Medicina Intensiva 49 (2025) 502165

medicina intensiva

http://www.medintensiva.org/en/

ORIGINAL ARTICLE

Penetrating trauma in Spain: analysis of the Spanish trauma registry (RETRAUCI)

Judit Gutiérrez-Gutiérrez[a,*], Jesús Abelardo Barea-Mendoza[a], Carlos García-Fuentes[a], Juan Antonio Llompart-Pou[b], Begoña Guardiola-Grau[b], Mikel Durán-Suquía[c], María Ángeles Ballesteros-Sanz[d], Javier González-Robledo[e], Lluís Serviá-Goixart[f], Cristina Méndez-Benegassi Cid[g], Jose Maria Toboso Casado[h], Mario Chico-Fernández[a], on behalf of the Neurointensivism and Trauma Working Group of the SEMICYUC

[a] *Servicio de Medicina Intensiva, UCI Trauma y Emergencias, Hospital Universitario 12 de Octubre, Madrid, Spain*
[b] *Servei de Medicina Intensiva, Hospital Universitari Son Espases, Balearic Islands, Spain*
[c] *Servicio de Medicina Intensiva, Hospital Universitario de Donostia, Donostia, Spain*
[d] *Servicio de Medicina Intensiva, Hospital Universitario Marqués de Valdecilla, Santander, Spain*
[e] *Servicio de Medicina Intensiva, Hospital Clínico Universitario de Salamanca, Salamanca, Spain*
[f] *Servei de Medicina Intensiva, Hospital Universitari Arnau de Vilanova, Lleida, Spain*
[g] *Servicio de Medicina Intensiva, Complejo Hospitalario de Torrecárdenas, Almería, Spain*
[h] *Servei de Medicina Intensiva, Hospital Universitari Germans Trias i Pujol, Barcelona*

Received 16 September 2024; accepted 20 January 2025
Available online 25 March 2025

KEYWORDS
Penetrating wounds;
Gunshot wound;
Stab wound;
Mortality;
Epidemiology

Abstract
Objective: To describe the epidemiology of penetrating trauma, mortality associated factors and its management in Spanish intensive care units.
Design: Multicenter, prospective registry. A comparison is established between two cohorts defined by the type of trauma (blunt and penetrating).
Patients: Patients with traumatic injury admitted to the participating ICUs from June 2015 to June 2022.
Interventions: None.
Main variable of interest: Epidemiology, injury pattern, prehospital and hospital care, resource utilization, and clinical outcomes.

DOI of original article: https://doi.org/10.1016/j.medin.2025.502165
* Corresponding author.
E-mail addresses: gutierrezgju@gmail.com, judit.gutierrez@salud.madrid.org (J. Gutiérrez-Gutiérrez).

https://doi.org/10.1016/j.medine.2025.502165

Results: 12,806 patients were eligible, of whom 821 (6.4%) suffered penetrating trauma; 418 patients (50.9%) from stab wounds, 93 (11.3%) from gunshot wounds, and 310 (37.8%) from other objects. The most common intent was assault (47.7%). The mean ISS was 15.2 ± 10.6 in penetrating trauma and 19.8 ± 11.9 in blunt trauma ($p < 0.001$). ICU mortality was 7.8% compared to 11.7% in blunt trauma, with deaths more frequently occurring within the first 24 hours (64% vs. 39%). Factors associated with mortality included female sex, prior use of antithrombotic agents, older age, higher NISS score, and the presence of cranial trauma or shock.
Conclusions: Penetrating trauma is an emergent pathology in our context with high complexity, highlighting the need for focused study and documentation, protocol development, and resource optimization to provide quality care.

PALABRAS CLAVE
Herida penetrante;
Arma de fuego;
Arma blanca;
Mortalidad;
Epidemiología

Traumatismo penetrante en España: análisis del registro español de trauma en UCI (RETRAUCI)

Resumen
Objetivo: Describir la epidemiología del trauma penetrante, los factores asociados a mortalidad y su manejo en unidades de cuidados intensivos españolas.
Diseño: Registro multicéntrico y prospectivo. Se establece una comparativa entre dos cohortes definidas por el tipo de trauma (contuso y penetrante).
Pacientes: Pacientes con enfermedad traumática que ingresan en las UCI participantes de junio 2015 a junio 2022.
Intervenciones: Ninguna.
Variable de interés principal: Epidemiología, patrón lesional, atención prehospitalaria y hospitalaria, consumo de recursos y resultados clínicos.
Resultados: 12806 pacientes fueron elegibles, de los cuales 821 (6,4%) sufrieron un trauma penetrante; 418 pacientes (50,9%) por arma blanca, 93 (11,3%) por arma de fuego y 310 (37,8%) por otro objeto. La intencionalidad más habitual fue la agresión (47,7%). La media de ISS fue de 15,2 ± 10,6 en trauma penetrante y de 19,8 ± 11,9 en trauma contuso ($p < 0,001$). La mortalidad en UCI fue del 7,8% frente al 11,7% en trauma contuso, siendo más frecuente el fallecimiento en las primeras 24 h (64% frente al 39%) en el grupo de traumatismo penetrante. Los factores que se asociaron a mayor mortalidad fueron el sexo femenino, la toma previa de antitrombóticos, la edad, mayor puntuación en la escala NISS y la presencia de traumatismo craneal o shock.
Conclusiones: El trauma penetrante supone una patología emergente en nuestro entorno y con alta complejidad, por lo que es necesario incidir en el estudio y registro de la patología, protocolización y optimización de recursos para ofrecer una atención de calidad.

Introduction

Trauma remains the leading cause of mortality and disability in individuals younger than 35 years,[1–4] with a significant increase in those above 65 years.[5,6] Globally, there are epidemiological and clinical differences between blunt and penetrating trauma depending on the social context.[1,7–9] However, these differences are not welldefined in our setting.

To date, we have limited data on penetrating trauma in Spain, obtained from local retrospective registries[10] and hospital records (using ICD-9-MC coding).[11,12]

An initial snapshot of data, obtained through RETRAUCI, can help provide more information about the epidemiology, clinical characteristics of penetrating trauma, its contributing factors, and its differences vs blunt trauma. Additionally, understanding the epidemiology of penetrating trauma and its impact can help establish potential lines of action and prevention according to the ecological model established by the World Health Organization.[13]

Therefore, the primary endpoint of this study is to describe the epidemiology of penetrating trauma, the factors associated with mortality, and its management in Spanish intensive care units (ICUs). Secondary endpoints include resource utilization analysis, clinical outcomes (organ support in ICUs), while comparing these with a cohort of patients with blunt trauma.

Methods

RETRAUCI is an observational, prospective, and multicenter registry sponsored by the Neurointensivism and Trauma Working Group of the Spanish Society of Intensive and Critical Care Medicine and Coronary Units (SEMICYUC). Currently, it includes 61 national hospitals with the collaboration of 198 investigators who enter updated data on traumatic disease on the platform http://www.retrauci.org. It has been approved by Hospital Universitario 12 de Octubre Ethics Committee (registration code 12/209).

This study analyzes a cohort of patients with severe traumatic injury from June 2015 through June 2022. Data on trauma epidemiology, severity indices, prehospital management, resource utilization, and clinical outcomes have been recorded. Follow-up is conducted until hospital discharge.

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for observational studies has been used.[14]

Definitions

Two patient cohorts are established based on the variable "type of trauma": blunt trauma and penetrating trauma, designated by the investigator coding the patient in the registry based on the predominant mechanism. Three categories of penetrating trauma are established based on the mechanism of action: penetrating trauma by sharp weapon, firearm, and other.

Data obtained from the Revised Trauma Score (RTS) are based on physiological variables from the first medical attention. The Injury Severity Score (ISS) is calculated prospectively by intensivists based on the 2008 update of the Abbreviated Injury Scale (AIS). The New Injury Severity Score (NISS) is the modification of the ISS, which consists of the sum of the squares of the 3 most severe injuries, regardless of the body region injured. Its calculation is performed prospectively based on the coded injury pattern. The probability of survival is calculated using Trauma and Injury Severity Score (TRISS) methodology. Expected mortality is the result of the sum of individual probabilities. Hemodynamic stability is considered when systolic blood pressure is >90 mmHg during initial care. If systolic blood pressure is <90 mmHg but requires only volume administration to recover, the patient is considered unstable yet responsive to volume. Shock is defined as the presentation of blood pressure <90 mmHg requiring only the administration of volume and vasopressor support to normalize. Refractory shock is defined as hypotension refractory to volume administration, vasopressor support, and activation of the massive hemorrhage protocol during initial care. Coagulopathy is defined as prolongation of prothrombin and activated partial thromboplastin times to >1.5 times the control, fibrinogen <150 mg/dL, or thrombocytopenia (<100,000/mcl) in the determination within the first 24 h after admission. Massive transfusion is defined as the need to activate the massive hemorrhage protocol by the clinician. Multiple organ dysfunction syndrome (MODS) is defined as the involvement of $\geq$2 organs with a score $\geq$3 on the Sequential Organ Failure Assessment (SOFA) scale.

Statistical analysis

Quantitative variables are expressed as mean $\pm$ standard deviation (SD) or as median with interquartile range (IQR) based on their distribution. Categorial variables are expressed as absolute values (percentages). Categorical variables were analyzed using the chi-square test or Fisher's exact test. The normality of continuous data was assessed using the Shapiro-Wilk test. For the evaluation of variables showing a non-normal distribution, the non-parametric Wilcoxon Mann–Whitney test was used. For the analysis of causes of mortality and predictive factors, patients managed as intensive care to facilitate organ donation were excluded. Logistic regression was used to determine risk factors for ICU mortality. In the maximum model, variables were included based on their significance ($p < 0.05$) and clinical relevance. The variables shock (shock and refractory shock), presence of TBI (MAIS head $\geq$ 3), and prior anticoagulant/antiplatelet use were dichotomized for analysis based on their absence or presence. p values < 0.05 were considered statistically significant. All statistical analyses were performed using RStudio version 2023.3.1. For the design of the figures, the BioRender® tool with a publication license was used.

Results

During the study period, 12,833 patients were included in RETRAUCI, 12,806 of whom were eligible. 821 (6.4%) suffered penetrating trauma. 418 of these traumas (50.9%) were due to bladed weapons, 93 (11.3%) to firearms, and 310 (37.8%) to other penetrating objects (Fig. 1). The rate of penetrating trauma is significant, although blunt trauma still accounts for more than 90% of all patients with traumatic injury admitted to participaiting ICUs.

Table 1 describes the study population and compares the variables of interest with blunt trauma. Broken down by age intervals, a higher rate of trauma by both mechanisms was observed in the 45–55 age group, although penetrating trauma was more incident at younger ages (23.6% vs 12.9% in patients aged 16–25 and 22.4% vs 13.8% in patients aged 26–35). The most common cause of injury was assault (47.7%) vs blunt trauma, which was accidental.

The mean ISS was 15.2 ± 10.6 in penetrating trauma and 19.8 ± 11.9 in blunt trauma ($p < 0.001$). Based on the AIS classification, the most frequently affected body areas in penetrating trauma were 33.5% in the chest and 23% in the abdomen, accounting for 56.3% of injuries with AIS $\geq$3 in the torso. Other affected areas were extremities (22.5%), head and neck (18.3%), and face (3.7%). In contrast, the body areas most frequently injured in blunt trauma were head and neck (45.9%) and chest (39.2%), followed by extremities (20.1%) and abdomen (14.1%) (Fig. 2).

The chances of survival calculated using TRISS methodology was 84.2 ± 27.6 in penetrating trauma and 81.3 ± 26.9 in blunt trauma ($p = 0.003$). The observed ICU mortality in the sample was 7.8% vs. 11.7% in blunt trauma. Regarding the timeframe distribution of death, blunt trauma tends to have a trimodal distribution (39% within the first 24 h, 36% within the first week, and 25% after day 7) vs. penetrat-

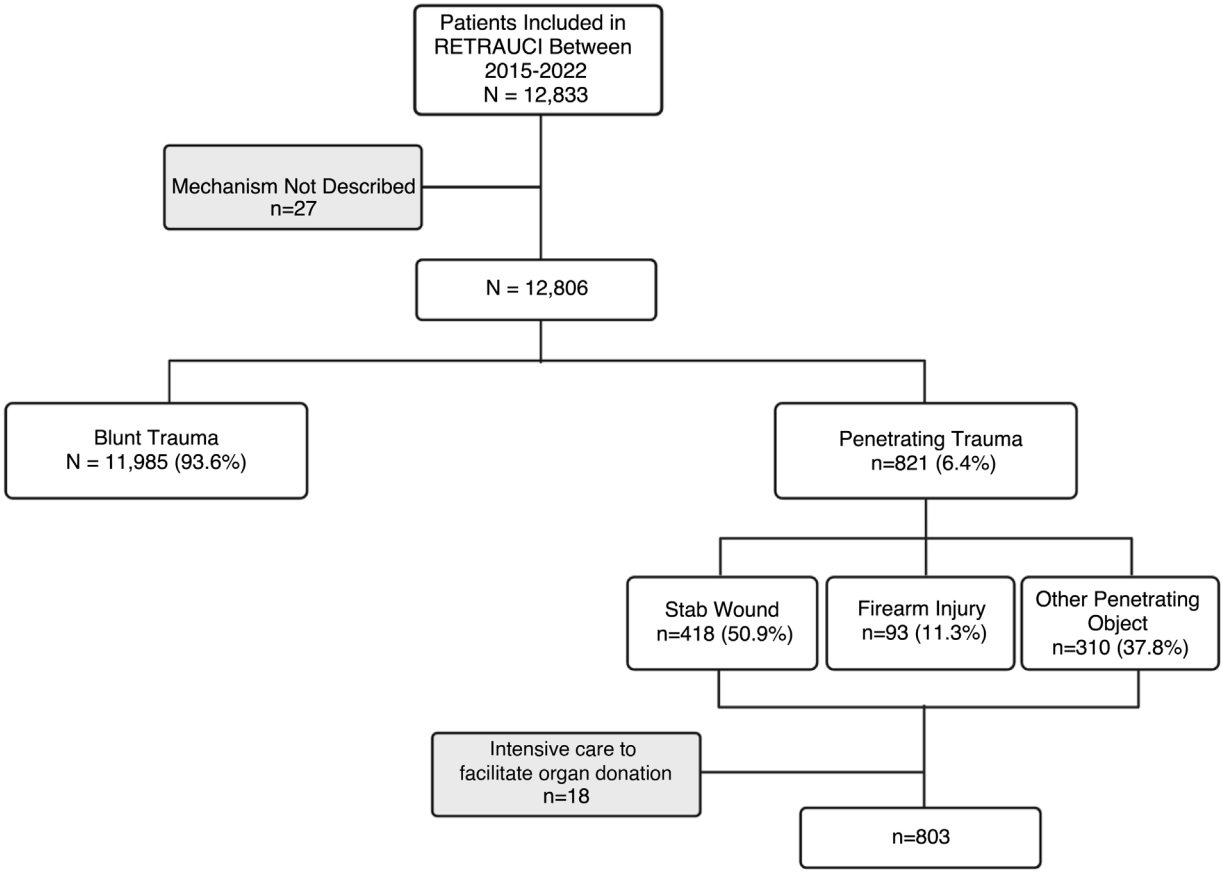

Figure 1 Identification of the cohort.

ing trauma, where death within the first 24 h remains more frequent (64% vs. 39% in blunt trauma) (Fig. 3).

The main cause of death in penetrating trauma was intracranial hypertension (42.1% vs. 19.3% in blunt trauma). After excluding patients admitted for intensive care to facilitate organ donation, the distribution of causes of mortality in penetrating trauma was exsanguinating hemorrhage (28.2%), intracranial hypertension (17.9%), and multiple organ dysfunction (17.9%) (p = 0.278) (Supplementary data 1 and 2).

In the multivariate analysis, independent factors associated with mortality in penetrating trauma were female sex, prior antithrombotic use, age, higher NISS score, and the presence of traumatic brain injury or shock (Table 2).

Discussion

This study provides an initial description of the characteristics of penetrating trauma in Spain. Although blunt trauma remains prevails in our setting, penetrating trauma is a condition with significant prevalence in Spain. Most European registries report incidence rates of penetrating trauma of around 4% or less (including patients with penetrating trauma regardless of ICU admission). In relation to these figures, and, in light of the presented results, Spain could be among the European countries with the highest rates of severe penetrating trauma[15–17] (Fig. 4). However, worldwide, South Africa and the United States are the countries with the highest incidence rate of recorded penetrating trauma at 23%.[18–20]

The incidence rate of this type of trauma has historically been associated with the percentage of interpersonal violence underlying social inequalities.[21,22] Additionally, in times of crisis, the increase in inequalities and, consequently, violence, is more evident. This social context is also reflected in the epidemiology of trauma in our setting, transcending the hospitalization episode and becoming a chronic and recurrent disease, with higher chronic mortality.[3,22,23] Although the most common cause for injury is assault, the percentage of patients who suffer penetrating trauma with suicidal ideation is worth highlighting. In the subgroup of patients older than 65 years who die from a firearm wound, 100% do so with suicidal ideation. This trend is evident in other European registries published in the literature.[24,25]

Considering the presented results, penetrating trauma entails a higher use of advanced prehospital resources, as well as greater utilization of hospital resources such as blood products, with higher percentages of massive hemorrhage protocol activation vs blunt trauma. In our setting, the need for surgery within the first 24 h, being more than double that of blunt trauma, stands out. These data are similar to those coming from other European registries, even with lower overall mortality rates.[15,16]

Patients with penetrating trauma predominantly die within the first 24 h, with the most frequent cause in our series being intracranial hypertension (42.1% vs. 19.3%).

Table 1 Characteristics of the study population. Comparison of major demographic and clinical variables in blunt trauma cases.

	Blunt Trauma (n = 11,985, 93.6%)	Penetrating Trauma (n = 821, 6.4%)	p-value
Demographic variables and severity indices, n (%) mean (SD)			
Age	49.1 ± 19.3	40.2 ± 17.0	<0.001
Age > 65 years	2,963 (24.7%)	73 (8.9%)	<0.001
Sex			<0.001
Women	2,628 (21.9%)	115 (14.0%)	
Men	9,382 (78.1%)	708 (86.0%)	
Mechanism of injury			
	Car accident 1,927 (16.1%)	Stab wound: 418 (50.9%)	
	Motorcycle accident 2,009 (16.8%)	Gunshot wound: 93 (11.3%)	
	Bicycle accident 738 (6.2%)	Other: 310 (37.8%)	
	Pedestrian accident 1,040 (8.7%)		
	Fall 2,852 (23.8%)		
	Precipitation 1,867 (15.6%)		
	Other 1,532 (12.8%)		
Cause of injury			
Traffic-related	5,311 (44.3%)	121 (14.7%)	<0.001
Fall	3,435 (28.6%)	22 (2.7%)	
Work-related	943 (7.9%)	69 (8.4%)	
Sports-related	763 (6.4%)	14 (1.7%)	
Assault	291 (2.4%)	392 (47.7%)	
Self-harm	689 (5.7%)	137 (16.7%)	
Other activities	346 (2.9%)	57 (6.9%)	
Unknown	213 (1.8%)	9 (1.1%)	
Substance Use			
Alcohol consumption (yes)	1,954 (17.8%)	172 (23.2%)	<0.001
Other drug use (yes)	945 (8.6%)	123 (16.6%)	
RTS (mean ± SD)	6.4 ± 2.0	6.6 ± 2.0	0.006
ISS (mean ± SD)	19.8 ± 11.9	15.2 ± 10.6	<0.001
NISS (mean ± SD)	25.6 ± 14.9	21.1 ± 14.2	<0.001
Probability of survival (TRISS) (mean ± SD)	81.3 ± 26.9	84.2 ± 27.6	0.003
Prehospital management			
Prehospital OTI	2,696 (22.7%)	131 (16.1%)	<0.001
Prehospital resources used			<0.001
Mobile ICU	8,646 (72.6%)	677 (82.9%)	
Non-medicalized transport	1,326 (11.1%)	32 (3.9%)	
Helicopter	625 (5.2%)	31 (3.8%)	
No medical transport	902 (7.6%)	61 (7.5%)	
Unknown	413 (3.5%)	16 (2.0%)	
Initial heart rate	84.4 ± 31.1	93.6 ± 29.7	<0.001
Initial SBP	121.4 ± 33.2	111.4 ± 33.5	<0.001
Initial GCS	11.8 ± 4.3	13.3 ± 3.6	<0.001
Initial respiratory rate	17.9 ± 6.3	18.0 ± 6.3	0.700
Hospital management			
Hemodynamic profile			<0.001
Stable	7,683 (65.7%)	414 (51.3%)	
Unstable but responsive	1,477 (12.6%)	140 (17.3%)	
Shock	2,040 (17.4%)	204 (25.3%)	
Refractory shock	499 (4.3%)	49 (6.1%)	
Trauma-associated coagulopathy	1,853 (15.8%)	192 (23.8%)	<0.001
Massive hemorrhage	651 (5.6%)	111 (13.8%)	<0.001
Blood component transfusion (yes)			
Packed red blood cells	2,631 (21.9%)	362 (44.0%)	<0.001
Fresh frozen plasma	1,296 (16.9%)	204 (36.7%)	<0.001
Emergency surgery (< 24 h)	3,993 (33.2%)	561 (68.2%)	<0.001
Multiple organ dysfunction			0.001
Early	978 (8.4%)	55 (6.8%)	
Late[a]	226 (1.9%)	3 (0.4%)	

Table 1 (*Continued*)

	Blunt Trauma (n = 11,985, 93.6%)	Penetrating Trauma (n = 821, 6.4%)	p-value
Days on mechanical ventilation	4.3 ± 12.8	3.7 ± 34.0	0.623
CRRT	192 (1.8%)	14 (2.1%)	0.751
ICU stay	8.7 ± 13.0	5.2 ± 9.3	<0.001
ICU mortality	1,304 (11.7%)	57 (7.8%)	0.002
Life Support Withdrawal (ATSV)			<0.001
AALST	867 (8.0%)	25 (3.5%)	

AALST: Adequation of advance life sustaining therapies; SD: Standard deviation; GCS: Glasgow Coma Scale; OTI: Orotracheal intubation; ISS: Injury Severity Score; NISS: New Injury Severity Score; RTS: Revised Trauma Score; SBP: Systolic blood pressure; CRRT: Continuous renal replacement therapy; TRISS: Trauma Injury Severity Score.

[a] Considered in patients with ICU stays >3 days.

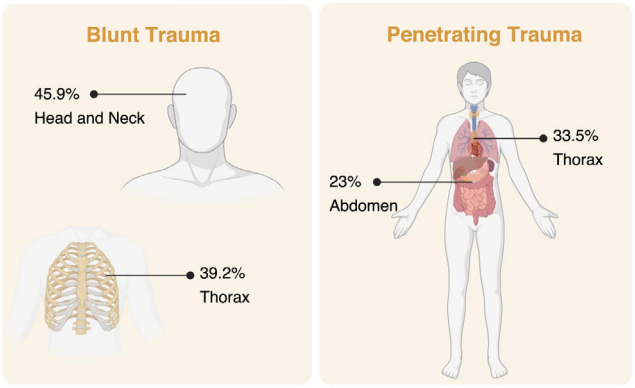

Figure 2 Lesion pattern (percentage of patients with AIS lesion ≥3) in patients with blunt (n = 11,985) and penetrating trauma (n = 821) according to RETRAUCI.

These data contrast with those presented in the literature, where the main cause of death is exsanguinating hemorrhage.[24–26] However, when conducting an adjusted analysis of the causes of mortality, excluding patients admitted for intensive care to facilitate organ donation, it was observed that the predominant cause of death in penetrating trauma was exsanguinating hemorrhage, followed by a non-negligible percentage of patients who die from intracranial hypertension. The presence of variables that could influence this outcome, such as secondary brain injury, traumatic arrest, or cervical vascular involvement, are not recorded in the registry. Regarding the expected mortality in penetrating trauma calculated by the TRISS methodology (15.8%), the observed mortality is less than half (ICU mortality rate: 7.8%).

Most factors associated with higher mortality in penetrating trauma also reflect its severity (higher NISS score, presence of shock, traumatic brain injury, and elder population under antiplatelet or anticoagulation therapy). Although the most common injury pattern in penetrating trauma is torso involvement (with implication of 1 or 2 cavities), the presence of TBI is independently associated with higher mortality rates. Of note, mortality rate is higher in women (OR, 3.8; 95%CI, 1.38–10.44). A gender-adjusted deeper analysis on aspects related to injury pattern, age, cause of injury, and other social determinants is required. The presence of gender-based violence is a variable that is not usually identified in major trauma registries (only a comparable variable is found in the Victorian State Trauma Registry (VSTORM)[27–31] and can help put the problem into perspective.

The 2021 Delphi Consensus on the definition of severe trauma defined it as ä traumatic event that results in fatal damage or significant damage with high physiological impact and requires a high level of intervention.[32] The higher resource consumption and associated mortality of penetrating trauma, mainly within the first 24 h, involves a greater need for trauma intervention, which in turn defines the complexity and severity of this disease.[33]

This study provides a global perspective of penetrating trauma in Spain; however, it has limitations, such as being a retrospective analysis of a national registry. Although it has a high implementation rate across the country, its voluntary participation and the inclusion only of patients requiring ICU admission are limitations for data collec-

Table 2 Factors associated with mortality in penetrating trauma. Multivariate Model (AUROC 0.95).

Variable	Standard Error	Odds Ratio	95% Confidence Interval	p-value
Female sex	0.51	3.80	1.38–10.45	0.01
Age	0.01	1.02	1.00–1.05	0.04
Antiplatelet/anticoagulant use	0.84	5.80	1.01–29.53	0.03
RTS	0.08	0.62	0.52–0.73	<0.01
NISS	0.01	1.06	1.03–1.09	<0.01
Presence of TBI	0.46	2.65	1.06–6.60	0.03
Presence of shock	0.56	6.56	2.35–22.05	<0.01

NISS: New Injury Severity Score; RTS: Revised Trauma Score; TBI: Traumatic brain injury.

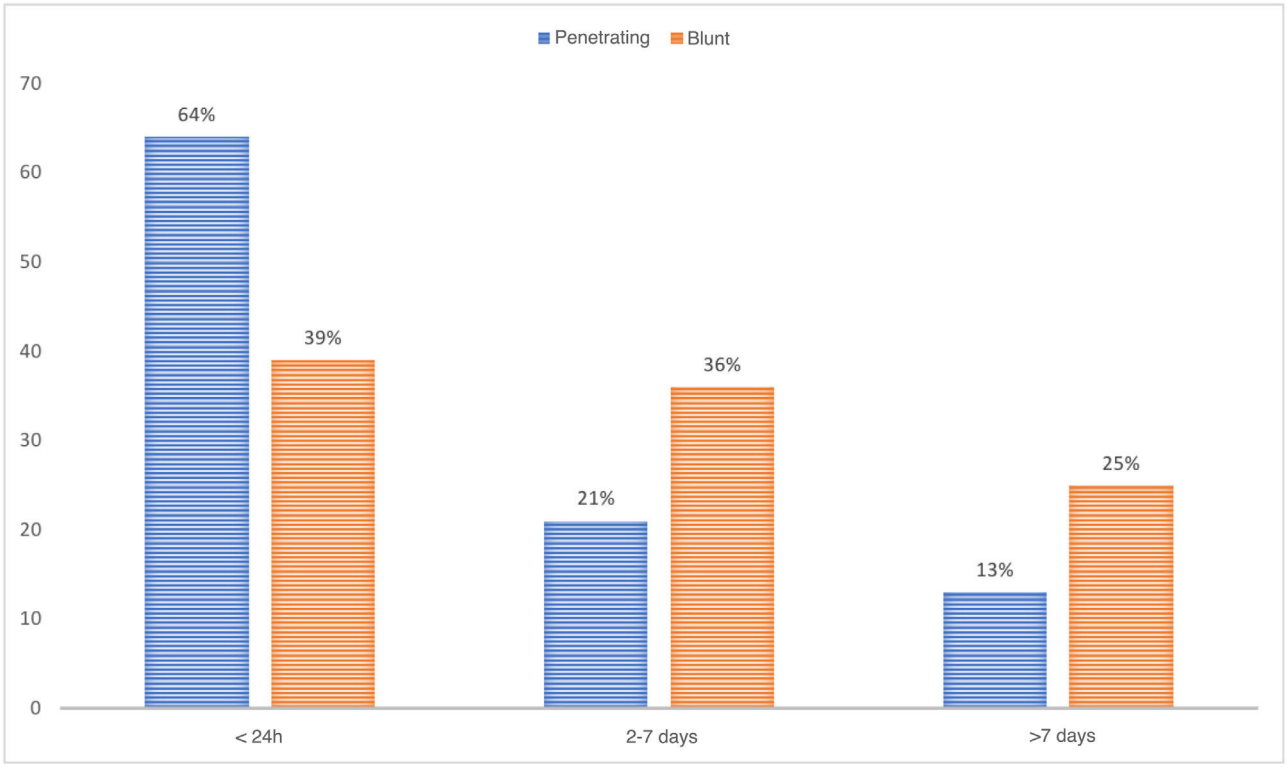

Figure 3 Time distribution of mortality by type of trauma.

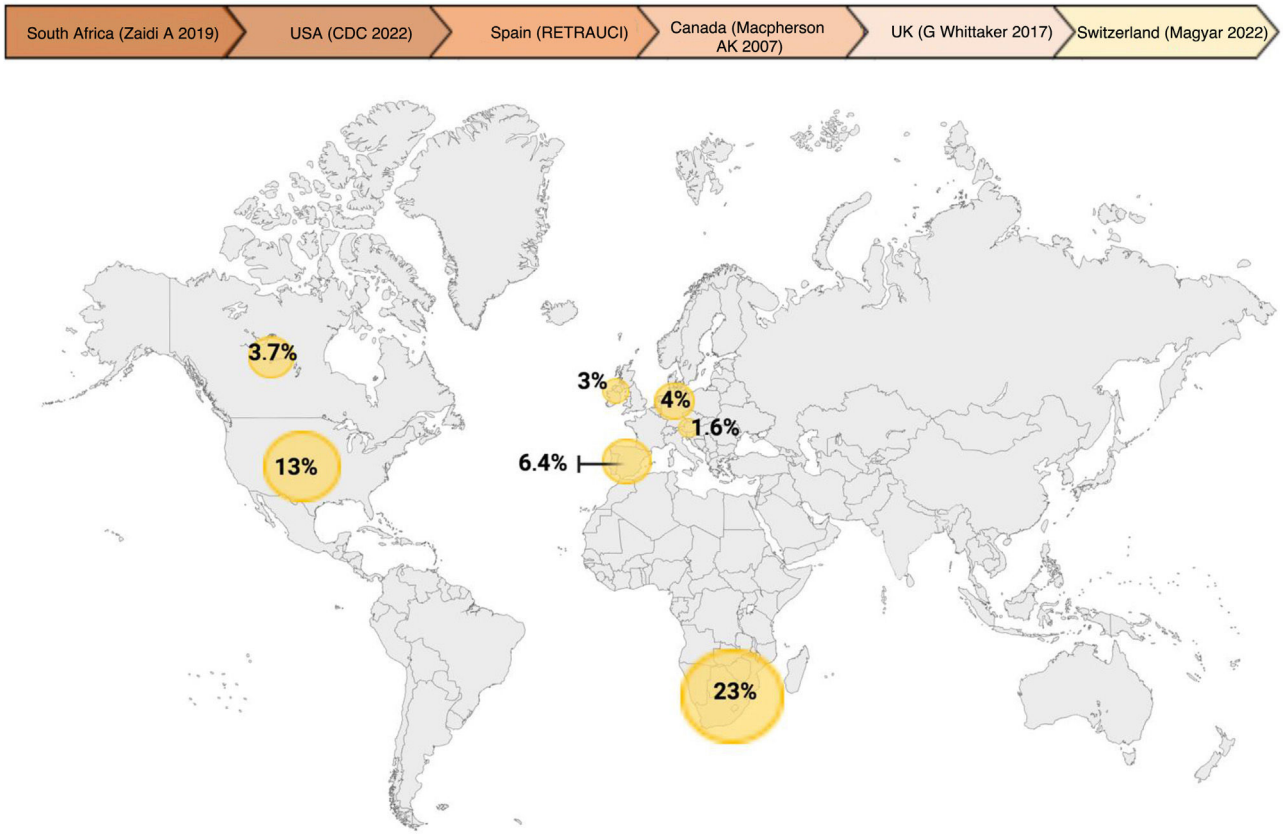

Figure 4 Comparison of the overall incidence rate of penetrating trauma. Figures expressed as percentages based on national records (15–20).

tion. Similarly, patients who die during prehospital care are excluded. The percentage of patients with mixed trauma could influence the evaluation of clinical variables, so it is necessary to redefine the m̈echanismv̈ariable when including patients in the registry (16% are included in the öther mechanismsc̈ategory).

Clinical outcomes depend on multiple factors within the care chain, from prehospital care to hospital arrival and subsequent ICU admission, the analysis of which exceeds the objective of this study and requires a deeper process perspective. In Spain, trauma care is not homogeneous. The trauma code is not present in all regions, with variable prehospital care and transfer times depending on geographical dispersion, as well as variable care upon hospital arrival.[34]

Being a low-prevalence condition in our setting, but associated with high complexity and impact on patients, it is necessary to focus on homogeneous action protocols and clinical practice guidelines, as well as on the training of involved personnel. Traumatic injury is the disease associated with the greatest decrement in quality of life in the critical patient population,[35] which is why its mid- and long-term evaluation and rate of recurrence should be endpoints of future studies. Similarly, a systemic vision is necessary to address both violence and inequalities.

Conclusions

The average rate of penetrating trauma requiring ICU admission in Spain is 6.4%. One in two patients is unstable, requiring higher consumption of prehospital and hospital resources with greater transfusion of blood components. The ICU mortality rate in our series is < 8%, predominantly within the first 24 h. Given the significant prevalence of penetrating trauma in Spain, it is necessary to emphasize the importance of recording related data and analyzing the process, also focusing on the training of personnel involved in the care of these patients and the search for possible preventive activities.

CRediT authorship contribution statement

1 Judit Gutiérrez-Gutiérrez: Study design, data collection, drafting of the first and final draft, approved the final version.
2 Jesús Abelardo Barea-Mendoza: Study design, data collection, statistical analysis, critical review, approved the final version.
3 Carlos García-Fuentes: Data collection, approved the final version.
4 Juan Antonio Llompart-Pou and Mario Chico-Fernández: Data collection, critical review, approved the final version.
5 Begoña Guardiola-Grau, Mikel Durán-Suquía, María Ángeles Ballesteros-Sanz, Javier González-Robledo, Lluís Serviá-Goixart, Cristina Méndez-Benegassi Cid, and Jose Maria Toboso Casado: Data collection, approved the final version.

Funding

None declared.

Declaration of competing interest

None declared.

Acknowledgments

We wish to thank all RETRAUCI investigators for their efforts in data collection.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.medine.2025.502165.

References

1. Krug EG, Sharma GK, Lozano R. The global burden of injuries. Am J Public Health. 2000;90(4):523–6, http://dx.doi.org/10.2105/ajph.90.4.523.
2. Chico-Fernández M, Llompart-Pou JA, Guerrero-López F, Sánchez-Casado M, García-Sáez I, Mayor-García MD, et al., en representación del Grupo de Trabajo de Trauma y Neurointensivismo SEMICYUC. Epidemiology of severe trauma in Spain. Registry of trauma in the ICU (RETRAUCI). Pilot phase. Med Intensiva. 2016;40(6):327–47, http://dx.doi.org/10.1016/j.medin.2015.07.011.
3. Chico-Fernández M, Llompart-Pou JA, García-Fuentes C, Barea-Mendoza JA, Fernández Hervás H, et al. Evolución temporal reciente e impacto de la pandemia COVID-19 en la enfermedad traumática grave (ETGE). Madrid: Fundación MAPFRE; 2023.
4. Giner J, Mesa Galán L, Yus Teruel S, Guallar Espallargas MC, Pérez López C, Isla Guerrero A, et al. El traumatismo craneoencefálico severo en el nuevo milenio. Nueva población y nuevo manejo. Neurología. 2022;37(5):383–9, http://dx.doi.org/10.1016/j.nrl.2019.03.012.
5. Chico-Fernández M, Sánchez-Casado M, Barea-Mendoza JA, García-Sáez I, Ballesteros-Sanz MA, Guerrero-López F, et al., Neurointensive care and trauma working group of the Spanish Society of Intensive Care Medicine (SEMICYUC). Outcomes of very elderly trauma ICU patients. Results from the Spanish Trauma ICU registry. Med Intensiva (Engl Ed). 2020;44(4):210–5, http://dx.doi.org/10.1016/j.medin.2019.01.006. Epub 2019 Feb 21. PMID: 30799042.
6. Llompart-Pou JA, Pérez-Bárcena J, Chico-Fernández M, Sánchez-Casado M, Raurich JM. Severe trauma in the geriatric population. World J Crit Care Med. 2017;6(2):99–106, http://dx.doi.org/10.5492/wjccm.v6.i2.99.
7. Donohue JK, Gruen DS, Iyanna N, Lorence JM, Brown JB, Guyette FX, et al. Mechanism matters: mortality and endothelial cell damage marker differences between blunt and penetrating traumatic injuries across three prehospital clinical trials. Sci Rep. 2024;14(1):2747, http://dx.doi.org/10.1038/s41598-024-53398-1.
8. Stevens J, Phillips R, Reppucci ML, Pickett K, Moore H, Bensard D. Does the mechanism matter? Comparing thrombelastography between blunt and penetrating pediatric trauma patients. J Pediatr Surg. 2022;57(7):1363–9, http://dx.doi.org/10.1016/j.jpedsurg.2021.09.010. Epub 2021 Sep 20. PMID: 34588132.

9. Beattie G, Cohan CM, Tang A, Yasumoto E, Victorino GP. Differences in clinical characteristics and outcomes for blunt versus penetrating traumatic pulmonary pseudocysts. Am J Emerg Med. 2021;45:433–8, http://dx.doi.org/10.1016/j.ajem.2020.09.048. Epub 2020 Sep 23. PMID: 33036865.
10. Serracant A, Montmany S, Llaquet Bayo H, Campos Serra A, Navarro Soto S. Registro prospectivo en politraumatismos graves. Análisis de 1200 pacientes. Cir Esp. 2016;94(1):16–21.
11. Gil-Borrelli CC, Latasa Zamalloa P, Martín Ríos MD, Rodríguez Arenas MÁ. La violencia interpersonal en España a través del Conjunto Mínimo Básico de Datos [Interpersonal violence in Spain through national hospital discharge survey]. Gac Sanit. 2019;33(4):317–24, http://dx.doi.org/10.1016/j.gaceta.2018.02.008. Epub 2018 Jun 1. PMID: 29866371.
12. Agencia de Calidad del Sistema Nacional de Salud. In: Metodología de análisis de la hospitalización en el Sistema Nacional de Salud. Modelo de indicadores basado en el Registro de Altas (CMBD) documento base. Madrid: Ministerio de Sanidad y Consumo; 2007.
13. Departamento de Prevención de los Traumatismos y la Violencia, Organización Mundial de la Salud. In: Prevención de la violencia: guía para aplicar las recomendaciones del Informe mundial sobre la violencia y la salud. Ginebra: OMS; 2006. ISBN 92 4 359207 6.
14. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61(4):344–9, http://dx.doi.org/10.1016/j.jclinepi.2007.11.008. PMID: 18313558.
15. Bieler D, Kollig E, Hackenberg L, Rathjen JH, Lefering R, Franke A, Committee on Emergency Medicine, Intensive Care and Trauma Management(Sektion NIS) of the German Trauma Society (DGU). Penetrating injuries in Germany - epidemiology, management and outcome an analysis based on the TraumaRegister DGU®. Scand J Trauma Resusc Emerg Med. 2021;29(1):80, http://dx.doi.org/10.1186/s13049-021-00895-1. PMID: 34120631; PMCID: PMC8201843.
16. Magyar CTJ, Bednarski P, Jakob DA, Schnüriger B. ''Swiss Trauma Registry''. Severe penetrating trauma in Switzerland: first analysis of the Swiss Trauma Registry (STR). Eur J Trauma Emerg Surg. 2022;48(5):3837–46, http://dx.doi.org/10.1007/s00068-021-01822-w. Epub 2021 Nov 2. PMID: 34727193.
17. Whittaker G, Kovacs A, Paton E. Epidemiology of penetrating injuries in the United Kingdom: a systematic review. Int J Surg. 2017;41:65–9, http://dx.doi.org/10.1016/j.ijsu.2017.03.051.
18. Macpherson AK, Schull MJ. Penetrating trauma in Ontario emergency departments: a population-based study. CJEM. 2007;9(1):16–20, http://dx.doi.org/10.1017/s1481803500014688.
19. Sifford MC, Newgard CD, Garrison HG, Bulger EM, Hedges JR. CDC field triage criteria accurately predict outcomes in high impact trauma. J Inj Violence Res. 2022;14(1):115–24, http://dx.doi.org/10.5249/jivr.v14i1.1650.
20. Zaidi AA, Dixon J, Lupez K, De Vries S, Wallis LA, Ginde A, et al. The burden of trauma at a district hospital in the Western Cape Province of South Africa. Afr J Emerg Med. 2019;9 Suppl:S14–20, http://dx.doi.org/10.1016/j.afjem.2019.01.007. Epub 2019 Jan 19. PMID: 31073509; PMCID: PMC6497867.
21. Programa de las Naciones Unidas para el Desarrollo. Informe Regional de Desarrollo Humano 2021: Atrapados: alta desigualdad y bajo crecimiento en América Latina y el Caribe. Capítulo 4;2021.
22. Dicker R, Brohi K. Violence and surgeons. Br J Surg. 2023;110(10):1247–8, http://dx.doi.org/10.1093/bjs/znad246. Erratum in: Br J Surg. 2023 Oct 10;110(11):1563. doi: 10.1093/bjs/znad268. PMID: 37548285.
23. Ministerio de Sanidad. In: Equidad en Salud y COVID-19. Análisis y propuestas para abordar la vulnerabilidad epidemiológica vinculada a las desigualdades sociales. Madrid: Ministerio de Sanidad; 2020.
24. Scherer J, Jensen KO, Suda AJ, Lefering R, Kollig E, Pape HC, et al. Gunshot injuries in Central Europe - Epidemiology and outcome in Germany, Switzerland and Austria - an analysis based on the TraumaRegister DGU®. Injury. 2024;55(10):111734, http://dx.doi.org/10.1016/j.injury.2024.111734. Epub ahead of print. PMID: 39047388.
25. Holmberg L, Mani K, Linder F, Wanhainen A, Wahlgren CM, Andréasson H. Penetrating trauma on the rise- nine-year trends of severe trauma in Sweden. Eur J Trauma Emerg Surg. 2024, http://dx.doi.org/10.1007/s00068-024-02601-z. Epub ahead of print. PMID: 39078493.
26. Ball CG, Williams BH, Tallah C, Salomone JP, Feliciano DV. The impact of shorter prehospital transport times on outcomes in patients with abdominal vascular injuries. J Trauma Manag Outcomes. 2013;7(1):11, http://dx.doi.org/10.1186/1752-2897-7-11. PMID: 24360286; PMCID: PMC3933386.
27. Victorian State Trauma Registry & Victorian Orthopaedic Trauma Outcomes Registry. [Documento PDF] Versión 6.0 May 2020.
28. Guide to completion the data entry sheet of TraumaRegister DGU®. [Documento PDF].Versión 1.5 for V2020.
29. National Trauma Data Standard. Data dictionary. [Documento PDF]. American College of Surgeons. July 2024.
30. The Trauma Audit and Research Network Standard Dataset Specification I.S.B. 1606. [Documento PDF]. Version Number 0.5.
31. ANZICS CORE - ADULT PATIENT DATABASE. [Documento PDF]. Version 6.1. April 2022.
32. Thompson L, Hill M, Lecky F, Shaw G. Defining major trauma: a Delphi study. Scand J Trauma Resusc Emerg Med. 2021;29(1):63, http://dx.doi.org/10.1186/s13049-021-00870-w. PMID: 33971922; PMCID: PMC8108467.
33. Roden-Foreman JW, Rapier NR, Yelverton L, Foreman ML. Asking a better question: development and evaluation of the need for trauma intervention (NFTI) metric as a novel indicator of major trauma. J Trauma Nurs. 2017;24(3):150–7, http://dx.doi.org/10.1097/JTN.0000000000000283. PMID: 28486318.
34. Dijkink S, Nederpelt CJ, Krijnen P, Velmahos GC, Schipper IB. Trauma systems around the world: a systematic overview. J Trauma Acute Care Surg. 2017;83(5):917–25, http://dx.doi.org/10.1097/TA.0000000000001633.
35. Porter LL, Simons KS, Corsten S, Westerhof B, Rettig TCD, Ewalds E, et al. Changes in quality of life 1 year after intensive care: a multicenter prospective cohort of ICU survivors. Crit Care. 2024;28(1):255, http://dx.doi.org/10.1186/s13054-024-05036-5. PMID: 39054511; PMCID: PMC11271.