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Head injuries in prehospital and Emergency Department settings: a prospective multicenter cross-sectional study in France

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Abstract

Background Head injuries are the leading cause of trauma in Emergency Departments (EDs). Recent studies have shown epidemiological changes in patients consulting ED for head injuries. The main objective of this study was to describe the profile of head injury patients consulting in the EDs in France and assess i) head injury severity across age groups; ii) the delay between the occurrence of head injury and ED arrival; iii) factors associated with traumatic intracranial hemorrhage (ICH).

Methods This cross-sectional study collected patient data over a three-day period in March 2023. All adult patients (≥ 18 years old) admitted to the ED with a head injury (defined as a trauma to the head) were included. TBI severity was classified according to patients' initial Glasgow Coma Scale score in the ED: severe (3–8); moderate (9 -12); mild (13–15); and simple head trauma in the absence of transient or persistent neurological symptoms.

Results Among the 71 participating EDs, 26,008 patients visited EDs and a total of 1070 patients (4.1%, IC 95 3.9—4.4) presented a head injury were included in the study, with a median age of 68.5 [37–85] years old. Most of the patients (66.7%) were referred to ED after a call to the Emergency Medical Dispatcher (EMD). The median time from head injury to ED visit was 2 h [1.0 – 5.5]. Ground-level falls were the leading cause of head injury (60.3%). Most of patient presented a simple head trauma ($n=715$, 66.8%) followed by mild TBI ($n=337$, 31.5%). CT head scans were performed for 636 patients (59.6%), of which 58 were positive. Traumatic ICH prevalence was 5.4% (95% CI: 4.1–6.9) and three patients (0.3%) required an urgent neurosurgical intervention. Neither preinjury anticoagulant ($p=0.97$) nor antiplatelet ($p=0.93$) use was associated with an increased risk of traumatic ICH.

Conclusions One head injury patient out of two presenting in the ED is aged over 65 years. Patients referred by EMD were more likely to visit ED promptly. The majority of older patients underwent a head CT scan and preinjury anticoagulant use was not associated with increased risk of traumatic ICH.

Keywords Traumatic brain injury, Head injury, Prehospital triage, Epidemiology, Intracranial hemorrhage, Emergency Department, Emergency Medical Dispatcher

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Background

Every year, more than 50 million people worldwide experience Traumatic Brain Injuries (TBIs) [1, 2]. In the last two decades, the epidemiology of TBI has changed significantly and rapidly. First, the mean age of TBI patients has almost doubled [3]. The cause of this increase is still unclear and cannot be fully explained by population ageing [4, 5]. The mechanisms of injury have also changed, with falls becoming the leading cause of TBI in high-income countries, thus surpassing road traffic accidents [5, 6]. The latest literature has also shown that TBI-related Emergency Department (ED) visits among older patients have disproportionally increased, reaching 156% in ten years in some European countries [7].

TBI patients undergo various tests to rule out traumatic Intracranial Hemorrhage (ICH) while in the ED, including head Computed Tomography (CT) scans. Although the prevalence of this complication appears to be stable at around 8%, ranges between 2–21% are still being reported [8–10]. These differences could be explained by the variation in patient management and in the constantly evolving diagnostic tests, particularly with the emergence of biomarkers [11]. Besides the diagnostic performance of each biomarker, the delay between the occurrence of the TBI and ED arrival is of prime importance [12]. Understanding the current profile and characteristics of TBI patients is crucial to better guide and adapt patient management, as TBI is a significant cause of death and hospital admissions in European and Western countries [13, 14].

The main objective of this study was to describe the profile of head injury patients consulting in the ED in France. The secondary objectives are to describe and assess i) head injury severity across age groups; ii) the delay between the occurrence of head injury and ED arrival; iii) factors associated with traumatic ICH.

Methods

Study design and settings

This cross-sectional study collected patient data over a three-day period in 2023 from Monday 06 March 8:00 am to Thursday 09 March 8:00 am, continuously H24) across 71 French EDs. The study cohort comprised EDs across France that accepted an invitation to participate from the Initiative Recherche Urgence (IRU; Emergency Research Initiative) network of the *Société Française de Médecine d'Urgence* (SFMU; French Society of Emergency Medicine). The IRU is a research group of the French national society of emergency medicine that includes more than 100 EDs in France [15, 16]

The emergency medical system in France operates at three levels of response, which include Emergency Medical Dispatchers (EMDs, *SAMU "Services d'Aide Médicale Urgente*"), medicalized Mobile Intensive Care Units (MICU) and EDs. Patients can consult directly to the ED or they can be referred by the EMD. Depending on the medical situation, the EMD may provide medical advice or recommend phone follow-up, patient referral to either a family physician or to the ED, ambulance dispatches or MICU in case of a life-threatening situation.

The prescription of head CT scans in mild TBI patients in French EDs is guided by National Guidelines published in 2012 and updated in 2022 [17, 18]. These guidelines recommend a head CT scan for mild TBI patients at intermediate risk (patients aged ≥ 65 years with antiplatelet therapy, Glasgow Coma Scale (GCS) score < 15 two hours after the trauma with a suspected/confirmed intoxication, who sustained a high-energy trauma, or with amnesia ≥ 30 min after the trauma) within 8 h of ED admission. In patients presenting with a high risk of traumatic ICH (hemostasis disorders, suspected basilar or cranial skull fracture, GCS < 15 two hours after the trauma without intoxication, > 1 vomiting episode, post-traumatic seizures, focal neurological deficit) a head CT scan is required within the first hour. The management of severe TBI is also guided by National Guidelines published in 2016 [19].

Participants

All adult patients (≥ 18 years old) admitted to a participating ED with a head injury were included in the study. We broadly defined head injury as any blunt or penetrating trauma to the head, regardless of its severity.

Data collection and study variables

Upon admission to the ED, the attending physicians gathered standardized data using the DoqBoard.com observational research platform. The physician in charge of the patients reported the data to the research platform. This included sociodemographic information, pre-injury use of antiplatelet and anticoagulant medications, the mechanism, time and location of the trauma, symptoms experienced after the injury, mode of arrival to the ED, and other relevant clinical information related to the patient's ED and hospital stay.

Overall number of ED visits was collected from a survey sent to each co-investigating center. This amount included all reasons for visit (medical and/or traumatic).

Outcome measures

Head injury severity was determined using the initial GCS score at ED arrival:

- Severe TBI (GCS 3–8),
- Moderate TBI (GCS 9–12)

- Mild TBI according to World Health Organization definition (GCS 13–15 and one or more of the following symptoms: < 24 h' post-traumatic amnesia; impaired mental state at time of accident and/or transient neurological deficit).
- Simple head trauma in the absence of transient or persistent neurological symptoms

The delay between the head injury and the ED consultation was calculated from the time of the trauma (according to patients or witnesses) to the time of the ED triage.

The decision to order a head CT scan was left to the treating physician's discretion. The presence and type of traumatic ICH were based on neuroradiology reports. Traumatic ICH were considered clinically important if one of the following were found on the head CT scan: parenchymal contusion > 5 mm in diameter, localized subarachnoid hemorrhage > 1 mm thick; subdural hematoma > 4 mm thick, or isolated pneumocephaly [20]. In case of uncertainty regarding the CT report interpretation, the study's principal investigator requested clarifications from the patients' treating center.

Statistical analysis

Descriptive analyses were computed for all study data, using means and their standard deviation, median and interquartile ranges and proportions where appropriate.

Patients were stratified into eight age groups: 18–24; 25–34; 35–44; 45–54; 55–64; 65–74; 75–84, and ≥ 85 years old. The proportions of mild, moderate, severe TBI and simple head trauma were compared using Chi 2 or Fisher test according to their respective conditions of use.

The delay between head injury occurrence and the ED consultation was stratified into four categories: ≤ 3 h, 3–6 h, > 6 h and "unknown". These categories correspond to the optimal sampling period for emerging biomarkers included in the latest national guidelines [17, 21]. Environmental factors such as the living environment, location of trauma, mode of arrival and the first medical contact before the ED visit were compared using bivariate analysis based on delay categories.

Associated factors with traumatic ICH were analyses among patients with head CT scan using univariate analysis. Factors associated with traumatic ICH with p-value ≤ 0.3 were tested in multivariate analysis using logistic regression. Traumatic ICH and clinically important ICH were also reported for each age group with their Odds Ratio (OR) using univariate analysis, with the ≥ 85 age range as a reference. ORs were adjusted for anticoagulants and antiplatelets use, and the mechanism of head injury using multivariable analysis (logistic regression).

Missing data rates were reported for each variable and no data imputation was performed. All analyses were performed with Stata 17.0 (StataCorp, Texas, USA). Our results are reported per the STROBE statement.

Results

Overall, 71 EDs participated in this study: 27 (38.0%) were university-affiliated teaching hospitals, and 23 (32.4%) had an onsite neurosurgery unit (Fig. 1). For EDs without an onsite neurosurgical unit, the median distance between the ED and the nearest neurosurgical unit was 50 km (12–80).

During the study period, 26,008 patients visited the ED. Of those, 1070 (4.1% [95% CI: 3.9—4.4]) had a head injury and were included in our analyses. The median age was 68.5 years old (IQR: 37–85) and 552 of our patients (52.7%) were female. Patient characteristics are displayed in Table 1.

Most ED visits were recommended by the EMD (66.6%) (Table 2) and ambulances were the most prevalent mode of ED arrival (66.7%) (shown in Fig. 2). Patient characteristics are displayed in Table 1. Of the intoxicated patients, 71 were intoxicated by alcohol and 6 by medication. The information regarding the first medical contact before the ED visit and ED disposition according to patient age category is available in Table 2.

A head CT scan was performed for 636 (59.6%) patients. The proportion of patients who underwent a head CT scan increased with age (from 38% in patients aged 25–34 to 79% in those aged 75–84; Table 2). Detailed ED disposition according to TBI severity are displayed in Additional file 2.

Ground-level falls were the leading cause of head injuries followed by road traffic accidents. Ground-level falls

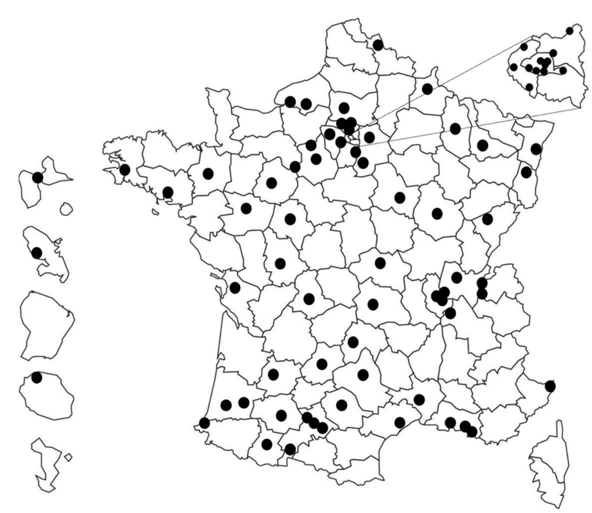


Fig. 1 Study investigating Emergency Departments

Table 1 Patient characteristics upon Emergency Department visit

	Overall *N* = 1070 N (%)	Missing value
Age, median (IQR)	68.5 (37–85)	
Sex, female	552 (52.7)	
Living condition		11 (1.0)
Community-dwelling	883 (82.5)	
Long Term facilities	161 (15.1)	
Homeless	15 (1.4)	
Place of trauma		18 (1.7)
Living place	605 (56.5)	
Public area	367 (34.3)	
Working place	80 (7.5)	
Antiplatelets	189 (17.7)	22 (2.1)
Aspirin	157 (14.7)	3 (0.3)
Clopidogrel	20 (1.9)	
Dual antiplatelets	9 (0.9)	
Anticoagulants	161 (15.1)	24 (2.2)
vitamin K antagonist	31 (2.9)	
apixaban	90 (8.4)	
rivaroxaban	24 (2.2)	
dabigatran	10 (0.9)	
parenteral anticoagulant	6 (0.6)	
Mechanism of TBI		29 (2.8)
Ground-level fall	645 (60.3)	
Road traffic accident	147 (13.7)	
Fall > 1 m/5 steps	68 (6.4)	
Head struck/hit by object	66 (6.2)	
Assault	68 (6.4)	
Sports	47 (4.4)	
Post TBI symptoms		
None	565 (52.8)	
Amnesia	72 (6.7)	
Loss of consciousness	121 (11.3)	
confusion	107 (10.0)	
headache	201 (18.8)	
vomiting	64 (6.0)	
Post-traumatic seizure	6 (0.6)	
Clinical findings in the ED		
GCS score		
15	997 (93.2)	
14	46 (4.3)	
13	9 (0.8)	
≤ 12	18 (1.7)	
Sign of skull base fracture	38 (3.6)	30 (2.8)
Focal neurological deficit[a]	24 (2.2)	36 (3.4)
Pupil abnormalities	33 (1.2)	42 (3.9)
Head CT scan performed	636 (59.6)	
Concomitant injuries[b]	387 (36.2)	
Intoxication	77 (7.2)	

IQR Interquartile range, *TBI* Traumatic Brain Injury, *ED* Emergency Department, *GCS* Glasgow Coma Scale, *CT* Computed Tomography

[a] Unilateral motor deficit: 17 patients; aphasia: 3 patients; vision impairment: 2 patients: vertigo: 1 patient; unknown: 1 patient

[b] Additional file 1: Detailed concomitant injuries

were more prevalent in older individuals, as they were the trauma mechanism in 84.8% of those aged ≥ 65 years. Mechanisms of head injury according to patient age are displayed in Table 2. Most head injury patients consulting in the ED presented a simple head trauma ($n = 715$, 66.8%) followed by mild TBI ($n = 337$, 31.5%). Nine patients in each age group had sustained a moderate or severe TBI (1.6%). There was no significant difference in TBI severity according to patient age category ($p = 0.63$).

Three patients (0.3%) required neurosurgical intervention, and in-hospital death occurred in eight patients (0.7%). The median time between head injury occurrence and ED arrival was 2 h (IQR: 1 – 5.5), while the delay between ED arrival and initial head CT scan was 3.5 h (IQR: 2.3 – 5.3). Overall, 535 patients (59.2%) visited the ED within three hours of their head injury, 82 (9.1%) between 3 to 6 h and 195 (21.6%) after 6 h. The time of TBI was unknown for 91 patients (10.1%) (Table 3).

Overall, 58 individuals had a traumatic ICH, with a prevalence of 5.4% (95% CI: 4.1–6.9), and 37 patients had a clinically important ICH (3.5% [95% CI: 2.4–4.7]) (shown in Fig. 3). The median delay between head injury and the head CT scan was 6.0 (3–14) among patients with traumatic ICH and 6.4 h (4–13) in patients without traumatic ICH. The prevalence of traumatic ICH was 5.3% ($n = 19$, [95% CI: 3.2–8.2]) in patients simple head trauma, 11.2% ($n = 30$, [95% CI 7.7–15.7]) in patients with mild TBI, 22.2% ($n = 2$, [95% CI 2.8–60.0]) in moderate TBI and 87.5% ($n = 7$, [95% CI: 40.0–97.2]) in patients with severe TBI. Among patients with traumatic ICH, 30 (51.7%) presented an acute subdural hematoma, 21 (36.2%) a subarachnoid hemorrhage, 10 (17.2%) an intraparenchymal hematoma, 8 (13.8%) an intraparenchymal contusion, 6 (10.3%) chronic subdural hematoma, and 1 (1.7%) an extradural hematoma and 2 (3.4%) diffuse axonal injury. In multivariate analysis, sign of skull base fracture (OR 5.2, CI95% 1.8–15.4) and altered Glasgow scale score (OR 5.1, CI95% 1.7–15.5) were associated with traumatic ICH (Table 4). Older age was not associated with an increased risk of any ICH or clinically important ICH (Additional file 3).

Discussion

According to this study, the profile of patients who consulted in French ED following a TBI has significantly changed. Indeed, three decades ago, the median age of TBI patients who consulted in the ED ranged between 28- and 48 years old [22–24]. Our study shows the median age of those patients has significantly increased to 68.5 (37–85) years, indicating a rapid evolution in this specific population. The world's population is undeniably ageing, but this alone cannot explain the changing profile of head injury patients admitted to EDs [7].

Table 2 Prior contact before ED visit, head injury mechanisms, Concomitant injuries, Head CT scan performed and ED outcome as function of patient age range

	Total	18–24 years-old *N* = 126	25–34 years-old *N* = 122	35–44 years-old *N* = 84	45–54 years-old *N* = 85	55–64 years-old *N* = 92	65–74 years-old *N* = 115	75–84 years-old *N* = 169	≥ 85 years-old *N* = 277
Prior contact before ED visit									
Calling EMD	713 (66.6)	42 (33.3)	59 (48.4)	48 (57.1)	46 (54.1)	75 (81.5)	82 (71.3)	133 (78.7)	228 (82.3)
None	295 (27.6)	79 (62.7)	60 (49.2)	31 (36.9)	36 (42.4)	16 (17.4)	23 (20.0)	22 (13.0)	28 (10.1)
General Practitioner	34 (3.2)	2 (1.6)	0	2 (2.4)	3 (3.5)	1 (1.1)	2 (1.7)	9 (5.3)	15 (7.6)
TBI Mechanisms									
Ground-level fall	645 (62.0)	24 (19.5)	26 (21.5)	22 (26.8)	38 (47.5)	59 (66.3)	89 (78.1)	141 (87.0)	246 (88.8)
Road traffic accident	147 (14.1)	38 (30.9)	35 (28.9)	27 (32.9)	16 (20.0)	8 (9.0)	10 (8.8)	8 (4.9)	5 (1.8)
Fall > 1 m/5 steps	68 (6.5)	4 (3.3)	6 (5.0)	10 (12.2)	7 (8.8)	9 (10.1)	7 (6.1)	11 (6.8)	17 (4.2)
Assaults	68 (6.5)	20 (16.3)	18 (14.9)	11 (13.4)	11 (13.8)	5 (5.6)	2 (1.8)	0	1 (0.4)
Head struck/hit by object	66 (6.3)	12 (9.8)	28 (23.1)	5 (6.1)	6 (7.5)	7 (7.9)	3 (2.6)	1 (0.6)	4 (1.4)
Sport	47 (4.5)	25 (20.3)	8 (6.6)	7 (8.5)	2 (2.5)	1 (1.1)	3 (2.6)	1 (0.6)	0
Concomitant injuries	387 (36.2)	42 (33.3)	41 (33.6)	38 (45.2)	27 (31.8)	29 (31.5)	37 (32.2)	55 (32.5)	118 (42.6)
Head CT scan performed at the ED	636 (59.4)	54 (42.9)	47 (38.5)	42 (50.0)	40 (47.1)	51 (55.4)	67 (58.3)	120 (71.0)	235 (84.8)
ED disposition									
Discharged from ED	806 (75.9)	120 (96.0)	112 (93.3)	69 (83.1)	72 (84.7)	72 (78.3)	83 (73.5)	117 (70.1)	161 (58.1)
Hospitalization	221 (20.8)	1 (0.8)	7 (5.8)	12 (14.5)	9 (10.6)	17 (18.5)	28 (24.8)	43 (25.8)	104 (37.5)
Intensive Care Unit	17 (1.6)	3 (2.4)	0	2 (2.4)	3 (3.5)	2 (2.2)	0	4 (2.4)	3 (1.1)
Hospital Transfer	18 (1.7)	1 (0.8)	1 (0.8)	0	1 (1.2)	1 (1.1)	2 (1.8)	3 (1.8)	9 (3.2)

CT Computed Tomography, *ED* Emergency Department, *EMD* Emergency Medical Dispatcher, *TBI* Traumatic Brain Injury

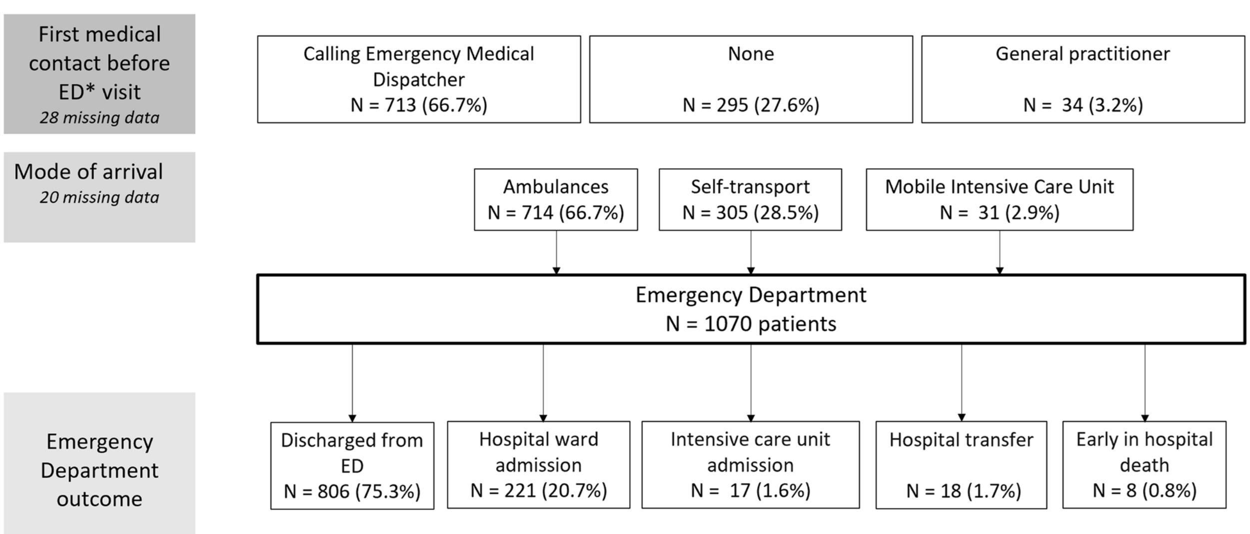


Fig. 2 Patient care pathways

This trend is consistent with recent literature in high-income countries and represents a challenge for our healthcare system [6, 25]. For instance, current clinical decision rules guiding CT head scans identify older age as a risk factor for intracranial hemorrhage (CHIP [≥ 60 years], NOC [≥ 60 years], Canadian CT Head Rule (CCHR) [≥ 65 years], NICE decision rule [≥ 65 years]) [26]. These clinical decision tools, including the CCHR,

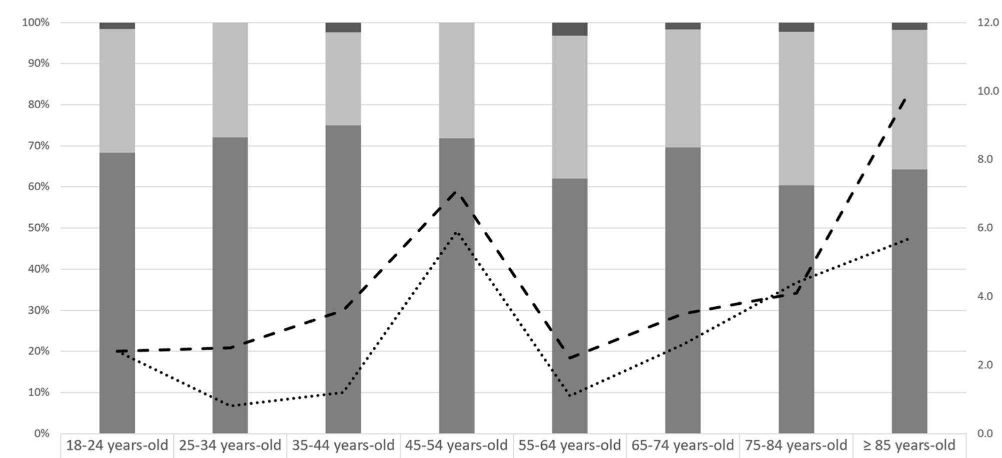
Table 3 Environmental factors and delay[a] from head injury to ED visit

	Delay ≤ 3 h 535 (59.2%) *N* = 535	**Delay 3–6 h 82 (9.1%)** *N* = 82	**Delay > 6 h 195 (21.6%)** *N* = 195	**Delay unknown 91 (10.1%)** *N* = 91	***p*-value[$]**
Age, median (IQR)	66 (36–84)	72 (43–87)	64 (29–86)	69 (44–84)	
Sex, male	277 (30)	32 (4)	86 (9)	40 (4)	0.08
Living condition					0.82
Community-dwelling	447 (60)	67 (9)	166 (22)	67 (9)	
Long Term care facilities	77 (57)	14 (10)	25 (18)	20 (15)	
Homeless	8 (73)	1 (9)	2 (18)	0	
Trauma event location					0.01
At home	276 (54)	52 (10)	126 (25)	54 (11)	
Public area	210 (67)	22 (7)	55 (18)	27 (9)	
At work	46 (62)	8 (11)	11 (15)	9 (12)	
First medical contact before ED visit					0.001
Calling EMD	416 (69)	53 (9)	84 (14)	50 (8)	
General practitioner	6 (22)	4 (14)	14 (50)	4 (14)	
None	107 (43)	22 (9)	92 (36)	29 (12)	
Mode of arrival					0.001
Ambulance	399 (66)	58 (10)	92 (15)	54 (9)	
Self-transport	110 (42)	22 (9)	98 (38)	29 (11)	
MICU	21 (88)	0	2 (8)	1 (4)	

ED Emergency Department, *EMD* Emergency Medical Dispatcher, *MICU* Mobile Intensive Care Unit. TBI: Traumatic Brain Injury

[a] 167 missing data

[$] Man-Whitney test was used for variable age; Chi2 or Fisher test was used for categorical variable



	18-24 years-old N=126	25-34 years-old N=122	35-44 years-old N=84	45-54 years-old N=85	55-64 years-old N=92	65-74 years-old N=115	75-84 years-old N=169	≥ 85 years-old N=277
Moderate-Severe TBI (%)	1.5	0.0	2.4	0.0	3.2	1.7	2.3	1.8
Mild TBI (%)	30.2	27.9	22.6	28.2	34.8	28.7	37.3	33.9
Simple Head Trauma (%)	68.3	72.1	75.0	71.8	62.0	69.6	60.4	64.3
Any ICH prevalance (%)	2.4	2.5	3.6	7.1	2.2	3.5	4.1	10.0
Clinically important ICH prevalance (%)	2.4	0.8	1.2	5.9	1.1	2.6	4.4	5.7

Fig. 3 Traumatic brain injury severity and intracranial hemorrhage prevalence

Table 4 Patient characteristics according to Head CT scan prescription

	No Head CT scan performed	Head CT scan performed		Univariate Analysis[a]	Multivariate Analysis[a]		
	N = 434	N = 636		P-value	OR	CI 95%	p-value
		Traumatic ICH	No Traumatic ICH				
		N = 56	N = 579				
Age, years, mean	52.6 (± 1.2)	72.7 (± 3.2)	67 (± 1.0)	0.09	1	0.9—1.1	0.2
Male	223 (51.4)	24 (42.9)	271 (46.8)	0.32			
Antiplatelets	18 (4.1)	17 (30.4)	154 (26.6)	0.93			
Aspirin	15 (3.5)	14 (25.0)	128 (22.1)				
Clopidogrel	1 (0.2)	2 (3.6)	17 (2.9)				
Aspirin + Clopidogrel	1 (0.2)	1 (1.8)	7 (1.2)				
Anticoagulants	9 (2.1)	14 (25.0)	138 (23.8)	0.97			
vitamin K antagonist	2 (0.5)	4 (7.1)	25 (4.3)				
apixaban	6 (1.3)	4 (7.1)	80 (13.8)				
rivaroxaban	1 (0.2)	1 (1.8)	9 (1.6)				
dabigatran	0	4 (7.1)	20 (3.5)				
subcutaneous anticoagulant	1 (0.2)	1 (1.8)	4 (0.7)				
Mechanisms				0.3	1.2	0.9—1.6	0.2
Ground-level fall	224 (51.6)	34 (60.7)	387 (66.8)				
Fall > 1 m/5 steps	24 (5.5)	7 (12.5)	37 (6.4)				
Road traffic accident	69 (15.9)	4 (7.1)	74 (12.8)				
Sports	22 (5.1)	3 (5.4)	22 (3.8)				
Head struck/hit by object	45 (10.4)	1 (1.8)	20 (3.5)				
Assault	39 (9.0)	3 (5.4)	26 (4.5)				
Post-TBI symtomes							
Amnesia	14 (3.2)	7 (12.5)	51 (8.8)	0.7			
Loos of consciousness	26 (6.0)	12 (21.4)	83 (14.3)	0.45			
confusion	16 (3.7)	16 (28.6)	75 (12.9)	0.02	1.1	0.4—2.8	0.9
Headache	68 (15.7)	15 (26.8)	118 (20.4)	0.55			
Vomiting	18 (4.1)	6 (10.7)	40 (6.9)	0.66			
Seizure	2 (0.5)	2 (3.6)	2 (0.3)	0.05	6.5	0.6—75.4	0.1
Glasgow scale score				< 0.001			
15	421 (97.0)	33 (58.9)	535 (92.4)		Reference		
14	7 (1.6)	11 (19.6)	28 (4.8)		5.1	1.7—15.5	0.004
13	0	4 (7.1)	5 (0.8)		7.3	1.3—39.2	0.02
≤ 12	0	8 (14.3)	8 (1.4)		12.6	3.2—49.9	< 0.001
Focal neurological sign	1 (0.2)	8 (14.3)	15 (2.6)	< 0.001	2.9	0.8—9.8	0.09
Sign of skull base fracture	5 (1.2)	10 (17.9)	23 (4.0)	< 0.001	5.2	1.8—15.4	0.003
Head cutaneous impact location				0.62			
No impact	124 (28.6)	14 (25.0)	156 (2.7)				
Facial	92 (21.2)	8 (14.3)	88 (15.2)				
Frontal	88 (20.3)	12 (21.4)	134 (23.1)				
Temporale-parietale-occipale	103 (23.7)	19 (33.9)	140 (24.2)				
Multiples	18 (4.1)	2 (3.6)	57 (9.8)				

[a] Univariate and multivariate analysis were conducted among patients with Head CT scan performed

were developed over two decades ago and mostly used data from younger adults (aged between 36 and 41 years) [10, 27, 28]. Some authors have suggested adapting the CCHR's age threshold (from 65 years old to 75 years old) [29]. Even though their results were promising, they need to be prospectively validated. Moreover, a recent prospective study found that these tools have suboptimal performance in older adults when age was not taken into account as a risk factor [30]. Therefore, Consistent with a recent meta-analysis, preinjury anticoagulant use was not associated with an increased risk of traumatic ICH [31]. Thus, it is clear that these clinical decision rules must be updated to improve their senior-friendliness and promote efficient resource use.

Three decades ago in France, road traffic accidents were the primary cause of TBI (59.6%), followed by falls (32.5%) [32]. Our results highlight the trend described in recent literature where falls account for 60.3% of head injury cases, increasing to 78.1% in patients aged 65–74 years and to 90.1% in those aged 85–94 years [13, 33, 34]. This new "burden" of TBI from low-energy falls has been described in a recent multicenter study, in which older patients with ground-level falls represented 40% of the head CT scans performed for mild TBI [35]. Our results are consistent with this study. We found that despite the low-energy trauma mechanism of head injury in older patients, the prevalence of ICH is similar to that observed in younger adult patients [35]. The proportions of clinically important ICH also remained similar across age groups. This could probably be explained by the previously mentioned very broad indication for head CT scans in older patients. Some head CT scans may show slight abnormalities that do not require any specialized management. Further research is needed to better characterize the outcomes of older patients based on ICH features.

Our study also shows differences in pre-hospital triage. This current study shows that the majority of patients are referred to ED following an EMD call (66.7%). This finding is very different from other European countries. For example, a recent study in Denmark found that only 27.2% of these patients were transferred to ED following a call to EMD [36]. Our study revealed that a call to the EMD was associated with a shorter delay in admission to the ED. The Danish study did not find difference in mortality between patients referred by their GP and those referred by the EMD, but the latter were more frequently transferred to a neurosurgical referral center [36]. These results reinforce the role of EMD in the pre-hospital triage of these patients. Outside of Europe, recent literature has shown that there are varying delays between TBI and ED consultations. For instance, a retrospective study performed in Korea reported a mean delay of 6 h, whereas the most common delay in a low-income country (Tanzania) was one to four hours [37, 38]. These different findings indicate that TBI management is complex and varies based on the healthcare policy and TBI epidemiology of a particular country.

Our study also highlights a recent change in head injury presentation at the ED. Our results show that over 98% of the TBIs seen in the ED are mild TBI or simple head trauma, which is an increase from 80% 30 years ago [32]. These findings bring attention to the significant disparities that exist among countries. A recent Chinese multicenter study on older TBI patients showed that, although falls were the leading cause of TBI, only 57.9% were mild TBI. This large difference highlights the disparity of these patients according to country and demographic pattern [34].

Limitations

An inherent limitation of this type of multicenter cross-sectional IRU study is its short duration over three consecutive days, which did not allow for follow-up beyond 24 h. It does, however, allow for the inclusion of a large number of participants across the country in just a few days [39]. Further, not all patients included in this study underwent a head CT scan. The decision to order a scan was left to the treating physicians, who typically follow published national guidelines. These guidelines suggest that patients who do not require head CT scans have a very low risk of ICH [17, 18].

Conclusions

The characteristics of patients admitted to EDs for head injury have undergone significant changes in recent years. The median age has increased to 68.5 years, and falls have become the primary cause of head injury. Most head injury seen in the ED are simple head trauma followed by mild TBI. Most of French patients with head injury are referred to ED following an EMD call. Patients with head injury referred by EMD are more likely to visit ED promptly. The majority of older patients underwent a head CT scan. Although almost one patient out of two with head CT scan had preinjury antiplatelet or anticoagulant use, these medications were not associated with increased risk of traumatic ICH.

Abbreviations

ED	Emergency Department
EMD	Emergency Medical Dispatcher
ICH	Intracranial Hemorrhage
MICU	Mobile Intensive Care Units
SAMU	Services d'Aide Médicale Urgente
TBI	Traumatic Brain Injury

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

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Authors' contributions

XD: Methodology (equal), Investigation (lead); Project administration (equal); Investigation; Data analysis (lead); Writing – original draft (lead); Visualization (lead). TL: Methodology (supporting); Investigation (supporting); Project administration (equal); Writing – review & editing (equal). RA, SL, FT, FN and MS: Project administration (supporting); Resources; Review & editing (supporting). VB: Writing – original draft (supporting); Writing – review & editing Visualization (equal). EM: Writing – review & editing (equal); Visualization (supporting). ME: Validation (equal); Writing – review & editing (equal). SC: Methodology (equal); Resources(supporting); Validation (equal); Writing – review & editing (equal); Supervision (equal). FB, Methodology (equal); Investigation (equal); Project administration (equal); Investigation; Data analysis (supporting); Writing – original draft (supporting) Writing – review & editing (equal); Supervision (equal). EPI-TC IRU SFMU group: Project administration (supporting); Resources (equal).

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Data availability
Data from the study are available from corresponding author request. The authors agree to provide the full content of the manuscript on request by contacting the corresponding author.

Declarations

Ethics approval and consent to participate
According to French and European law on ethics, all included patients were informed that their anonymized data will be used for the study. The oral non-opposition of all patients was collected and a written information notice was given to each included patient explaining the objectives of the study and the legislation explaining this research. According to the French ethics and regulatory law (public health code) prospective studies based on the exploitation of usual care data don't should be submit at an ethics committee but they have to be declared or covered by reference methodology of the French National Commission for Informatics and Liberties (CNIL). Toulouse University Hospital signed a commitment of compliance to the reference methodology MR-004 of the French National Commission for Informatics and Liberties (CNIL). After evaluation and validation by the data protection officer and according to the General Data Protection Regulation (Regulation EU 2016/679 of the European Parliament and of the Council of 27 April 2016), this study completing all the criteria, it is register in the register of data study of the Toulouse University Hospital (number's register: RnIPH 2022–78) and cover by the MR-004 (CNIL number: 2206723 v 0). This study was approved by Toulouse University Hospital and confirms that ethical requirements were totally respected in the above report.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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