

Acute Post-Traumatic Subdural Haematoma in a Resource-Limited Setting: Presentation, Management and Prognostic Factors for Unfavourable Outcome

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ABSTRACT

Background. Acute subdural haematoma (ASDH) is one of the deadliest focal lesions after traumatic brain injury (TBI). Where CT, intracranial-pressure monitoring and operating theatres are hard to access, little is known about its prognosis.

Objective. To describe the presentation and management of ASDH as the principal lesion and to look for factors associated with unfavourable outcome.

Methods. Retrospective single-centre study using the TBI database of Bouaké University Hospital (Côte d'Ivoire), historical (2016–2021) and recent (2025–2026) series. We included patients whose principal lesion was ASDH (n = 149). Outcome was unfavourable when the Glasgow Outcome Scale (GOS) was ≤ 3 at last documented contact, deaths included. After univariable comparisons (Mann–Whitney, Fisher's exact test), we fitted Firth penalised logistic regression restricted to two variables, because events were few.

Results. Median age was 35 years, 85.9% of patients were male and median admission GCS was 13. A procedure was entered in the operating register for 66.4%; in-hospital mortality was 6.7%. Of 138 patients with evaluable outcome, 12 (8.7%) had an unfavourable outcome. Low GCS, anisocoria, intubation and severe TBI were associated with it (all $p \leq 0.003$); age and time to admission were not. GCS remained strongly associated with unfavourable outcome after adjustment for age (OR 0.58 per point; 95% CI 0.42–0.74).

Conclusion. On admission, GCS was strongly associated with unfavourable outcome, independently of age. With 12 events the analysis is exploratory: it could not adjust for anisocoria or for surgery.

KEYWORDS: acute subdural haematoma; traumatic brain injury; Glasgow Coma Scale; prognosis; Firth regression; low- and middle-income countries; sub-Saharan Africa.

INTRODUCTION

Traumatic brain injury (TBI) is a major cause of death and disability in low- and middle-income countries. It mostly affects young people in their most active years [1]. Among focal intracranial lesions, acute subdural haematoma (ASDH) is one of the deadliest. It is often accompanied by damage to the underlying brain, which weighs on prognosis even after the haematoma has been evacuated [2, 3].

Where resources are limited, the management of ASDH runs into practical obstacles: CT scanning is irregularly available, intracranial pressure is not monitored, transfers are late, and the operating theatre is sometimes unavailable. The reference prognostic models were built under very different conditions [4, 5]. Brain Trauma Foundation guidelines exist, but few data are available on the prognostic value of clinical signs in these countries [6]. A local description was needed.

We report the patients in our TBI database whose principal lesion was an ASDH. We aim to describe their presentation and management, and then to look for factors associated with unfavourable outcome. Because events are few, the analysis is deliberately restrained.

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MATERIALS AND METHODS

Design and population. Retrospective single-centre study, conducted in the neurosurgery department of Bouaké University Hospital (CHU de Bouaké), Côte d'Ivoire. The department's TBI database is fed by the register of consecutive admissions, the operating register and the medical records. It comprises a historical series (2016–2021), reconstructed from these sources, and a recent series (2025–2026) in which pathway variables were collected in a standardised way: 1,366 patients in total. The report follows the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist [7]. We consecutively included patients whose principal lesion was an ASDH ($n = 149$). The responsible neurosurgeon designated this principal lesion on the first brain CT scan. ASDH was defined as an acute hyperdense subdural collection visible on this scan, performed within 72 hours of the trauma; this window applies to the scan, not to admission to neurosurgery. In patients admitted to neurosurgery after more than 72 h, the initial brain CT scan had been performed within 72 h of the trauma at the referring facility, before transfer to Bouaké University Hospital. We excluded ASDH associated with another principal lesion and chronic subdural haematomas, so as to keep only patients whose prognosis depended mainly on the ASDH. Data entry was checked for inconsistencies and then cross-checked against the source records.

Overlap with other work. The same database has been used for other manuscripts from the department: the main report on the recent series (epidemiology, mortality, prognostic models), a lesion map with a study of whether surgery was carried out, a study of extradural haematoma, a comparison of the two series and a paediatric study (manuscripts not yet published). Our question and our outcome measure are specific to this work. Only the general description of the cohort and, for the recent series, the patients with an ASDH included in the lesion map overlap. We declare this overlap here and in the cover letter, in accordance with the recommendations of the International Committee of Medical Journal Editors.

Variables and management. We recorded age, sex, mechanism, mode and time of admission, Glasgow Coma Scale (GCS) score and TBI severity at admission, anisocoria, intubation, haemodynamic instability, mass effect and surgical procedure. The GCS was the first one measured on admission, before any sedation or intubation. TBI was mild (GCS 13–15), moderate (9–12) or severe (3–8). Mass effect corresponded to a midline shift or a compression of the basal cisterns. Time to admission was the number of whole days between the trauma and admission to neurosurgery (0 for admission on the same day). In referred patients it covered the whole journey, transfers included. Counted in days, it does not detect delays of a few hours. A surgical procedure was recorded when it appeared in the operating register for the admission; we could not verify the completeness of this register against the source records. The on-call neurosurgeon decided on surgery on the basis of the clinical state and the CT scan, without invasive intracranial pressure monitoring and without a standardised decompressive craniectomy protocol. Outcome was assessed with the Glasgow Outcome Scale (GOS) [8] at the last documented contact (consultation, hospital stay or telephone call), and by in-hospital death. Sex, mechanism, mode of admission, mass effect and surgical procedure are described but were not cross-tabulated with outcome (see Strengths and limitations).

Outcome measure. The primary outcome was unfavourable outcome: $GOS \leq 3$ at the last documented contact, deaths included (GOS 1). Patients lost to follow-up, with no documented GOS, were excluded from the main analysis.

Statistical analysis. Continuous variables are given as median and interquartile range (IQR), categorical variables as counts and percentages. We compared favourable and unfavourable outcomes with the Mann–Whitney test (continuous variables) and Fisher's exact test (categorical variables). With 12 events, conventional logistic regression risked separation and biased estimates. We therefore chose Firth's penalised logistic regression [9–11], restricted to two variables: GCS alone, then GCS with age. The second model has 6 events per variable, below the usual threshold of 10. Penalisation corrects estimation bias, not lack of power: confidence intervals remain wide. Odds ratios (OR) are given with their 95% confidence interval (95% CI) by profile penalised likelihood; all the univariable ORs in Table 2 come from a single-variable Firth regression. We were looking for factors associated with unfavourable outcome, not a predictive model to be validated; no larger model was fitted. The significance threshold was $p < 0.05$. Analyses were performed in Python 3.12.3 (pandas 3.0.2, SciPy 1.17.1), with the Jeffreys prior for Firth estimation [11]. Two values (1.3%) were missing for time to admission: analyses of this variable use the available cases, without imputation. Apart from these data and the outcome of patients lost to follow-up, the variables analysed were complete.

RESULTS

Presentation at admission. One hundred and forty-nine patients had an ASDH as principal lesion (Table 1). They were young (median age 35 years), the great majority were men (85.9%), and road traffic accidents predominated (85.2%). Median GCS at admission was 13; 19 patients (12.8%) had a severe TBI. Anisocoria was noted in 28 patients (18.8%) and mass effect in 71 (47.7%). The time between trauma and admission, known in 147 patients, was 2 days (IQR 1–3), with a maximum of 8 days. Twenty-two patients (15.0%) were admitted after 4 days or more, a threshold that, since time was coded in whole days, approaches exceeding 72 h.

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Management. A surgical procedure was recorded in the register for 99 patients (66.4%): evacuation/drainage (n = 64), decompressive craniectomy (n = 27), craniotomy with bone flap (n = 17), some patients having more than one procedure. Five patients (3.4%) were reoperated. The others had surgical abstention or conservative treatment, the reason for which was not always recorded.

Outcome. In-hospital mortality was 6.7% (10/149). Eleven patients (7.4%) were lost to follow-up and excluded from the main analysis. Among the 138 patients with evaluable outcome, 12 (8.7%) had an unfavourable outcome: 10 in-hospital deaths and 2 survivors with severe disability (GOS 3). No death after discharge was documented.

Table 1 describes the population, Table 2 compares patients according to outcome, and Figure 1 shows the flow diagram.

Table 1. Characteristics of the population (ASDH as principal lesion, n = 149).

Variable	Value
Age, years — median (IQR)	35 (25–54)
Male sex — n (%)	128 (85.9)
Mechanism: RTA — n (%)	127 (85.2)
Initial loss of consciousness — n (%)	79 (53.0)
Time from trauma to admission, days — median (IQR)	2 (1–3)
GCS at admission — median (IQR)	13 (10–14)
Severe TBI (GCS 3–8) — n (%)	19 (12.8)
Anisocoria — n (%)	28 (18.8)
Intubation — n (%)	25 (16.8)
Haemodynamic instability — n (%)	14 (9.4)
Mass effect on CT — n (%)	71 (47.7)
Surgical procedure performed — n (%)	99 (66.4)
In-hospital mortality — n (%)	10 (6.7)

ASDH: acute subdural haematoma; CT: computed tomography; GCS: Glasgow Coma Scale; IQR: interquartile range; RTA: road traffic accident; TBI: traumatic brain injury. Time to admission is recorded for 147 patients (2 missing values); maximum 8 days.

Univariable analysis. Admission GCS was markedly lower in the 12 patients with unfavourable outcome than in the 126 with favourable outcome (median 8 versus 13; $p < 0.001$). Anisocoria, intubation and severe TBI were also more frequent in this group. Thus, 7 of 12 patients (58.3%) had anisocoria, against 21 of 126 (16.7%) of those with favourable outcome. Age, time to admission, initial loss of consciousness and haemodynamic instability were not associated with outcome (Table 2).

Table 2. Univariable comparison according to outcome (n = 138 with evaluable outcome).

Variable	Favourable (n = 126)	Unfavourable (n = 12)	Univariable (95% CI)	OR p
GCS — median (IQR)	13 (11–14)	8 (7–10)	0.58 (0.42–0.74)*	<0.001
Age, years — median (IQR)	35 (25–53)	31 (28–55)	1.02 (0.75–1.37)†	0.94
Time to admission, days — median (IQR)	2 (1–3)	1 (0–2)	0.73 (0.46–1.09)*	0.12
Loss of consciousness — n (%)	68 (54.0)	7 (58.3)	1.16 (0.37–3.90)	1.00
Anisocoria — n (%)	21 (16.7)	7 (58.3)	6.69 (2.04–23.3)	0.003
Intubation — n (%)	17 (13.5)	8 (66.7)	11.8 (3.52–45.0)	<0.001
Haemodynamic instability — n (%)	12 (9.5)	2 (16.7)	2.18 (0.39–8.74)	0.35
Severe TBI — n (%)	11 (8.7)	8 (66.7)	19.0 (5.43–75.5)	<0.001

Univariable OR: unadjusted odds ratio, estimated for each variable by a single-variable Firth regression; 95% CI by profile penalised likelihood. * OR per GCS point or per day of delay; † OR per decade of age. p: Mann–Whitney test (continuous variables)

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or Fisher's exact test (categorical variables). Column percentages. Time to admission is analysed on available cases (2 missing values). CI: confidence interval; GCS: Glasgow Coma Scale; IQR: interquartile range; OR: odds ratio; TBI: traumatic brain injury.

Firth regression. With 12 events, we limited ourselves to two variables. In the single-variable model, each additional GCS point lowered the odds of unfavourable outcome (OR = 0.58; 95% CI 0.42–0.74; $p < 0.001$), as in the univariable analysis of Table 2. Adding age did not change this result (OR = 0.58; 95% CI 0.43–0.74), and age contributed nothing more (OR per decade = 1.05; 95% CI 0.76–1.46; $p = 0.77$) (Table 3). GCS therefore remains strongly associated with unfavourable outcome after adjustment for age. Anisocoria and the other variables could not be adjusted for.

Table 3. Firth penalised logistic regression for unfavourable outcome.

Model / variable	OR (95% CI)	p
Model 1 — GCS (per point)	0.58 (0.42–0.74)	<0.001
Model 2 — GCS (per point)	0.58 (0.43–0.74)	<0.001
Model 2 — Age (per decade)	1.05 (0.76–1.46)	0.77

OR: odds ratio (unfavourable outcome = GOS ≤ 3 , deaths included); 95% CI by profile penalised likelihood. CI: confidence interval; GCS: Glasgow Coma Scale; GOS: Glasgow Outcome Scale. Twelve events in total, i.e. 6 per variable in model 2: confidence intervals should be interpreted with caution.

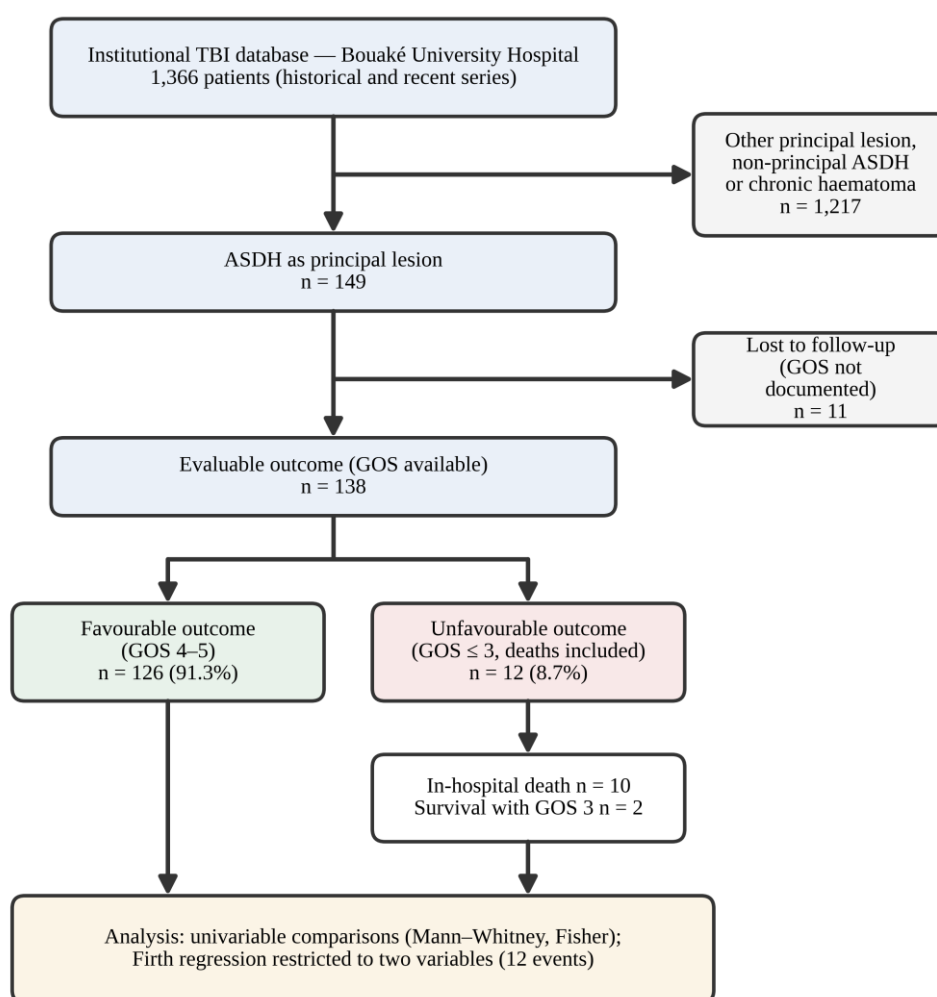


Figure 1. Flow diagram (STROBE). Of 1,366 patients in the TBI database (historical and recent series), 149 had an ASDH as principal lesion. Eleven patients lost to follow-up were excluded, leaving 138 patients with evaluable outcome: favourable (GOS 4–5, $n = 126$) or unfavourable (GOS ≤ 3 , deaths included, $n = 12$). ASDH: acute subdural haematoma; GOS: Glasgow Outcome Scale.

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DISCUSSION

Our patients with an ASDH as principal lesion were mostly young people. Severe TBI was uncommon (12.8%), operated patients were numerous (66.4%), and in-hospital mortality was 6.7%. There are only 12 unfavourable events: this limits what the analysis can demonstrate.

Our main result is the strength of the association between admission GCS and unfavourable outcome. Each additional GCS point reduces the odds by about 40% (OR 0.58), and age adds nothing once GCS is taken into account. This is consistent with large series and international prognostic models, in which the level of consciousness on admission is among the best predictors [4, 5]. It cannot be concluded that GCS outweighs anisocoria or treatment: with 12 events, these variables could not be adjusted for together.

Comparison with the literature. Our observations are in line with work describing a high mortality of ASDH among the focal lesions of TBI, and a prognosis that depends as much on the underlying brain injury as on evacuation of the haematoma [2, 3, 12]. Series on ASDH in comatose patients [13, 14] cover only low GCS scores: they cannot isolate the effect of GCS, and one of them is mainly concerned with the timing of surgery [13]. By contrast, the IMPACT and CRASH models clearly show the weight of GCS (or of its motor component) and of pupillary reactivity [4, 5]. Our in-hospital mortality (6.7%) is lower than that of series of severe or comatose ASDH. The median GCS of 13 reflects a majority of mild to moderate forms, and the most severe patients may have died before reaching the department or the scanner: only survivors then remain. Crude rates are therefore not directly comparable.

Interpretation of negative results. The absence of association with age or time to admission should be read with caution. Twelve events leave little power. The population is young, so the age range is narrow. Time, counted in days, does not see the delays of a few hours that matter for a lesion that needs to be evacuated. Hospital selection also plays a part: median time to admission was not longer in patients with unfavourable outcome (1 day versus 2), which suggests a selection of survivors without proving it. The wide confidence intervals are a reminder that absence of association does not mean absence of effect.

Anisocoria, intubation and severe TBI also stood out in univariable analysis. But they reflect the depth of coma, and including them in the model would have led to overfitting. We chose Firth regression to avoid the unstable estimates caused by rare events and quasi-separation [9, 10]. For the same reason, mass effect and surgery were not modelled; nor were they cross-tabulated with outcome, which is a limitation. Surgery depended on the clinical picture and the CT scan. Non-operated patients group together forms judged benign and forms judged hopeless: the effect of surgery therefore cannot be read here.

Practical implications. Where invasive intracranial pressure monitoring is rare [15, 16], GCS remains an accessible triage marker: it is measured at the bedside and does not depend on the technical platform. It helps to place the risk at admission; it does not say who should be operated on. Our results come from a single centre. They cannot be transposed without reservation to other hospitals in sub-Saharan Africa, even if their constraints are similar.

Decompressive surgery. Among the 99 operated patients, 27 had a decompressive craniectomy (27.3% of procedures, 18.1% of the series). It was performed without intracranial pressure monitoring and without a standardised protocol, far from the conditions of the trials [15, 17] and of the guidelines [18]. The RESCUE-ASDH trial compared, for ASDH, decompressive craniectomy with craniotomy and replacement of the bone flap: functional results were comparable, with more wound complications after craniectomy and more reoperations after craniotomy [19]. Complications of craniectomy also weigh on prognosis [20]; we did not collect them, and the effect of the techniques on outcome was not analysed.

STRENGTHS AND LIMITATIONS

The subgroup is well defined: ASDH as principal lesion, chronic forms excluded. The database rests on consecutive registers, with checks for inconsistencies and cross-verification against the source records. The rate of loss to follow-up is low (7.4%).

The first limitation is power. With 12 events, we could model only two variables, i.e. 6 events per variable in the second model. Firth regression limits estimation bias, not lack of power. The independent effects of anisocoria, intubation and surgery are therefore not estimable, and the univariable associations remain exploratory. Nor does this work say anything about the effect of surgery: the procedure comes from an operating register whose completeness is not verified, it was not cross-tabulated with outcome, and non-operated patients combine very different situations. The decision to operate itself depended on GCS; a limitation of care based on this score may therefore strengthen its link with outcome. Outcome was recorded at the last documented contact, at variable dates. Since no death after discharge is documented among the 128 evaluable survivors, late developments may have gone unnoticed. The 11 patients lost to follow-up were not compared with the others. The neurosurgeon designated the principal lesion on the CT scan, without a numerical threshold for thickness or shift. Time is counted in days. The study is single-centre, and the two series were not collected in the same way (historical series reconstructed, recent series standardised). These results are exploratory; they will need to be confronted with larger multicentre series.

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CONCLUSIONS

In this series of ASDH as principal lesion, admission GCS was strongly associated with unfavourable outcome, independently of age. This simple marker retains its value when the technical platform is limited, but our data do not place it above anisocoria or surgical treatment: 12 events did not allow them to be separated. Larger multicentre series, recording the reason for surgical abstention and time in hours, will have to clarify the respective weight of clinical markers and surgical strategies.

ETHICAL APPROVAL AND INFORMED CONSENT

Retrospective study of anonymised routine care data, conducted in accordance with the principles of the Declaration of Helsinki. The Institutional Ethics Committee of Bouaké University Hospital approved the protocol (no. CEI/CHU-BKE/137/2026, covering the 2016–2021 and 2025–2026 series) and granted a waiver of individual consent, the study being retrospective and using only anonymised care records.

Consent for publication

Not applicable: the manuscript contains no data that could identify a patient.

Author contributions

All authors contributed to the study design, data collection, analysis and interpretation of the results, or to the drafting and critical review of the manuscript. All have read and approved the submitted version and take collective responsibility for it.

Data availability

The data are available from the corresponding author on reasonable request.

Conflict of interest

The authors declare no conflict of interest.

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Abbreviations

ASDH, acute subdural haematoma; CI, confidence interval; CT, computed tomography; GCS, Glasgow Coma Scale; GOS, Glasgow Outcome Scale; IQR, interquartile range; OR, odds ratio; RTA, road traffic accident; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology; TBI, traumatic brain injury.

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