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Trends in Etiology and Mortality in Severe Polytrauma Patients with Traumatic Brain Injury: A 25-Year Retrospective Analysis

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Abstract

Background: Polytrauma is a leading cause of mortality and disability worldwide. Despite a decline in trauma-related deaths over recent decades, the specific factors driving this trend remain unclear. Traumatic brain injury (TBI) is the primary cause of death and long-term disability among polytraumatized patients, making it a key determinant in outcomes. **Methods:** This retrospective observational study analyzed a prospectively collected trauma registry over a 25-year period (1993–2018) at Gregorio Marañón University General Hospital (Madrid, Spain). The study included adult patients with polytrauma and associated TBI. Epidemiological, clinical, and outcome data were analyzed globally and across four time periods to assess trends. **Results:** Among 768 patients with PTBI, the mean age was 43 years (±20), with 71% being male. Most had closed TBIs (96%) and severe injuries to the head, chest, and extremities (median ISS/NISS: 27/34). Emergency surgery was required in 51% of cases, and 84% were admitted to intensive care units. Over time, patient age, comorbidities, and prehospital care increased, while ISS/NISS scores and early mortality decreased. Mortality dropped significantly—especially deaths within the first 24 hours—primarily due to improved hemorrhage control. However, TBI-related mortality remained stable at 28%. **Conclusions:** The incidence of polytrauma declined over time, notably due to fewer traffic-related injuries—likely reflecting advances in safety legislation and prevention. Despite an aging and more comorbid patient population, overall mortality decreased, highlighting the impact of improved trauma care. TBI continues to be the leading cause of death and a persistent clinical challenge.

Keywords: trauma epidemiology; traumatic brain injury; trauma mortality

1. Introduction

Trauma is a major global public health issue and one of the leading causes of death worldwide [1], responsible for over 5.8 million deaths annually and a significant proportion of fatalities in people under 45 [2] According to the WHO, the main causes include road traffic accidents, suicides, and homicides [3]. In Spain, it remains common, mainly due to traffic accidents, falls, and high-energy impacts, though these trends have changed over time [4].

Although the global epidemiological landscape of health issues was significantly impacted by the COVID-19 pandemic [5], declines in morbidity and mortality patterns had already been observed prior to its onset [6]. These improvements were largely due to medical advances and the centralization of trauma care in specialized centers [1,7]. In addition, legal and technical interventions—particularly those aimed at reducing traffic-related injuries—may have contributed to a downward trend in trauma incidence and its associated morbimortality [8,9]. All this highlights the importance of examining how the clinical and epidemiological profile of severe trauma patients have evolved in specialized centers over the long term.

Effective management of severe polytrauma requires evaluating trauma severity, physiological impact, and injury distribution using tools like the Glasgow Coma Scale (GCS), the Abbreviated Injury Score (AIS), the Injury Severity Score (ISS), and the New Injury Severity Score (NISS) among others [10–13]. Traumatic brain injury (TBI) is recognized as the primary determinant of both mortality and long-term disability, making its thorough assessment essential [14–16]. Early diagnosis, hemorrhage control, and multidisciplinary care in specialized centers has shown to significantly improve patient outcomes [17–20], although precise and updated data from lon-term series are still lacking. This study examines the incidence, causes, and prognostic factors of severe polytrauma with TBI (PTBI) based on data collected from 1993 to 2018 at a level I trauma reference hospital in Madrid, Spain.

2. Materials and Methods

Study Design and Methods

This is a retrospective study using prospectively collected data over a 25-year period prior to the COVID-19 pandemic. It includes adult patients with severe traumatic brain injury (TBI), either as isolated trauma or as part of polytrauma, treated at the Emergency Department of Hospital General Universitario Gregorio Marañón (HGUGM) between June 1993, and October 2018.

Inclusion Criteria

- Adults with severe trauma (ISS>15) with TBI
- Treated at HGUGM
- Trauma occurring between 1993 and 2018
- Accessible data

Variables Analyzed

Epidemiological, clinical, prehospital and in-hospital course, initial treatment, intensive care unit (ICU) admission, hospitalization, mortality, and complications. The study initially evaluates the entire cohort and then subdivides it into four equal-duration groups (73.25 months) to assess temporal trends (1993-1999; 1999-2005; 2005-2012; 2011-2018).

Specific Variables Included:

- Epidemiological: age, sex, trauma date
- Medical history and trauma characteristics: type (blunt/penetrating), intent (accidental/self-inflicted/assault)
- Trauma cause: traffic accidents (car, motorcycle, pedestrian), falls, assaults, others
- Severity indicators and protective factors: seatbelt/helmet use, fall height, prehospital vital signs, care by emergency medical teams (SAMUR-061), initial shock, cardio-pulmonary resuscitation (CPR), intubation, lactate, fluid resuscitation
- In-hospital: vital signs, emergency surgery, transfusions, injury location and severity (AIS, ISS, NISS)
- Outcomes: ICU admission, complications, and mortality (day 1, 30-day, overall), including preventable deaths

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation for normally distributed data, or as median and interquartile range for non-normally distributed data. Categorical variables were analyzed using Pearson's Chi-square test with odds ratios (OR) and 95% confidence intervals (CI), or Fisher's exact test when appropriate. Quantitative variables were compared using Student's t-test for parametric data and the Kruskal-Wallis test for non-parametric data. Binary logistic regression was employed for multivariate analysis. Survival analysis was performed using Kaplan–Meier survival curves, and Cox regression models were used to estimate hazard ratios (HR) with 95% confidence intervals. All analyses were conducted using IBM® SPSS® Statistics version 29, with statistical significance set at $p < 0.05$.

3. Results

A total of 2,816 polytraumatized patients who met the study's inclusion criteria were reviewed. They had a median ISS of 21 and an overall mortality rate of 17%, with traumatic brain injury being the leading cause of death (45%). From this group, only patients with associated polytrauma and traumatic brain injury (PTBI) were selected—768 cases—and the study variables were analyzed accordingly.

3.1. General Analysis

The annual incidence of PTBI was heterogeneous (Figure 1), as were the causes of trauma. Road traffic accidents (RTAs) were the leading overall cause (58%). However, the frequency and type of RTAs varied over time, with car accidents predominating in the earlier years and pedestrian injuries becoming more frequent towards the end of the study period ($p < 0.001$). These trends were associated with different patterns of protective measures (e.g., seatbelt and helmet use), which are described later. The remaining PTBI cases were due to falls from height (29%), suicide attempts (5%), assaults without weapons (4%), and assaults involving sharp or firearm weapons (3%).

Regarding patient characteristics, summarized in Table 1, the mean age of the 768 PTBI cases was 43 years (±20), with a predominance of male patients (71%). Most TBIs were closed injuries (96%). A substantial number of patients (53%) had no relevant medical history, while 19% had one significant pre-existing condition, and 21% had two or more.

Most patients presented with severe associated injuries to the head, chest, and extremities as disclosed in AIS scores, with median ISS and NISS scores of 27 and 34, respectively. Of these, 51% required emergency surgery—half of which involved the central nervous system (CNS). Additionally, 84% were admitted to intensive care units, with a median stay of 8 days, providing evidence that most patients presented with severe or life-threatening conditions.

As for complications, 50% of patients did not develop clinically significant complications and only 9% required reoperation. The overall mortality rate was 34%. Mortality occurred in 8% upon arrival and in 19% within the first 24 hours, with a median time to death of 14 days. The distribution of causes of death shows brain injury as the most common etiology (28%) followed by exsanguination (5%).

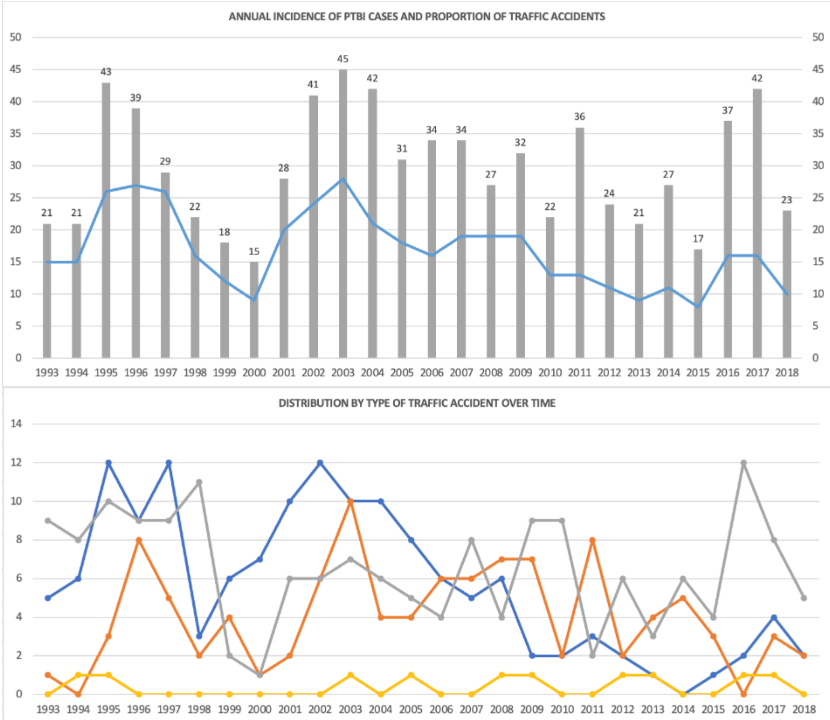

Figure 1. Distribution of the patient series over the 25-year study period. **Top:** Annual number of total PTBI cases (bars) and proportion attributed to road traffic accidents (line). **Bottom:** Breakdown of traffic accident types by year. Colors represent specific mechanisms: blue = car accidents, orange = motorcycle, gray = pedestrian (run-over), yellow = bicycle.

Table 1. General characteristics of the patient cohort. **SD**: standard deviation; **CPR**: cardiopulmonary resuscitation; **IQR**: interquartile range; **AIS**: Abbreviated Injury Scale.

PATIENTS (n/%)			INITIAL NEUROLOGICAL ASSESSMENT		
Age in years (mean, SD)	**43**	**20**	**Pupillary disfunction (n/%)**	129	17
Male	548	71	Deficit (n/%)	52	7
Female	220	29	**INJURIES BY REGION AND SEVERITY (median, IQR)**		
Number of comorbidities			Head AIS	4	3-5
0	409	53	Face AIS	0	0
1	145	19	Thorax AIS	2	0-3
≥2	158	28	Abdomen AIS	0	0-2
Type of comorbidities			Extremities AIS	2	0-3
Hypertensión	65	9	Skin AIS	0	0-1
Cardiopathy	23	3	ISS	27	19-38
Ischemic heart disease	23	3	NISS	34	24-41
Diabetes	32	4	**INITIAL SURGERIES (n/%)**		
Anticoagulation	33	4	Chest tube	169	22
Substance abuse	38	5	Emergent surgery	388	51
Alcoholism	32	4	Neurosurgery	193	25
Psychiatric disorder	61	8	**MORTALITY (n/%)**		
INITIAL MANAGEMENT (n/%)			Total deaths	262	34
061-SAMUR team	722	94	Death upon arrival	64	8
Prehospital status			Death on first day	137	19
Intubation	488	64	**CAUSE OF DEATH (n/%)**		
CPR	36	5	CNS injury	212	28
Apnea	115	15	Exanguination	40	5
Shock	136	9	Sepsis	13	2
CAUSES OF SHOCK AT ADMISSION (n/%)			Multiorgan failure	13	2

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CNS	36	26	Distributive shock	5	0.7
Multiple	26	19	Cardiorrespiratory injury	14	2
Hemoperitoneum	20	15	**COMPLICATIONS (n/%)**		
Fractures	12	9	1	252	33
Other	42	31	>1	14	2

3.2. Initial Care

Regarding prehospital care, 94% of patients were treated by 061-SAMUR emergency teams. Endotracheal intubation was required in 64% of cases, and CPR was performed in 5%. Initial shock was observed in 18% of patients, mainly due to CNS injury or hemorrhage (Table 1). Despite this, most patients arrived at the hospital in hemodynamically stable condition, although with severe neurological impairment: the median GCS score was 7; 52% of patients presented with a GCS below 8 upon initial assessment, and 17% exhibited pupillary abnormalities.

3.3. Period-Base Analysis

Patient characteristics were then analyzed across four equal time periods (Table 2). A progressive increase in mean age was observed from 38 to 54 years ($p < 0.001$), along with a higher proportion of female patients, from 25% to 37% ($p = 0.014$), and a significant rise in comorbidities, from 21% to 61% ($p < 0.001$). In addition to the previously mentioned variation in the incidence of RTA ($p < 0.001$), there was an increase in suicide attempts, from 0% to 13% ($p < 0.001$), and in the proportion of patients treated by prehospital emergency services, rising from 89% to 96% ($p=0.016$).

Initial assessment data showed improved neurological status over time, with the median GCS increasing from 3 to 11 ($p < 0.001$), and better systemic condition, as reflected by decreasing median ISS/NISS scores: from 34/41 in the first period to 25/29 in the last ($p < 0.001$), (Figure 2). In contrast, there were no significant changes in the rates of emergency surgery, reinterventions, or ICU admissions.

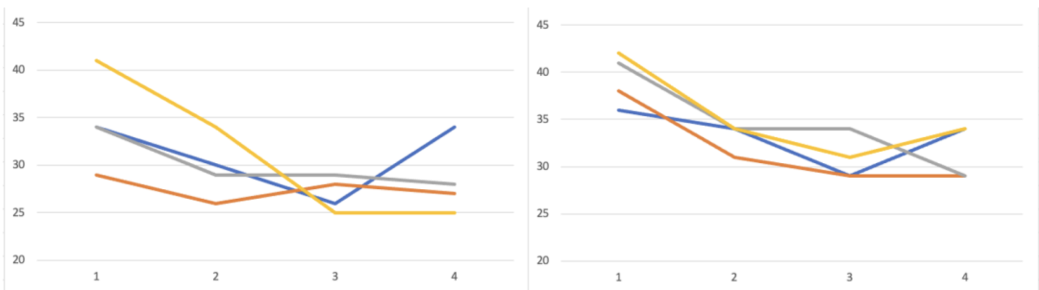

Figure 2. Distribution of ISS values on the left and NISS values on the right across the four evolutionary periods of the study. Colors represent specific mechanisms: blue = car accidents, orange = motorcycle, gray = pedestrian (run-over), yellow = bicycle.

Table 3 presents a detailed analysis by the most frequent causes of PTBI, highlighting differences depending on the injury mechanism. The study shows a progressive decline in car accidents as a cause of polytrauma admissions (from 52 to 12 cases per period), alongside increased referred use of safety measures—likely attributable to legislation and technological advancements. However, in-hospital mortality among these patients remained similar (33%). More notably, motorcycle-related trauma cases remained relatively stable in frequency (from 24 to 18), but there was a marked increase in helmet use providing a greater cerebral protection, as reflected by an improvement in median GCS at admission in these patients (from 4 to 11) and by a significant reduction in mortality, as described below.

Table 2. Evolution of patient characteristics and causes of trauma along the series. SD: standard deviation.

STUDY PERIODS	1	2	3	4
n	184	206	191	187
Age (mean, +/- SD)	38 (+/- 17)	38 (+/- 17)	42 (+/-21)	54 (+/-22)
Sex				
Male	137 (75%)	151 (73%)	143 (75%)	117 (63%)
Female	47 (25%)	55 (27%)	48 (25%)	70 (37%)
COMORBIDITY				
No history	145 (79%)	101 (49%)	91 (48%)	72 (39%)
Hypertension	0	6 (3%)	20 (10%)	39 (21%)
Cardiopathy	0	3 (1%)	6 (3%)	14 (7%)
Ischemic heart disease	0	7 (3%)	6 (3%)	10 (5%)
Diabetes	0	6 (3%)	6 (3%)	20 (11%)
Anticoagulation	0	6 (3%)	5 (3%)	22 (12%)
Substance abuse	6 (3%)	16 (8%)	8 (4%)	8 (4%)
Alcoholism	5 (3%)	14 (7%)	8 (4%)	5 (3%)
Psychiatric disorder	5 (3%)	16 (8%)	17 (9%)	24 (13%)
CAUSE OF TRAUMA				
Car	52 (28%)	59 (29%)	24 (13%)	12 (6%)
Motorcycle	24 (13%)	31(15%)	37 (19%)	18 (10%)
Bicycle	2 (1%)	2 (1%)	2 (1%)	5 (3%)
Pedestrian	59 (32%)	32 (16%)	49 (26%)	59 (32%)
Fall	40 (22%)	36 (17%)	53 (28%)	68 (36%)
Suicide	0	6 (3%)	10 (5%)	25 (13%)
Firearm	4 (2%)	7 (3%)	5 (3%)	3 (2%)
Sharp weapon	1 (0,5%)	2 (1%)	4 (2%)	1 (0,5%)

Table 3. Main epidemiological changes in PTBI caused by traffic accidents.

	TRAUMA BY CAR ACCIDENT				TRAUMA BY MOTORCYCLE ACCIDENT			
Period	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
n	52	59	24	12	24	31	37	18
Age (mean +/- SD)	34 (+/- 14)	34 (+/- 14)	26 (+/-8)	41 (+/-21)	24 (+/-6)	29 (+/-12)	33 (+/-13)	37 (+/-14)
Seat-belt/Helmet n/%(n/%)	7 (13%)	18 (31%)	12 (50%)	9 (75%)	8 (33%)	11 (35%)	21 (57%)	16 (89%)
Scales								
• GCS	5 (3-9)	8 (5-12)	7 (3-14)	6 (4-15)	4 (3-10)	6 (3-11)	7 (3-13)	11 (6-15)
• IIS	34 (24-50)	30 (19-38)	26 (20-34)	34 (26-36)	29 (22-42)	26 (20-36)	28 (22-24)	27 (18-34)
• NISS	36 (25-50)	34 (25-43)	29 (26-41)	34 (29-41)	38 (25-47)	31 (25-41)	29 (22-37)	29 (22-34)
Mortality								
• Total	17 (32%)	18 (33%)	4 (15%)	4 (33%)	5 (20%)	9 (30%)	4 (11%)	2 (11%)
• On arrival	3 (6%)	1 (2%)	1 (4%)	0	0	0	1 (3%)	0
• CNS injury	13 (24%)	13 (24%)	4 (16%)	4 (33%)	3 (12%)	9 (30%)	4 (11%)	2 (11%)

3.3. Mortality Rates

Overall mortality in this series declined significantly from 1993 to 2018 (p=0.039), including early mortality upon arrival (p<0.001), mainly due to a decrease in deaths from exsanguination and distributive shock. Mortality related to central nervous system injury remained stable at 28%. Likewise, a progressive reduction in mortality was observed across the different analyzed time periods. These data are illustrated for selected variables in Figure 3, based on Kaplan-Meier survival analysis and summarized in Table 4.

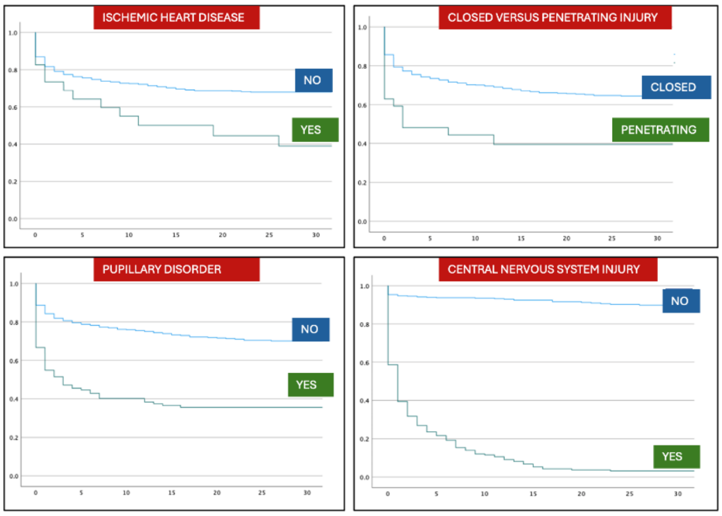

Figure 3. Mortality data according to several variables analyzed. Patient comorbidities as ischemic heart disease, penetrating trauma, pupillary disorder and CNS injury showed an increased mortality rate as depicted through Kaplan-Meier survival function.

Subgroups with the highest statistically significant mortality rates, summarized in Table 5, included patients of advanced age (p<0.001), those with a history of ischemic heart disease (p=0.017), mechanisms such as falls from height (p=0,005) or fire weapon (p<0.001), higher ISS/NISS scores, penetrating injuries (p<0.004), pupillary abnormalities (p<0.001), and markers of severe systemic compromise such as hypotension, intubation, shock, or the need of CPR (p<0.001). Similarly, patients requiring chest tube (p<0.001) and abdominal emergent surgery (p=0.002) showed increased mortalities rates.

Table 4. Evolution of mortality along the study periods. GCS: Glasgow Coma Scale; ISS: Injury Seerity Score; NISS: New Injury Severity Score; ICU: Intensive Care Unit; CNS: Central Nervous System.

PERIODS	1	2	3	4
n	184	206	191	187
TRAUMA SCORES				
GCS	3 (3-9)	8 (3-12)	7 (3-13)	11 (6-15)
ISS	34 (25-50)	27 (17-36)	25 (19-34)	25 (16-34)
NISS	41 (29-50)	32 (22-41)	29 (24-38)	29 (22-38)
INJURY DISTRIBUTION PER REGION (AIS)				
Head	5 (4-5)	4 (3-4)	4 (3-4)	4 (3-5)
Face	0	0 (0-1)	0 (0-2)	0 (0-2)
Thorax	3 (0-4)	3 (0-4)	1 (0-3)	0 (0-3)
Abdomen	0 (0-2)	0	0 (0-2)	0 (0-2)
Extremities	2 (0-3)	2 (0-3)	0 (0-3)	0 (0-3)
Skin	0	0 (0-1)	0 (0-1)	0
INITIAL SURGERIES				
Chest tube	43 (23%)	44 (21%)	39 (20%)	43 (23%)
Emergent surgery	95 (52%)	114 (55%)	99 (52%)	80 (43%)
Neurosurgery	27(15%)	58 (28)	57 (30%)	34 (18%)
ICU ADMITTANCE				
ICU	146 (79%)	181 (88%)	167 (87%)	147 (79%)
MORTALITY				
Total	75 (41%)	73 (35%)	58 (30%)	57 (30%)
On arrival	29 (16%)	10 (5%)	15 (8%)	10 (5%)
First day	61 (33%)	53 (26%)	26 (14%)	27 (14%)

CAUSE OF DEATH				
CNS injury	52 (28%)	61 (30%)	47 (25%)	52 (28%)
Exsanguination	9 (5%)	14 (7%)	14 (7%)	3 (2%)
Sepsis	2 (1%)	6 3%)	4 (2%)	1 (0,5%)
Multiorgan failure	3 (2%)	8 (4%)	1 (0,5%)	1 (0,5%)
Cardio-respiratory	2 (1%)	8 (4%)	3 (1%)	3 (2%)
Distributive shock	1 (0,5%)	2 (1%)	2 (1%)	0

Table 5. Statistical analysis of mortality rates based on different variables. HR: Hazar Ratio; CI: Confidence Interval; CPR: Cardiopulmonary resuscitation; GCS: Glasgow Coma Scale; ISS: Injury Severity Score; NISS: New Injury Severity Score.

VARIABLE	p	HR	CI 95%
PATIENTS			
Advanced age	<0,001	1,01	1,004 - 1,016
Period 4	<0,001	0,806	0,717 - 0,906
Ischemic heart disease	0,017	1,977	1,128 - 3,463
TYPE OF TRAUMA			
Penetrating trauma	<0,004	2,118	1,276 - 3,517
Motorcycle RTA	<0,001	0,457	0,289 - 0,721
Fall from height	0,005	1,458	1,124 - 1,892
Fire weapon	<0,001	2,549	1,457 - 4,457
INITIAL ASSISTANCE			
Intubation	<0,001	2,677	1,950 - 3,674
CPR	<0,001	6,323	4,344 - 9,202
Initial Shock	<0,001	2,808	2,161 - 3,648
Fixed pupil	<0,001	2,851	2,180 - 3,728
GCS	<0,001	0,82	0,790 - 0,851
Normal systolic pressure	<0,001	0,988	0,984 - 0,991
ISS	<0,001	1,055	1,045 - 1,064
NISS	<0,001	1,058	1,049 - 1,067
INITIAL SURGERY			
Chest tube	<0,001	1,544	1,185 - 2,011
Emergent surgery	<0,001	0,394	0,303 - 0,511
Limb surgery	<0,001	0,133	0,071 - 0,252
Abdominal surgery	0,002	1,785	1,231 - 2,588

Although there was a downward trend in hemorrhage-related mortality and among patients requiring non-neurosurgical emergency procedures, mortality related to CNS injury remained unchanged (Figure 3). In fact, this type of mortality remained stable across all analyzed time periods.

4. Discussion

Polytrauma is defined as injury affecting multiple body regions, resulting in two or more major lesions [21–23]. A trauma is considered “major” when the ISS or NISS score exceeds 15, the two main scoring systems currently used to assess trauma severity, both of which correlate directly with the risk of mortality [21,24]. Trauma holds critical significance as it represents one of the major causes of morbidity and mortality, particularly among individuals under 40 years of age, and is the third most common cause of death worldwide [1].

However, it is essential to determine whether major trauma involves TBI, as this is the leading cause of death in these cases [15,20,24–26]. It is also crucial to analyze the causal mechanism (accidents, suicide attempts, assaults) and the patient’s physiology [3,14,27,28], as well as the prioritized, specialized care provided in trauma centers [29–31], since patients with similar ISS or

NISS scores can show very different mortality rates [10,12,13]. Recent studies have proposed new prognostic models (TRISS, CRASH, IMPACT) with stronger correlations to mortality, although they involve more complex analyses and are beyond the scope of this study [11,12,32,33].

Mortality after severe trauma has been significantly reduced in the last decades [2,7,21], especially due to early, protocolized treatment of massive hemorrhage—the foremost preventable cause of death in approximately 40% of cases [6,18,19,34,35]. However, mortality due to TBI remains high. TBI affects an estimated 50 million people annually [14–16,20]. Beyond its lethality, it is the principal source of acquired brain injury in young populations. Its prognosis worsens with hypotension and hemorrhagic injuries, making high-quality care essential to reduce its impact. The origins and prognosis of TBI have evolved in recent decades, thanks to mandatory preventive measures [9,36,37] and improved clinical protocols for stabilizing polytraumatized patients [2,18,20,38].

This study analyzes the incidence, causes, prognosis, and long-term variability of PTBI. Its value lies in the extensive database collected over a 25-year period, allowing us to contribute new, robust data on polytrauma in our setting. This is of significant scientific relevance, as it underscores the current lack of comprehensive, multidisciplinary data on the management of severely polytraumatized patients in Spain. Previous study in this setting is from Chicote et al from 2016 in a pilot phase [39].

The results hereby presented confirm prior epidemiological findings on the incidence of PTBI: it primarily affects middle-aged patients (mean age ~40) and is more frequent in males. RTA remain the most common cause, although falls from height and suicides are increasing as leading causes of major trauma [9,21,23,24,39].

The period-based analysis reveals the temporal evolution of key variables, comparable in scope to the Scottish series by Hamill et al. (1974–2012) [25]. As in that study, we observed a steady increase in the average age of patients, from 38 to 54 years, likely reflecting changes in injury mechanisms and the progressive aging of the population. Although men continue to represent most cases, the gender disparity has gradually diminished over time.

We also observed a gradual increase in relevant comorbidities, even considering missing data from early years. These conditions are known to influence physiological responses to trauma and were associated with higher mortality in our series as well as in previous studies in the literature [2,27]. Nonetheless, contrary to global trends, substance abuse rates remained stable throughout the study period [23,28].

In terms of injury mechanisms, a decline in both car and motorcycle accidents was noted, from 28% to 6%, likely reflecting national legislation (speed limits, mandatory seatbelt and helmet use, enforcement measures) [8,9,40]. In contrast, pedestrian injuries showed a progressive rise—particularly among the elderly and in urban settings—and various strategies are currently under evaluation to address this trend [41]. Notably, suicide-related trauma increased significantly in recent years, increasing till 13% at the final period of the series. This emphasizes a severe public health problem confirmed by suicide rates in Spain reaching 7.906 per 100,000 inhabitants in 2017. These cases demand targeted preventive strategies, as emphasized by national and international agencies (WHO) [42,43].

Over time, nearly all patients received specialized prehospital care, which contributed to improved physiological status upon hospital arrival (evidenced by better trauma scores at admission). Hospital outcomes were favorable in this cohort, likely due to the level I trauma center setting. Specialized center experience has been previously linked to better results, as in the study by Schubert et al., between 2010 and 2015, describing a reduced mortality in American trauma certified centers [1]. Similar results were shown in the series by Moore et al., in Canadian trauma centers, with an 18.2% relative decrease in risk-adjusted mortality in 2012 compared to 2006 [6].

A significant decline in mortality was observed in this study and may be attributed to improved hemorrhage control, modern transfusion strategies, and advanced treatment techniques (e.g., surgical, endovascular, and hybrid room interventions) [2,17,19,35]. As a result, exsanguination-

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related deaths decreased. Yet, mortality due to CNS injury remained the determinant cause of death and even increased slightly in recent years, likely due to the reduction of other causes—highlighting it as a persistent clinical challenge [15,20,24,26].

Limitations of this study include its retrospective design, although nearly all TBI patients treated at HGUGM between 1993 and 2018 were included, minimizing selection bias. Additionally, missing data were more frequent in the early years due to changes in data collection practices. Another limitation lies in the variability and heterogeneity of trauma scoring systems, some of which focus solely on anatomical criteria and are often replaced by newer models in contemporary studies.

5. Conclusions

In conclusion, polytrauma frequency has declined over time in the reviewed series here presented, particularly due to the decrease in traffic accidents. Technical protective advances and legislation may have played an important role in this epidemiological shift. Nonetheless, TBI remains the primary cause of death, albeit with a lower incidence than in earlier years. Despite the trend toward older and more comorbid polytrauma patients, mortality has decreased thanks to significant improvements in both prehospital and hospital trauma care.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki. Ethical review and approval were not required, as the database is historical and patient identification or follow-up is no longer possible.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

AIS	Abbreviated Injury Scale
CNS	Central nervous system
CRASH	Corticosteroid Randomisation After Significant Head Injury
GCS	Glasgow Coma Score
HDUDM	Hospital General Universitario Gregorio Marañon
IMPACT	International Mission for Prognosis and Analysis of Clinical Trials in TBI
ICU	Intensive Care Unit
ISS	Injury Severity Score
NISS	New Injury Severity Score
PTBI	Polytrauma with Traumatic Brain Injury
RTA	Road Traffic Accidents
SAMUR-061	Madrid Emergency Medical Service
TBI	Traumatic Brain Injury
TRISS	Trauma and Injury Severity Score
WHO	World Health Organization

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