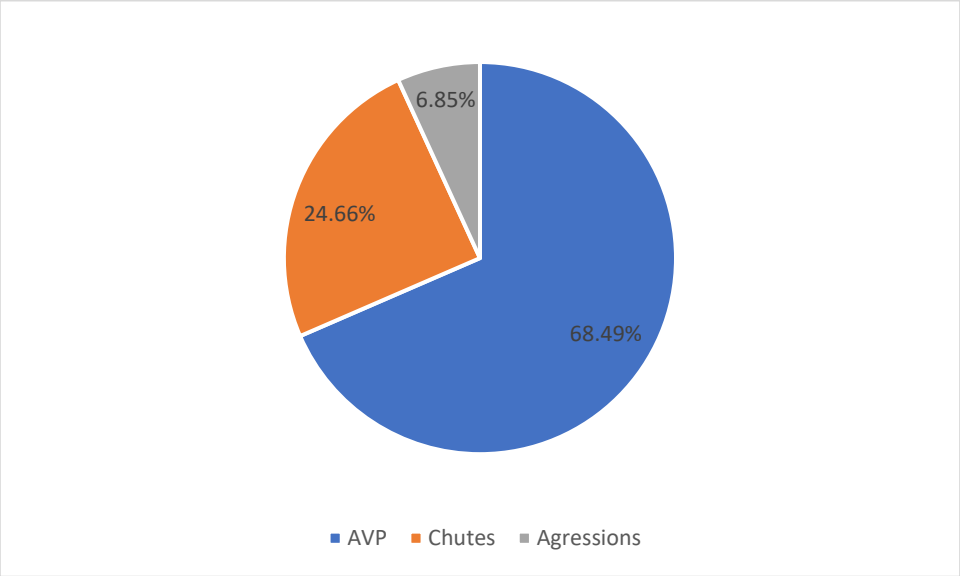

Figure 1 : *Repartition on patients*

In terms of transportation, 97.26% of patients were brought to the hospital by ambulance, making it the predominant mode of transport. Fire department services and another category of ambulance were each used in 1.37% of cases. Additionally, the average delay between the time of the accident and hospital admission was 9.31 hours, ranging from 1.2 to 16 hours, highlighting a potential area for improvement in the speed and efficiency of pre-hospital transport.

Initial clinical evaluation on the neurological level revealed that 97.26% of patients had sustained closed head injuries, while only 2.74% had open head injuries. A notable majority of 91.78% did not present with seizures. Regarding the initial Glasgow Coma Scale (GCS) score, a plurality of patients (43.55%) had a score below 8, indicating severe brain injury, while 24.19% had a moderate score between 8 and 13, and 32.26% had a high score between 14 and 15, indicating mild or no injury. In terms of pupillary evaluation, 60.93% of patients had symmetrically reactive pupils, with some cases presenting miosis, mydriasis, and anisocoria. Information about neurological deficits was missing in a large proportion of patients (73.97%), with the majority of the remaining patients showing no deficits. Scalp wounds and skull depressions were relatively rare, underscoring the predominance of closed head trauma in this sample.

Hemodynamic evaluation showed that 71.23% of patients were stable, while 28.77% were in an unstable condition. Blood pressure measurements varied widely, with the most common being 90/60 mmHg, observed in 27.40% of patients. The average heart rate was 101 beats per minute. Regarding conjunctival appearance, 83.56% of patients had normally colored conjunctivae—a reassuring sign—while 16.44% showed pale conjunctivae. Another positive finding was that the vast majority of patients (97.26%) did not exhibit signs of hemorrhagic shock, a critical factor in the initial assessment of patients with severe traumatic brain injury in the prehospital setting.

On the respiratory level, our data indicated an average respiratory rate of 31 breaths per minute. The average oxygen saturation (SpO_2) was 98%, though some variations were observed, indicating generally adequate oxygenation among patients. A majority of 72.60% showed no signs of respiratory distress, which is an encouraging indicator of preserved respiratory function. In contrast, 17.81% of patients did show signs of respiratory effort, and data were missing or unspecified in 9.59% of cases. Furthermore, 76.71% of patients did not suffer from respiratory distress, while 23.29% did, underlining the need for careful airway monitoring and management in the initial prehospital care of severe TBI patients.

The initial injury assessment showed that a cerebral CT scan was performed in 95.89% of patients, reflecting a strong focus on accurate evaluation of intracranial injuries. A cervical spine CT scan was carried out in 82.19% of cases, an essential step to assess the extent of associated injuries. A full-body scanner was used in the evaluation of 20.55% of patients. Cervical spine X-rays were less commonly performed, with 85.94% of patients not undergoing one. A majority of patients underwent chest X-rays (79.69%), and over half had pelvic X-rays (54.69%). Limb X-rays were less frequent, with 71.88% of patients not receiving one. Abdominal ultrasound was performed in just over half of the patients (54.69%), serving as a crucial diagnostic tool for identifying potential associated intra-abdominal injuries.

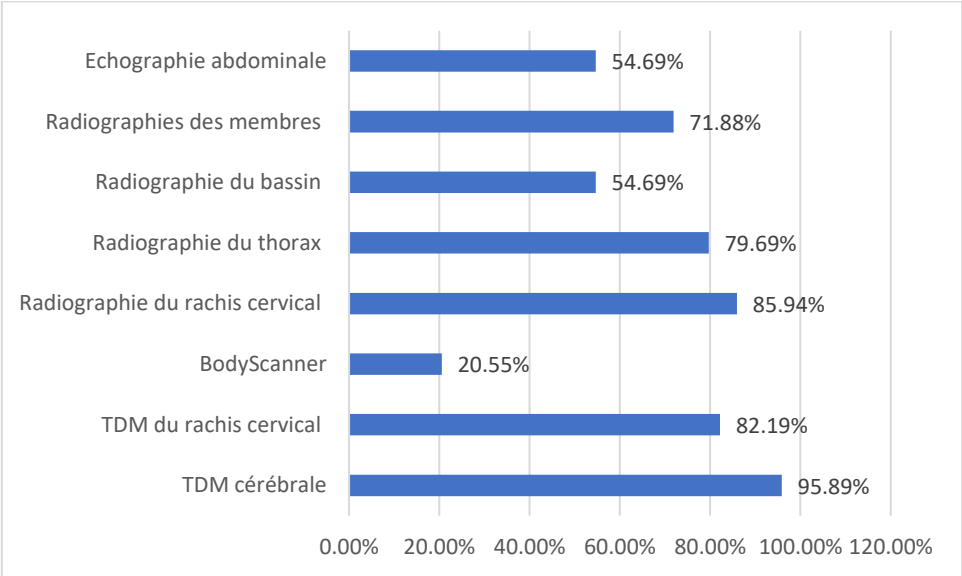

Figure 2 : Distribution of patients according to the initial injury assessment performed

These results highlight the importance of detailed and systematic assessment to identify and manage associated injuries during the initial management of patients with severe traumatic brain injury.

Initial injury assessment revealed that 9.59% of patients had an epidural hematoma (EDH) and an acute subdural hematoma (ASDH), respectively. A high proportion of patients (86.30%) had brain contusions. Subarachnoid hemorrhages were identified in 24.66% of cases. More than half of the patients (60.94%) did not present with cerebral edema, but a significant percentage (39.06%) were affected. Brain herniation and pneumocephalus were relatively rare, with 95.31% and 93.75% of patients unaffected, respectively. Facial fractures were present in 26.56% of patients, and skull base fractures in 10.94%. A large majority (92.19%) did not sustain pelvic trauma. In terms of injury severity, 79.45% of patients were polytrauma cases and were intubated, illustrating the complexity and severity of the injuries associated with severe traumatic brain injury in this sample.

On the respiratory management side, the initial care of patients involved various interventions to ensure adequate ventilation. A majority (60.27%) of patients were intubated and mechanically ventilated, ensuring optimal airway and respiratory management. Another 31.51% received oxygen via mask, while 8.22% were assisted with nasal cannulas, reflecting tailored oxygenation strategies based on the severity of injury and the respiratory status of the patients. Additionally, although most patients (95.89%) did not require chest drainage, a small proportion (4.11%) did, underscoring the diversity of clinical presentations and respiratory care needs among patients with severe traumatic brain injuries.

Regarding initial hemodynamic management, a venous line was established in nearly all patients (97.26%), facilitating the administration of fluids and medications. A significant proportion (80.82%) received fluid resuscitation to stabilize their hemodynamic status. Urinary catheterization was performed in 35.62% of patients, while the majority (64.38%) did not undergo this procedure, illustrating a selective approach based on

injury severity and clinical indication. Moreover, a minority of patients (12.33%) received a blood transfusion, reflecting careful management of transfusion resources and individualized clinical evaluation of transfusion needs in the context of severe TBI and associated injuries.

In terms of initial neurological management, just over half of the patients (58.90%) did not receive sedation, indicating careful monitoring of consciousness levels. For those who required sedation (41.10%), the vast majority (98.63%) received a bolus dose, while a small proportion (1.37%) were placed under continuous sedation, demonstrating personalized approaches based on neurological severity and clinical requirements. Regarding spinal stabilization, most patients (98.63%) did not receive a cervical collar, possibly due to the nature of the injuries or specific care protocols, while a small number (1.37%) did, to prevent potential complications related to cervical spine injury.

The majority of patients (95.89%) did not require limb immobilization, suggesting that extremity injuries were either not prevalent or did not necessitate immobilization in this cohort. However, for the 4.11% who did, this underscores the importance of comprehensive assessment and management to prevent further complications. In terms of surgical needs, 12.5% of patients were taken to the operating room, a figure that reflects the severity of the injuries observed. Among them, the vast majority (98.63%) were referred to a neurosurgeon, indicating the predominance of intracranial injuries, while a small proportion (1.37%) were referred to a trauma surgeon, pointing to the presence of associated injuries requiring specialized intervention. These data highlight the complexity and diversity of injuries and the need for multidisciplinary management in treating severe traumatic brain injury.

IV. Discussion

In our study of patients with severe traumatic brain injury, it was clearly observed that males were significantly more affected, accounting for 93.15% of cases. This male predominance aligns with existing literature. For instance, a retrospective study using data from the Qatar Trauma Registry also highlighted a sex discrepancy among TBI patients, although the exact proportions were not specified in the available excerpt [1]. Other research emphasizes that traumatic brain injury is a major public health issue, with higher incidence and prevalence typically found among men than women [2].

The mean age of affected individuals in our study was 33.5 years, indicating a marked vulnerability in this age group. Literature also shows a wide age distribution among TBI patients, with hospitalization rates varying across age groups [3]. Another study explored age distribution by sex in a pediatric TBI population, although specific details were not provided in the available excerpt [4]. These findings are consistent with the age range observed in our study (0.5 to 68 years) and underline the need for tailored approaches in the initial prehospital management of TBI, taking into account the diversity of ages affected.

It is crucial to note that age and sex differences in TBI prevalence can influence the administration of prehospital care. Considering demographic characteristics can help optimize the initial management of severe TBI by tailoring interventions to the specific needs of different patient groups. Moreover, understanding disparities across sex and age groups can provide valuable insights for TBI prevention strategies.

In our study, the majority of severe TBI cases were due to road traffic accidents, representing 68.49% of all cases, followed by falls (24.66%) and assaults (6.85%). These findings are consistent with other studies that identify road accidents and falls as leading causes of TBI. For example, a narrative review reported that falls and work-related injuries were cited as the second most common cause of TBI [5].

In terms of transport, 97.26% of patients were brought to the hospital by ambulance, highlighting the crucial role of emergency medical services in the prehospital management of severe traumatic brain injury (TBI). Other studies have also examined the impact of transport mode on patient outcomes. A multivariable analysis found that mode of transport, among other factors, was correlated with intubation, although only pupillary reactivity was independently associated with outcomes [6]. It is important to note that transport time can impact outcomes in patients with severe TBI, as indicated by a study showing that prehospital care and transport time can influence patient prognosis [7].

Moreover, the average delay of 9.31 hours between the accident and hospital admission observed in our study highlights a potential area for improvement in the speed and efficiency of prehospital transport. Prehospital care is clearly an essential part of the treatment process for many acute illnesses and traumas [8]. Reducing this delay may be crucial to improving outcomes in patients with severe TBI.

Our results reflect trends observed in other studies and highlight key areas for improvement in prehospital care and patient transport in cases of severe traumatic brain injury.

In our study, the initial neurological assessment revealed that 97.26% of patients sustained closed head injuries, while only 2.74% had open head trauma. These findings are consistent with existing literature, which defines TBI as either open (penetrating) or closed (non-penetrating), depending on the nature of the external force applied to the brain [9]. The classification of TBI as severe, moderate, or mild is typically based on clinical severity assessed using the Glasgow Coma Scale (GCS) [10].

Regarding seizures, a notable majority of 91.78% of patients did not experience any, which warrants further exploration in the literature to better understand clinical implications and associated factors.

As for the initial GCS score, our study found that a plurality of patients (43.55%) recorded a score below 8, indicating severe brain injury. Additionally, 24.19% had a moderate score between 8 and 13, while 32.26% had a high score between 14 and 15, suggesting mild or no brain injury. These findings are in line with standard practice in TBI severity assessment, where a score of 8 or less typically corresponds to severe TBI [11–12].

The diversity of GCS scores in our cohort underscores the wide range of clinical presentations among patients with severe TBI, which may influence both management and prognosis. Further analysis of factors contributing to GCS variation and its implications for prehospital care could provide valuable insights for improving patient management.

In our study, pupillary assessment revealed that 60.93% of patients had symmetrically reactive pupils. This observation is consistent with literature that highlights the importance of pupillary evaluation in the neurological assessment of TBI patients. Pupillary responses can provide information on the degree of brain injury and neurological reactivity. Changes in pupillary reactivity may signal neurological deterioration, potentially indicating expanding intracranial lesions or impending brain herniation [13].

The lack of information regarding neurological deficits in a large proportion of patients (73.97%) is a notable aspect of our study. This lack of data could be due to several factors, such as the severity of the trauma, the patient's level of consciousness, or the limitations of prehospital services in conducting complete neurological assessments in the field.

Scalp wounds and skull depressions (depressed fractures) were relatively rare in our sample, consistent with the predominance of closed head injuries (97.26%) observed. Literature indicates that closed head trauma is often associated with diffuse brain injury rather than focal lesions, which may explain the absence of visible scalp wounds or other external trauma signs [14].

With regard to hemodynamic evaluation, several findings emerged in our study. Initially, the stability of 71.23% of patients compared to 28.77% who were unstable was a significant observation. In the context of severe TBI, prehospital secondary brain injuries are often linked to poor outcomes, underscoring the importance of early and precise management during the prehospital phase to potentially improve outcomes and reduce mortality rates [15].

Regarding blood pressure, the most commonly observed measurement was 90/60 mmHg, seen in 27.40% of individuals. Guidelines for prehospital management of severe TBI emphasize monitoring for hypotension, defined as systolic blood pressure (SBP) below 90 mmHg. These recommendations underline the critical importance of maintaining adequate blood pressure to prevent secondary brain injury [16]. Our results align with these guidelines, although the specific measurement of 90/60 mmHg warrants further exploration in the broader literature to fully understand its implications.

The average observed heart rate was 101 beats per minute. Although this specific value is not directly addressed in the referenced guidelines, heart rate remains a crucial parameter in hemodynamic evaluation to ensure adequate cerebral and systemic perfusion and oxygenation.

Upon examining the conjunctival status, 83.56% of patients had normally colored conjunctivae, which is reassuring, while 16.44% showed pale conjunctivae. Although not directly discussed in the literature, conjunctival color can serve as an indirect indicator of perfusion and oxygenation and may offer valuable insight into a patient's hemodynamic status.

Additionally, a reassuring 97.26% of patients did not present with hemorrhagic shock, a critical element in the initial assessment of patients with severe TBI in prehospital settings. Literature reaffirms the importance of optimal management of blood pressure, airway, ventilation, and oxygenation, as these factors significantly influence outcomes following severe TBI [17].

The variability in blood pressure, heart rate, and conjunctival color—alongside the presence or absence of hemorrhagic shock—are key hemodynamic parameters requiring meticulous prehospital evaluation to effectively tailor management strategies. Hemodynamic stability plays a pivotal role in prognosis and care planning for TBI patients, emphasizing the necessity of thorough initial assessment and timely intervention to mitigate secondary brain injury and improve overall outcomes.

In our study, initial respiratory management involved various interventions to ensure adequate ventilation, aligning with the literature that emphasizes the importance of optimal airway and ventilation management in patients with severe TBI. A significant majority (60.27%) were intubated and ventilated, consistent with current recommendations that stress mechanical ventilation to protect the airway from aspiration risk and to prevent hypoxemia and hypercapnia—two major systemic contributors to secondary brain injury [18]. Protective ventilation, in particular, has shown benefit in the early phase of brain injury [19].

Another 31.51% of patients received oxygen via face mask, and 8.22% were supported with nasal cannulas, reflecting individualized oxygenation strategies based on the severity of injury and respiratory status. Although most patients (95.89%) did not require thoracic drainage, a small proportion (4.11%) did—again

aligning with literature noting that severe respiratory failure develops in 20–25% of isolated severe TBI cases and is associated with increased risk of mortality and vegetative state [20].

The literature emphasizes the need for intensive management, with particular attention to airway, oxygenation, and adequate hemodynamic support to avoid secondary insults such as hypoxia and hypotension [21]. It is crucial to adapt respiratory interventions to the specific needs of TBI patients to minimize secondary brain damage and optimize clinical outcomes.

Our study highlighted the importance of precise lesion assessment through various imaging modalities. Cranial CT scans were performed in 95.89% of cases, in line with standard recommendations to conduct CT imaging for all suspected severe TBI cases, underscoring its critical role in intracranial lesion evaluation [22]. Cervical spine CT was performed in 82.19% of patients, reflecting the need to assess associated injuries often present in severe head trauma. Whole-body CT ("BodyScanner") was used in 20.55% of patients to evaluate multi-system injuries. While cervical spine X-rays were less frequently used (85.94% did not have one), chest and pelvic radiographs were commonly performed to assess associated injuries, particularly in polytrauma cases. Abdominal ultrasound was used in just over half of patients (54.69%) and remains a key diagnostic tool to identify potential intra-abdominal injuries.

These findings underline the importance of systematic and thorough evaluation to identify and manage associated injuries during the initial management of patients with severe TBI, as recommended in the literature [23–24].

The high prevalence of brain contusions observed in our study aligns with literature describing cerebral contusions as common lesions following severe TBI. The progression of contusions is often explored under the concept of "progressive hemorrhagic injury," which also includes other types of intracranial hemorrhages such as subarachnoid, subdural, and epidural hemorrhages [25]. Cerebral edema was present in about 39% of cases in our study, indicative of the trauma's severity and consistent with literature citing cerebral edema as a frequent post-traumatic complication.

Meningeal hemorrhages and hematomas are notable complications post-TBI. Subdural and epidural hematomas are particularly concerning and may require surgical intervention. Literature also notes the likelihood of expanding intracranial hemorrhage following TBI, necessitating careful monitoring and management [26]. Facial and skull base fractures are associated injuries that can occur with severe TBI and may signal the extent and severity of the trauma.

The large proportion of patients in a state of severe polytrauma and intubated illustrates the complexity and seriousness of injuries associated with TBI. Severe TBI is a major cause of disability and death in individuals under 45 years old, reflecting its significant public health impact [27–28]. Variability in injury incidence and severity among patients underscores the need for in-depth evaluation and tailored management in the prehospital context of TBI care.

Initial hemodynamic management in the prehospital setting for severe TBI is essential to optimize patient outcomes. Our study found that nearly all patients (97.26%) had a venous line established, facilitating the administration of medication and fluids—consistent with current recommendations. According to the Brain Trauma Foundation, a peripheral venous line should be established as early as possible after EMS arrival, and fluids should be administered to maintain adequate blood pressure, although fluid type may vary [29].

In our sample, 80.82% of patients received fluid resuscitation to stabilize their hemodynamic status. Fluid administration is a key strategy to maintain both cerebral and systemic perfusion. Literature suggests that hypertonic saline solutions may be beneficial in managing severe TBI, although further research is needed to identify the optimal fluid therapy for prehospital care [30].

Urinary catheterization was performed in 35.62% of patients in our study, while the majority (64.38%) did not undergo this procedure. This likely reflects the severity of injuries and clinical priorities. Monitoring urine output and kidney function is essential but may be deferred until hospital arrival if other life-saving interventions take precedence.

Furthermore, a minority of patients (12.33%) received a blood transfusion, reflecting individualized clinical assessment of transfusion needs in the context of TBI and associated injuries. Blood transfusions may be necessary in cases of active bleeding or hemorrhagic shock, and specific guidelines exist for transfusion management in trauma patients, including those with TBI [31].

In the initial neurological management of TBI patients in prehospital settings, appropriate sedation and spinal stabilization are critical. Among patients requiring sedation (41.10% in our study), bolus administration was the approach for the vast majority (98.63%). This aligns with guidelines emphasizing the importance of maintaining adequate oxygenation and ventilation while avoiding hypoxia, which is a major risk factor for secondary brain injury [32–33]. The primary goal in prehospital care is to identify and manage potentially life-threatening increases in intracranial pressure to prevent brain herniation and secondary injuries [34].

Regarding spinal stabilization, the majority of patients (98.63%) in our study did not receive a cervical collar. This observation may be influenced by specific management protocols or the nature of the injuries. While

the placement of a cervical collar is commonly practiced when spinal injury is suspected, protocols may vary depending on the initial clinical assessment and the symptoms presented by the patient.

Prehospital management of TBI patients is inherently complex, requiring rapid assessment and timely interventions to minimize morbidity and mortality. Prehospital care providers play a vital role in initiating life-saving interventions, making critical decisions, and guiding patients toward definitive care [35].

Limb immobilization and surgical referrals are critical components of the initial management of patients with severe traumatic brain injury, particularly in cases of multiple injuries. Proper immobilization of the spine and limbs is essential to prevent additional complications in these patients. One study emphasized the importance of appropriate training for prehospital EMS technicians to ensure proper immobilization in patients suspected of spinal or limb injuries [36]. Another study found that the effectiveness of spinal and limb immobilization was inadequate in over 90% of cases, further highlighting the need for improved EMS training [37].

Regarding surgical management, the Brain Trauma Foundation offers specific guidelines for the surgical treatment of severe TBI [38]. These recommendations highlight the importance of timely referral to a neurosurgeon to assess and manage intracranial injuries. This is reflected in our findings, where most patients taken to the operating room were referred to a neurosurgeon.

These insights support the observations from our study regarding limb immobilization and surgical needs, emphasizing the complexity and diversity of injuries associated with severe TBI and the need for multidisciplinary management**.**

V. Conclusion

Our comprehensive study on the initial assessment and management of severe traumatic brain injury (TBI) in the pre-admission phase has revealed critical insights and highlighted specific areas in need of ongoing attention and improvement.

The prominent role of **road traffic accidents** as the leading cause of TBI, combined with the significant predominance of **male patients**, underscores the importance of **targeted preventive measures** and tailored intervention strategies.

The **notable delay** between injury and hospital admission points to a clear need for **optimization of prehospital transport and care processes**, ensuring timely and effective treatment—crucial to minimize complications and improve long-term outcomes.

The **clinical variability** in presentation, associated injuries, and required interventions—as evidenced by data on **neurological, hemodynamic, and respiratory status**—highlights the inherent complexity in managing TBI. Each patient presents a unique set of challenges that demand **rapid, accurate assessment and early intervention**.

In conclusion, this study identifies **significant opportunities** to refine **prehospital strategies** and optimize the **initial care** of patients with severe TBI. Further research and continuous analysis are essential to **develop more effective interventions** aimed at **reducing morbidity and mortality** associated with traumatic brain injury.

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