Open Journal of Modern Neurosurgery, 2026, 16(4), 326-343
https://www.scirp.org/journal/ojmn
ISSN Online: 2163-0585
ISSN Print: 2163-0569

Traumatic Brain Injury Managed through the Neurosurgical Pathway at Bouaké Teaching Hospital, Côte d'Ivoire: Profile and Determinants of In-Hospital Mortality in a Cohort of 772 CT-Confirmed Patients

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How to cite this paper: Teti, F.S.L., Derou, A.L.K., Dongo, K.Y.S., Yao, K.S., Fionko, Y.B. and Haidara, A. (2026) Traumatic Brain Injury Managed through the Neurosurgical Pathway at Bouaké Teaching Hospital, Côte d'Ivoire: Profile and Determinants of In-Hospital Mortality in a Cohort of 772 CT-Confirmed Patients. *Open Journal of Modern Neurosurgery*, **16**, 326-343.
https://doi.org/10.4236/ojmn.2026.164030

Received: August 16, 2026
Accepted: September 25, 2026
Published: September 28, 2026

Abstract

Background: Traumatic brain injury is a leading cause of death and acquired disability among young people in sub-Saharan Africa, where motorcycle transport has expanded faster than prevention. Ivorian data remain fragmentary. The objective was to describe the epidemiological and lesional profile of CT-confirmed traumatic brain injury managed through the neurosurgical pathway at Bouaké Teaching Hospital and to identify determinants of in-hospital mortality and functional outcome. **Methods:** Single-centre observational cohort of 772 consecutive CT-confirmed patients admitted through the neurosurgical pathway between January 2025 and June 2026, assembled by retrospective analysis of the neurosurgical department register and reported according to STROBE. Fisher exact test; Firth penalized logistic regression with profile-likelihood confidence intervals. **Results:** Patients were mainly young men (mean age 33.9 years; 83.8% male) injured in road-traffic crashes (89.4%), almost all involving two- or three-wheeled motorised vehicles; helmet use among documented users was 5.4%. Most injuries were mild (56.2%), with severe forms accounting for 7.9%. In-hospital mortality was 4.7% (36 deaths) and functional outcome favourable in 94.5%. After adjustment, depth of coma was the only independent determinant of mortality: each Glasgow point lost multiplied the odds of death by 1.56 (95% CI: 1.31 - 1.86). Age, helmet non-use and admission delay beyond 48 hours were not associated with mortality. **Conclusion:** Initial neurological severity dominates in-hospital outcome. Very low helmet use identifies primary prevention as the most accessible lever.

Keywords

Craniocerebral Trauma, Traffic Accidents, Epidemiology, Glasgow Coma Scale, Côte d'Ivoire

1. Introduction

Traumatic brain injury (TBI) remains one of the leading causes of death, permanent disability and disability-adjusted life years lost among young people [1] [2]. Despite advances in trauma systems in high-income countries, its burden continues to grow in low- and middle-income countries [3], where rapid urbanisation and the expansion of the motorcycle fleet have driven a rise in the incidence of road-traffic injuries [4]-[6]. In sub-Saharan Africa, this trend is compounded by limited resources for prevention, prehospital care and specialised neurosurgery [6].

Sub-Saharan series report a consistent profile: male predominance, a young population, a preponderance of road-traffic crashes involving motorcycles, low use of protective equipment and substantial delays before specialised care, all associated with high and potentially avoidable morbidity and mortality [4] [7]. In Côte d'Ivoire, structured data remain fragmentary, most often based on small samples or on specific subpopulations, and frequently burdened by missing data [8]. Bouaké Teaching Hospital, the main neurosurgical referral centre for the centre of the country, receives patients from several health regions; this regional representativeness makes it a relevant observatory of head injury in a resource-limited setting.

The present study is based on a consecutive hospital cohort with rigorous data-quality control and a low proportion of missing data, which distinguishes it from previous series in the region. The objectives were to describe the epidemiological, clinical and lesional profile of TBI managed through the neurosurgical pathway at Bouaké Teaching Hospital, and to identify the factors independently associated with in-hospital mortality and functional outcome.

2. Methods

2.1. Setting, Population and Design

This was a single-centre observational hospital cohort study, assembled by retrospective analysis of the register of consecutive admissions to the Department of Neurosurgery of Bouaké Teaching Hospital (Côte d'Ivoire) between January 2025 and June 2026, and reported in accordance with the STROBE recommendations [9]. The department receives patients with traumatic brain injury referred by peripheral health facilities as well as by the hospital emergency department; the most severe cases are subsequently transferred to the general intensive care unit, and deaths occurring there were counted, vital status being established by cross-checking the registers of both departments. Patients managed exclusively in the emergency department or in intensive care, without neurosurgical consultation, fell outside the scope of data collection and their number could not be established.

All consecutive patients admitted for traumatic brain injury during the study period were included, irrespective of age, provided they had undergone at least one brain computed tomography (CT) scan and had a usable medical record. The analytical cohort comprised 772 patients. Admissions that did not meet these criteria were not logged separately in the register: the number of patients excluded because computed tomography was unavailable or the medical record was unusable, and the reasons in individual cases, could not therefore be established. Recruitment was accordingly consecutive among eligible patients rather than among all neurosurgical admissions. Mortality analyses covered the whole cohort; functional outcome analyses covered the 703 patients for whom the Glasgow Outcome Scale score was documented (69 lost to follow-up). The study flow is summarised in Figure 1.

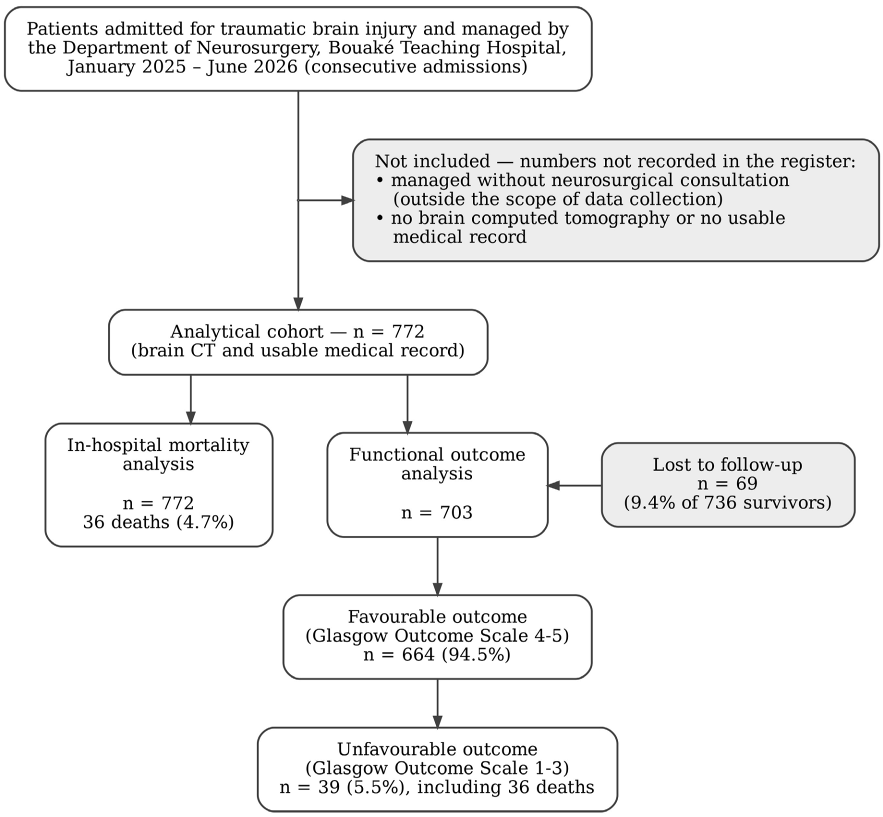

Figure 1. Study flow diagram. All 772 patients in the analytical cohort contributed to the mortality analysis; the functional outcome analysis covered the 703 patients for whom the Glasgow Outcome Scale score was documented.

2.2. Variables and Definitions

The variables collected covered six domains: sociodemographic characteristics; circumstances of injury (mechanism, type of road user, helmet use, initial loss of consciousness, time to and mode of admission, transport); clinical and haemodynamic data; CT findings; therapeutic management; and outcome measures.

Initial neurological severity was defined according to the Glasgow Coma Scale [10]: mild TBI (13 - 15), moderate (9 - 12) and severe (8 or below). The score analysed was the first Glasgow Coma Scale score recorded in the medical file on admission to the neurosurgical pathway. The register did not systematically document whether sedation, intubation or resuscitation had preceded this assessment in the referring facility or in the emergency department, and no imputation rule was applied to intubated patients, whose recorded admission score was used as documented; this limitation is discussed in Section 4.3. Hypotension was defined as a systolic blood pressure below 90 mmHg. Time to admission was the number of days elapsed between injury and admission to neurosurgery, transfers were included: it measures access to the specialised pathway and not access to first aid. Mass effect was defined as sulcal effacement or ventricular or cisternal compression, midline shift as displacement of midline structures (severity threshold of 10 mm or more), diffuse axonal injury when the admission CT showed punctate or petechial haemorrhages at the grey-white matter junction, in the corpus callosum or in the brainstem, or diffuse cerebral swelling out of proportion to focal lesions, in a compatible clinical context, and polytrauma as the presence of at least one extracranial lesion threatening life or function. A surgical indication was the operative decision recorded in the medical file before any procedure, distinct from the procedure actually documented in the operating register. The CT findings considered were those of the first scan available on admission to the neurosurgical pathway; the interval between injury and CT acquisition was not recorded as a separate variable and is bounded by the time to admission. Lesion coding was based on the radiology reports and on the imaging findings recorded in the medical file, harmonised into homogeneous categories during the quality-control step described in Section 2.3, with systematic re-reading of the images by the investigators.

The primary outcome was all-cause in-hospital mortality; late functional outcome, assessed using the Glasgow Outcome Scale [11]—a score of 1 to 3 defining an unfavourable outcome—was a secondary outcome. It was collected at outpatient review (n = 386), by telephone interview (n = 177) or from the medical file (n = 104), with the 36 deaths having occurred during the hospital stay; median follow-up was 3.2 months (interquartile range 2.1 - 5.4).

2.3. Data Quality and Missing Data

Before any analysis and independently of it, the database underwent systematic quality control covering the coding of binary variables, plausibility bounds for haemodynamic variables, recoding of diagnostic labels into homogeneous lesion categories, and agreement between the Glasgow Coma Scale score and the severity classification, with no discrepancy being observed. A data dictionary and a versioned change log accompany the database.

Completeness of admission variables was 100%. The only notable missing data concerned functional outcome (69 patients lost to follow-up, 9.4% of survivors), and helmet use being undocumented in only 0.7% of motorised two- or three-wheeler users. Midline shift measurement was missing in 62 of the 230 patients with mass effect (27%): this absence is not random and was addressed in sensitivity analyses. The analysis was conducted on complete cases, without imputation. Baseline characteristics of patients lost to follow-up did not differ from those of patients followed up (all p-values 0.19 or above).

2.4. Statistical Analysis

Categorical variables are expressed as counts and percentages, quantitative variables as mean ± standard deviation or as median with range or interquartile range. Bivariate comparisons used the Fisher exact test for all cross-tabulations, irrespective of expected cell counts. Confidence intervals for proportions were estimated by the Wald method.

Variables associated with each outcome at p below 0.20 in bivariate analysis, together with those judged clinically relevant, were entered into multivariable logistic regression models. An explicit causal framework guided the adjustment strategy (**Figure 2**): exposures present on admission were distinguished from downstream markers reflecting clinical management, such as intubation or surgical procedure, in order to avoid any adjustment for mediators. Helmet use and time to admission were treated as distal exposures. Two outcomes were modelled: in-hospital mortality and unfavourable functional outcome, all predictors being measured on admission. The mortality model was fitted on the 772 patients of the analytical cohort (36 events) and included the Glasgow Coma Scale score as a continuous variable, diffuse axonal injury, hypotension, anisocoria and mass effect. The functional outcome model was fitted on the 703 patients with a documented Glasgow Outcome Scale score (39 events) and included a

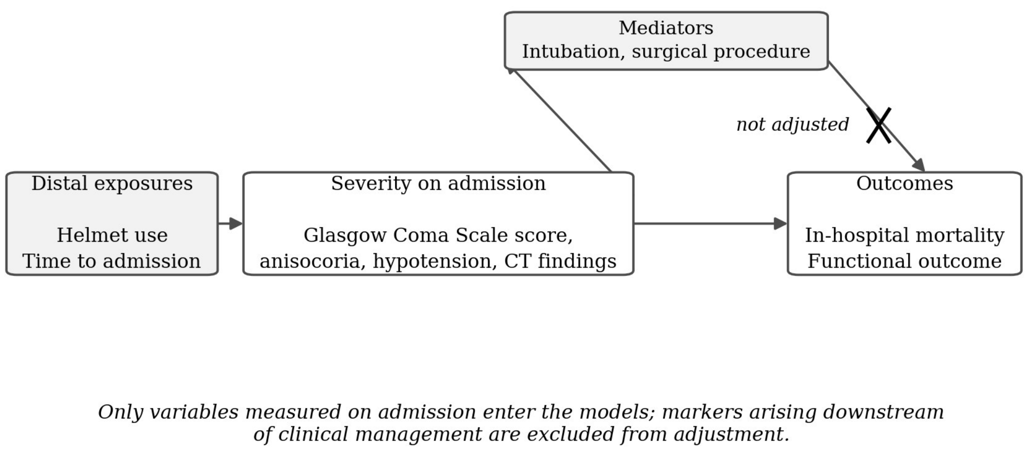

Figure 2. Causal framework guiding the adjustment strategy. Distal exposures and severity measured on admission are entered into the models; markers arising downstream of clinical management, such as intubation or surgical procedure, are excluded in order to avoid any adjustment for mediators.

Glasgow Coma Scale score of 8 or below, diffuse axonal injury, hypotension, mass effect and anisocoria. In accordance with this framework, helmet use and time to admission were treated as distal exposures whose effect on outcome is expected to operate through severity on admission, including the Glasgow Coma Scale score: they were therefore assessed in bivariate analysis without adjustment for admission severity and were not entered into the adjusted models, in which the score would have acted as a mediator of their effect. The Glasgow Coma Scale score was modelled as a continuous variable, dichotomisation at 8 being retained for sensitivity analysis. Because the small number of events and the quasi-separation observed for some variables made conventional logistic regression unstable, penalized regression using the Firth method [12] was applied, with confidence intervals estimated by profile penalized likelihood and p-values by likelihood ratio test [13]. Discrimination was quantified by the area under the ROC curve, corrected for optimism by bootstrapping (2000 replications). The significance threshold was 0.05 and analyses were performed with Python 3.12.

3. Results

3.1. Sociodemographic Profile and Circumstances of Injury

The cohort consisted mainly of young adults, with more than three-quarters of patients being under 45 years of age. Mean age was 33.9 ± 17.9 years (median 30 years; range 1 - 90 years) and the male-to-female ratio was 5.2. Slightly more than half of the patients (50.4%) were referred from another facility, and non-medicalised transport was the main mode of conveyance (60.1%) (**Table 1**).

Road-traffic crashes accounted for 89.4% of mechanisms (**Table 2**). Among users of motorised two- or three-wheeled vehicles for whom helmet use was documented, 5.4% (95% CI: 3.6 - 7.2) were wearing one. Median time to admission was two days, exceeding 48 hours in 34.8% of cases.

Table 1. Sociodemographic characteristics (n = 772).

Variable	n	%
Mean age ± standard deviation: 33.9 ± 17.9 years; median 30 years; range 1 to 90 years		
15 years or under	86	11.1
16 to 30 years	309	40.0
31 to 45 years	199	25.8
46 to 60 years	96	12.4
Over 60 years	82	10.6
Male sex	647	83.8
Female sex	125	16.2
Referred from another facility	389	50.4
Direct admission	383	49.6

Continued

Non-medicalised transport	464	60.1
Medicalised transport by ambulance	189	24.5
Transport by the military fire brigade	119	15.4

The category "over 60 years" comprises 82 patients; the category "60 years and over" used in the bivariate analyses comprises 94, twelve patients having turned 60.

Table 2. Circumstances of injury (n = 772).

Variable	n	%
Road-traffic crash	690	89.4
Fall	47	6.1
Assault	30	3.9
Occupational injury	5	0.6
User of a motorised two- or three-wheeled vehicle	615	79.7
Helmet worn, among the 611 documented users	33	5.4
No helmet worn, among the 611 documented users	578	94.6
Initial loss of consciousness	397	51.4
Time to admission over 48 hours (median 2 days; mean 2.8 days)	269	34.8

Helmet use is reported for the 611 users of motorised two- or three-wheeled vehicles for whom this item was documented.

3.2. Clinical Presentation and Lesion Profile

Most patients presented with mild injury, with severe forms accounting for only 7.9% (95% CI: 6.0 - 9.8) of the cohort (Table 3). Signs of neurological severity on admission remained infrequent: anisocoria 10.5%, intubation 14.4% and motor deficit 16.6%. Haemodynamic status was broadly stable (mean systolic pressure 130 mmHg, heart rate 85/min, pulse oximetry 97%) and systemic secondary brain insults were uncommon: hypotension in 8 patients (1.0%), desaturation in 9 (1.2%) and hyperglycaemia in 22 (2.8%).

Table 3. Clinical presentation on admission and comorbidities (n = 772).

Variable	n	%
Mild traumatic brain injury (Glasgow Coma Scale 13 to 15)	434	56.2
Moderate traumatic brain injury (Glasgow Coma Scale 9 to 12)	277	35.9
Severe traumatic brain injury (Glasgow Coma Scale 8 or below)	61	7.9
Anisocoria	81	10.5
Intubation on admission	111	14.4
Seizures	93	12.0

Continued

Motor deficit	128	16.6
Arterial hypertension	126	16.3
Chronic alcohol use	156	20.2
Diabetes mellitus	38	4.9
Epilepsy	17	2.2
Human immunodeficiency virus infection	20	2.6

Cerebral contusions, isolated or associated with an intraparenchymal haematoma, were the most frequent CT findings (43.5%), ahead of mass effect (29.8%), subarachnoid haemorrhage (15.0%), anterior skull base fracture (14.8%) and acute subdural haematoma (14.2%) (**Table 4**, **Figure 3**). A midline shift of 10 mm or more was present in 10.8% of cases. Among associated injuries, wounds and facial fractures predominated, polytrauma being recorded in 8.2% of patients.

Table 4. Computed tomography findings and associated injuries (n = 772).

Lesion	n	%
Cerebral contusion or intraparenchymal haematoma	336	43.5
Mass effect	230	29.8
Subarachnoid haemorrhage	116	15.0
Anterior skull base fracture	114	14.8
Acute subdural haematoma	110	14.2
Extradural haematoma	100	13.0
Midline shift of 10 mm or more	83	10.8
Depressed skull fracture	82	10.6
Diffuse axonal injury	72	9.3
Chronic subdural haematoma	66	8.5
Penetrating craniocerebral wound	64	8.3
Hydrocephalus	44	5.7
Skull fracture other than depressed or anterior skull base fracture	24	3.1
Intraventricular haemorrhage	18	2.3
Associated injuries: wounds or abrasions	165	21.4
Associated injuries: facial fracture	85	11.0
Associated injuries: limb fracture	56	7.3
Polytrauma	63	8.2

Midline shift could not be measured in 62 patients, all of whom had mass effect. The low frequency of skull fractures other than depressed fractures and anterior skull base fractures reflect under-documentation of simple linear fractures.

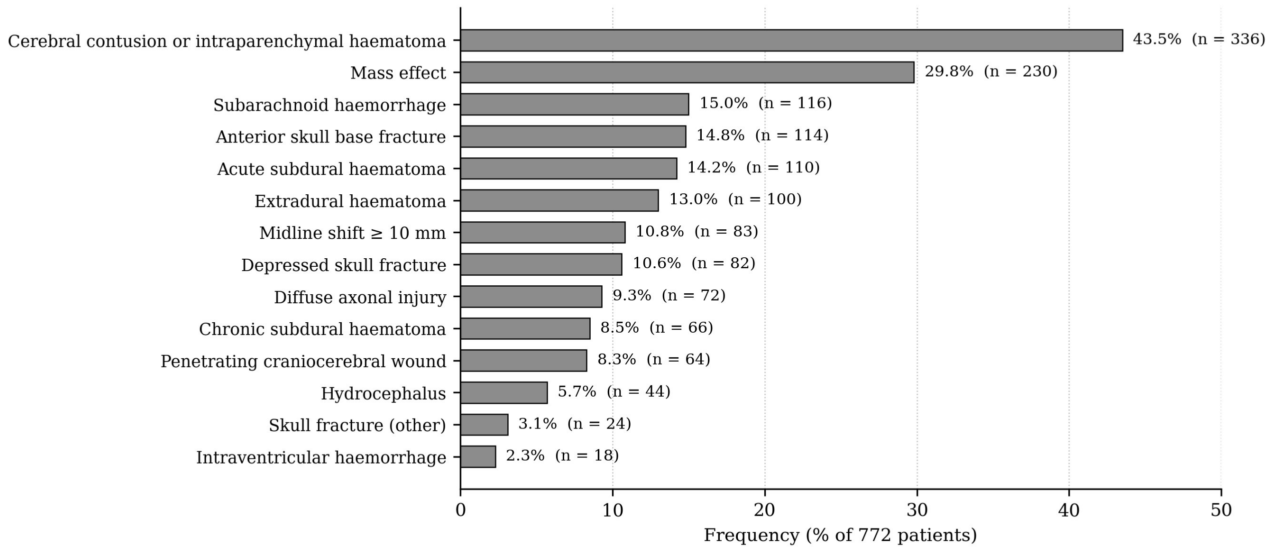

Figure 3. Frequency of computed tomography findings (n = 772). Categories are not mutually exclusive: a single patient may present with several lesions.

3.3. Management and Outcome

A surgical indication, in the sense of the operative decision recorded before any procedure, was retained in 72.9% of patients; a procedure was documented in the operating register in 47.8%. Evacuation or drainage of a haematoma was the most frequent procedure (18.0%), ahead of decompressive craniectomy (8.2%), external ventricular drainage (5.2%) and craniotomy (4.3%). Antibiotic therapy was administered to 75.5% of patients (Table 5).

In-hospital mortality was 4.7% (36 deaths; 95% CI: 3.2 - 6.2) and 78% of deaths occurred within the first forty-eight hours. Functional outcome, documented in 703 patients, was favourable in 94.5% of cases (95% CI: 92.8 - 96.1); an unfavourable outcome was observed in 39 patients (5.5%), of whom 36 died. Specialist opinions were requested mainly from oral and maxillofacial surgery (n = 135), trauma and orthopaedics (n = 76) and ophthalmology (n = 51) (Table 6).

3.4. Determinants of Mortality

In bivariate analysis, markers of neurological severity and space-occupying or diffuse lesions were most strongly associated with mortality: a Glasgow Coma Scale score of 8 or below (26.2% versus 2.8%), intubation (18.9% versus 2.3%), anisocoria (13.6% versus 3.6%), diffuse axonal injury (12.5% versus 3.9%), a midline shift of 10 mm or more (10.8% versus 3.9%) and hypotension (50.0% versus 4.2%). Conversely, age of 60 years or over, helmet non-use and a time to admission beyond 48 hours were not associated with mortality (Table 7). Among the 611 users for whom helmet use was documented, mortality was 5.0% in those without a helmet and 9.1% in those with one (3 deaths out of 33; $p = 0.246$): this apparent reversal, non-significant and based on three events, permits no interpretation.

Table 5. Therapeutic management (n = 772).

Procedure	n	%
Surgical indication retained	563	72.9
No surgical indication	209	27.1
Patients with at least one documented procedure	369	47.8
Indication retained without documented procedure	194	25.1
Evacuation or drainage of a haematoma	139	18.0
Decompressive craniectomy	63	8.2
External ventricular drainage	40	5.2
Craniotomy with bone flap	33	4.3
Cranioplasty	4	0.5
Reoperation	10	1.3
Debridement of a penetrating craniocerebral wound	59	7.6
Repair of an anterior skull base fracture	76	9.8
Elevation of a depressed fracture	35	4.5
Laminectomy or arthrodesis	5	0.6
Antibiotic therapy	583	75.5
Transfusion	3	0.4

Procedures are not mutually exclusive. The surgical indication refers to the operative decision recorded in the medical file; the documented procedure is the one recorded in the operating register.

Table 6. In-hospital and functional outcome.

Outcome measure	n	%
In-hospital death	36	4.7
Glasgow Outcome Scale 5: good recovery	421	59.9[1]
Glasgow Outcome Scale 4: moderate disability	243	34.6[1]
Glasgow Outcome Scale 3: severe disability	3	0.4[1]
Glasgow Outcome Scale 1: death	36	5.1[1]
Favourable outcome: Glasgow Outcome Scale 4 or 5	664	94.5[1]
Unfavourable outcome: Glasgow Outcome Scale 1 to 3	39	5.5[1]
Lost to follow-up: functional outcome not documented	69	9.4[2]

[1]Percentage among the 703 patients whose functional outcome was documented; [2]Percentage among the 736 survivors.

Table 7. Factors associated with in-hospital mortality, bivariate analysis (36 deaths).

Variable	Deaths among exposed (%)	Deaths among unexposed (%)	p-value
Glasgow Coma Scale score of 8 or below	16/61 (26.2)	20/711 (2.8)	<0.001
Intubation	21/111 (18.9)	15/661 (2.3)	<0.001

Continued

Hypotension: systolic blood pressure below 90 mmHg	4/8 (50.0)	32/764 (4.2)	<0.001
Anisocoria	11/81 (13.6)	25/691 (3.6)	<0.001
Diffuse axonal injury	9/72 (12.5)	27/700 (3.9)	0.004
Midline shift of 10 mm or more	9/83 (10.8)	27/689 (3.9)	0.010
Acute subdural haematoma	8/110 (7.3)	28/662 (4.2)	0.217
Mass effect	15/230 (6.5)	21/542 (3.9)	0.134
Motor deficit	7/128 (5.5)	29/644 (4.5)	0.646
Age 60 years or over	4/94 (4.3)	32/678 (4.7)	1.000
Helmet non-use	29/578 (5.0)	3/33 (9.1)	0.246
Time to admission over 48 hours	11/269 (4.1)	25/503 (5.0)	0.721

Fisher exact test. The helmet row is restricted to the 611 documented users.

In multivariable analysis, depth of coma was the only independent determinant of in-hospital mortality: each Glasgow point lost multiplied the odds of death by 1.56 (95% CI: 1.31 - 1.86; $p < 0.001$). No other admission variable reached the significance threshold, including diffuse axonal injury (adjusted odds ratio 1.83; 95% CI: 0.67 - 4.77; $p = 0.23$) (Table 8, Figure 4). Anisocoria, hypotension and mass effect, strongly associated in crude analysis, lost their significance after adjustment, their information being largely captured by overall neurological severity. Unfavourable functional outcome shared these determinants, with an independent association for a Glasgow Coma Scale score of 8 or below (odds ratio 7.89; 95% CI: 3.22 - 18.85) and for diffuse axonal injury (3.05; 95% CI: 1.14 - 7.61). Discrimination of the mortality model, corrected for optimism by bootstrapping, was 0.79. In sensitivity analysis, dichotomisation of the Glasgow Coma Scale score at 8 degraded discrimination, the corrected area under the curve falling to 0.74, and made diffuse axonal injury appear as an independent determinant (odds ratio 3.59; 95% CI: 1.34 - 9.03): part of the effect usually attributed to it therefore reflects the gradient in depth of coma. Restriction to patients aged 16 years and over left the estimates unchanged.

4. Discussion

This cohort, one of the largest single-centre series of traumatic brain injury reported to date in Côte d'Ivoire and one of the few in West Africa based on almost complete admission data, confirms that TBI there affects above all a young adult male injured in a two-wheeler crash. In-hospital mortality was 4.7% and functional outcome favourable in 94.5% of cases, figures consistent with the predominance of mild forms. After adjustment, initial neurological severity remained the central determinant of mortality. The decision to model the Glasgow Coma Scale score as a continuous variable rather than as a binary threshold is not inconsequential: it alters the interpretation of the role of diffuse axonal injury, which loses its independence as soon as depth of coma is taken into account point by point. Part of the effect usually attributed to it therefore reflects the gradient of consciousness rather than a lesion effect of its own—an observation that calls for caution when reading series reporting diffuse axonal injury as an independent prognostic factor on the basis of a dichotomised score.

Table 8. Factors independently associated with in-hospital mortality and with unfavourable functional outcome: Firth penalized logistic regression with profile-likelihood confidence intervals.

Model and variable	Adjusted odds ratio	95% confidence interval	p-value
Mortality—main model, Glasgow Coma Scale score as a continuous variable			
Glasgow Coma Scale score, per point lost	1.56	1.31 to 1.86	<0.001
Diffuse axonal injury	1.83	0.67 to 4.77	0.230
Hypotension: systolic blood pressure below 90 mmHg	3.63	0.81 to 15.85	0.089
Anisocoria	1.16	0.42 to 3.23	0.770
Mass effect	1.00	0.38 to 2.53	0.990
Unfavourable functional outcome—Firth model			
Glasgow Coma Scale score of 8 or below	7.89	3.22 to 18.85	<0.001
Diffuse axonal injury	3.05	1.14 to 7.61	0.027
Hypotension: systolic blood pressure below 90 mmHg	2.50	0.52 to 12.76	0.250
Mass effect	1.43	0.58 to 3.35	0.420
Anisocoria	1.34	0.48 to 3.73	0.580

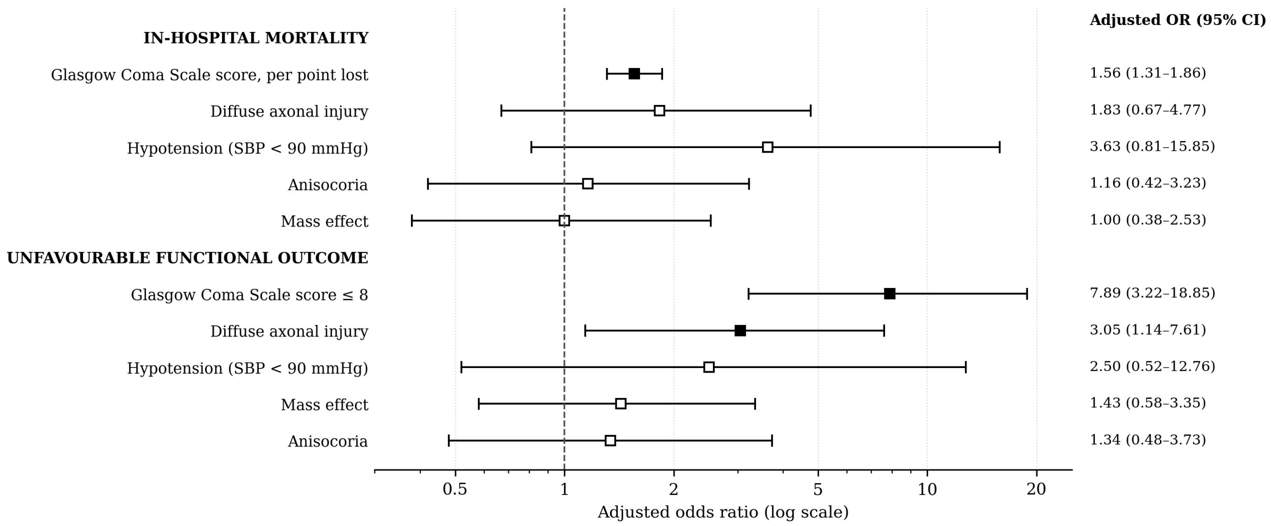

Figure 4. Adjusted odds ratios from the two Firth models with their profile-likelihood 95% confidence intervals (log scale). Filled squares indicate associations whose confidence interval excludes the value 1.

A methodological lesson follows from the completeness of the data. Several associations classically reported in regional series based on incomplete data are not confirmed here: age, helmet non-use and a time to admission beyond 48 hours were not independently associated with mortality. Likewise, very high odds ratios obtained on limited numbers of events most often reflect overfitting rather than clinical reality.

The attenuation of anisocoria, hypotension and mass effect after adjustment reflects their strong correlation with overall neurological severity: these signs are markers of raised intracranial pressure whose prognostic information is largely captured by the Glasgow Coma Scale score, which integrates the functional consequences of focal and diffuse lesions and of secondary brain insults. Hypotension on admission, although rare (1.0%), was accompanied by a crude mortality of 50%, a reminder of the weight of secondary insults and of the value of early haemodynamic resuscitation [14].

The absence of an association between age, helmet use and time to admission and mortality warrants cautious interpretation. Several explanations are possible: conditioning on hospitalisation, the patients analysed having already survived the prehospital phase; a small number of deaths limiting power; and selection bias related to the non-inclusion of deaths occurring before admission. These negative results therefore do not exclude a role for these factors in the occurrence or initial severity of injury: a demonstrated absence of association is not an absence of effect.

4.1. Comparison with African Series

The profile observed is consistent with that of West and Central African series: male predominance, mean age around the third decade and predominance of road-traffic crashes. In-hospital mortality of 4.7% is of the same order as that reported in N'Djamena in a series of 1022 head-injured patients of all grades (5.3%) [15]; it is probably underestimated by the non-inclusion of prehospital deaths. The concentration of deaths within the first forty-eight hours sheds light on two findings of this work. It explains first why time to admission is not associated with mortality: in patients who have survived until specialised care, it is initial lesion severity and the hours following arrival, not the time elapsed beforehand, that determine the outcome. It then places the lever for improvement upstream and at the very start of the hospital stay rather than in prolonging inpatient monitoring.

The earlier series from the same institution, covering the general intensive care unit between 2013 and 2014, reported a mortality of 66% among 92 patients with a Glasgow Coma Scale score below 14, with a mean time to admission of three hours [8]. The two cohorts describe two complementary segments of the same pathway: intensive care recruits its most severe end and the most direct admissions, neurosurgery the whole lesion spectrum, mostly after transfer. Both the difference in mortality and the difference in time to admission reflect this difference in recruitment setting rather than a change in practice, and serve as a reminder that any comparison between African hospital series presupposes knowing which segment of the pathway is being observed. Unlike cohorts from high-income countries, where falls in older people take an increasing share and prehospital care is medicalised and rapid, our series was characterised by the youth of the victims, the overwhelming share of two-wheelers and largely non-medicalised transport [16] [17].

4.2. Public Health and Clinical Implications

One of the main findings of this study is the very low rate of helmet use (5.4%) among documented users of motorised two- or three-wheeled vehicles. This level is markedly lower than that reported among motorcycle crash victims admitted to the emergency unit of Mulago Hospital in Kampala, where 19.2% of users were wearing a helmet [7], placing Bouaké among the most exposed settings documented in sub-Saharan Africa. Measured here on good-quality data, this figure constitutes a reference value for monitoring prevention policies. That helmet non-use is not associated with in-hospital mortality is expected: the helmet acts upstream, on the occurrence and initial severity of injury, rather than on lethality once the patient is hospitalised. The extent of non-use nonetheless identifies generalised helmet wearing as the most accessible primary prevention lever [18]. The prolonged times to admission further illustrate the obstacles in the prehospital pathway and constitute a priority target for organisational improvement, through regulation of referrals, medicalisation of transport and shortening of delays in access to computed tomography and to the operating theatre.

Clinically, the variables associated with outcome—Glasgow Coma Scale score, pupillary status, blood pressure, CT findings—are simple to collect from admission, without sophisticated equipment beyond the initial CT scan, and are consistent with the Brain Trauma Foundation guidelines [19]. Each Glasgow point lost is accompanied by an increase of about 56% in the odds of death, which justifies considering the score in its granularity rather than the threshold of 8 alone. Diffuse axonal injury should draw attention to neurological risk even in the absence of an evacuable surgical lesion, without however constituting a prognostic factor independent of the level of consciousness.

4.3. Strengths and Limitations

The strengths of this work lie in the consecutive recruitment of all eligible patients in the neurosurgical pathway over the study period, in the ascertainment of deaths from two sources, and in the very low proportion of missing data on admission variables, the result of a documented preliminary audit supported by a data dictionary and a change log. To these are added the sample size of 772 patients, among the largest in West African series, the joint assessment of clinical, haemodynamic and radiological factors, and the use of penalized regression suited to rare events.

Several limitations must be taken into account. The number of events remains moderate (36 deaths), which widens confidence intervals and calls for caution in interpreting rare variables such as hypotension. The single-centre design limits external validity. The mortality of 4.7% is that of the neurosurgical pathway and does not represent hospital lethality of traumatic brain injury at Bouaké Teaching Hospital: patients who died before a neurosurgical opinion was obtained—at the scene, during transport, in the emergency department or in intensive care—do not appear in the cohort and their number could not be established. This uncounted group probably leads to an underestimation of overall lethality and to an attenuation of the effect of determinants acting before specialised admission. In addition, the admission Glasgow Coma Scale score was abstracted retrospectively: whether sedation or intubation had preceded its recording could not be verified for every patient, and scores measured after intubation may underestimate the true level of consciousness in a minority of cases.

Functional outcome relied on the Glasgow Outcome Scale, assessed at variable intervals, with 9.4% of patients lost to follow-up; the absence of a standardised reassessment schedule may have introduced heterogeneity. The unfavourable outcome measure is moreover made up of deaths in more than nine tenths of cases (36 of 39 events): the two analyses therefore do not constitute two independent assessments. Finally, the cohort included 86 children aged 15 years or under (11.1%), in whom the properties of the Glasgow scales differ from those observed in adults, without the numbers allowing a separate analysis.

The bivariate association between midline shift and mortality does not withstand the extreme assumption regarding the 62 missing measurements and should not be over-interpreted. The analysis of helmet use rests on a denominator of 611 users, of whom only 33 were wearing a helmet: comparisons in this subgroup lack power and the observed difference in mortality, in an unexpected direction, must be regarded as a sampling artefact. The low frequency reported for skull fractures other than depressed fractures and anterior skull base fractures (3.1%) probably reflects under-documentation of simple linear fractures in CT reports. Residual confounding related to unmeasured variables, inherent to the observational design, cannot be excluded. Lastly, the absence of intracranial pressure monitoring and of detailed prehospital data limits the assessment of secondary brain insults.

5. Conclusion

In this hospital cohort of 772 CT-confirmed patients managed through the neurosurgical pathway at Bouaké Teaching Hospital, traumatic brain injury remains essentially a disease of young people injured in road-traffic crashes involving two- or three-wheeled vehicles. After adjustment, initial neurological severity, measured by the Glasgow Coma Scale score considered in its granularity, is the central independent determinant of in-hospital mortality; the association with diffuse axonal injury appears only when the score is dichotomised. Very low helmet use and prolonged times to admission identify two public health priorities: strengthening enforcement of compulsory helmet wearing and medicalisation of transport, together with faster access to emergency computed tomography. Multicentre validation of these observations in other neurosurgical centres in sub-Saharan Africa is the next step.

Ethical Approval

The study was conducted in accordance with the principles of the Declaration of Helsinki [20]. The protocol was approved by the Institutional Ethics Committee of Bouaké Teaching Hospital (approval No. CEI/CHU-BKE/101/2026), which determined that individual written consent was not required for this retrospective analysis of anonymised routine care data.

Declaration of Population Overlap

Three derived manuscripts draw on the same cohort of 772 patients: the first concerns the prehospital pathway and times to admission, the second concerns the lesion mapping and determinants of surgical realisation, the third concerns the paediatric subgroup. These works had not yet been submitted at the date the present article was sent, which constitutes the primary report of the cohort; they address distinct questions and variables. This overlap is declared in accordance with the recommendations of the International Committee of Medical Journal Editors and will be reported to the editorial office at the time of any subsequent submission.

Availability of Data and Materials

The data dictionary, the completed STROBE checklist and the analysis code are provided as supplementary material; the anonymised data are available from the corresponding author on reasonable request.

Consent to Publish

All authors have given their consent to the publication of the results of this study. No data allowing identification of a patient appear in the manuscript.

Funding

This work received no specific funding.

Acknowledgements

The authors thank the staff of the Department of Neurosurgery of Bouaké Teaching Hospital for their assistance with data collection.

Author Contributions

F.S.L. Teti designed the study, collected and analysed the data and drafted the manuscript. A.L.K. Derou, K.S. Yao, Y.B. Fionko and K.Y.S. Dongo contributed to data collection and to critical revision of the manuscript. A. Haidara supervised the work and gave final validation. All authors have read and approved the submitted version and take collective responsibility for it.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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