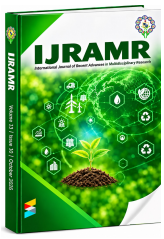
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REVIEW ARTICLE

PREHOSPITAL CARE PATHWAYS AND DELAYED ACCESS TO SPECIALIZED CARE AFTER TRAUMATIC SPINAL CORD INJURY IN A LOW-RESOURCE SETTING: AN ANALYTICAL COHORT STUDY OF 366 PATIENTS FROM CÔTE D'IVOIRE

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ABSTRACT

Objective: In low- and middle-income countries (LMICs), the prognosis of traumatic spinal cord injury (TSCI) depends on injury severity but also on the prehospital chain and the referral pathway upstream of the referral center. The authors described this care pathway and access delays, identified the determinants of delayed access, and explored their association with in-hospital outcome. **Methods:** This analytical observational study included 366 patients admitted for TSCI at Bouaké University Hospital (retrospective phase 2017–2021, prospective phase 2025–June 2026), after a database audit. The determinants of delayed access (time to reception > 48 hours) and of non-medicalized transport were modeled by multivariable logistic regression following a predefined causal framework; the association between care pathway and in-hospital mortality was estimated after adjustment for severity (ASIA grade) and age. Reporting followed STROBE. **Results:** Nearly three-quarters of patients (263/366; 71.9%) were referred, transiting through 93 originating facilities; 208 (56.8%) were conveyed by non-medicalized transport and 56 (15.3%) were insured. The median time to reception was 2 days (IQR 1–3), with a long right tail (11.7% at 7 days or more; maximum 72 days). Non-medicalized transport (aOR 2.09; 95% CI 1.29–3.37) and residence outside the region (1.76; 1.02–3.03) were independently associated with a delay exceeding 48 hours. Neurological severity remained the dominant determinant of mortality (ASIA A: aOR 11.0; 5.50–22.0; AUC 0.81). Delayed access was associated with lower in-hospital mortality (aOR 0.27; 0.13–0.55); this inverse association is interpreted as depletion of susceptibles, mortality being early (median time to death 5 days; 62.5% of deaths within the first week) and the injury composition of arrivals remaining stable across delay strata. **Conclusions:** Prehospital delays in TSCI at Bouaké are driven mainly by non-medicalized transport and geographic remoteness. Because mortality is early, a likely substantial proportion of deaths occurs before access to the referral center, making the hospital cohort an incomplete representation of the true burden. Strengthening medical transport and structuring the referral pathway—modifiable organizational levers—are public-health priorities.

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INTRODUCTION

Traumatic spinal cord injury (TSCI) is a major cause of death and permanent disability, and its incidence is rising in low- and middle-income countries (LMICs), driven by increasing motorization and inadequate road-safety measures. Global Burden of Disease data and reviews focused on sub-Saharan Africa report a high hospital incidence, a marked male predominance, and an etiology dominated by road traffic crashes, in a setting where robust epidemiological data are scarce.[1–6]

TSCI is a time-sensitive neurosurgical emergency: early decompression, by limiting the ischemic and inflammatory mechanisms of secondary cord injury, improves neurological recovery.[7,8] Reaching the appropriate facility within these time windows requires a functional chain of care—recognition of severity, adequate immobilization, safe transport, and referral to a center with neurosurgical capacity. In LMICs, these links frequently fail: prehospital emergency systems are rare, transport is often non-medicalized, and access to specialized care relies on a multi-tier referral system that generates

cumulative delays.[9–14] World Health Assembly resolution WHA72.16 established the strengthening of emergency care systems as a priority for universal health coverage.[14] The "three delays" model, developed for maternal mortality, offers a transferable framework: delay in deciding to seek care, delay in reaching an appropriate facility, and delay in receiving appropriate care once there.[15] Applied to TSCI, it shifts attention from clinical factors alone toward the organization of the care pathway—a decisive but poorly documented dimension in the region. Few African studies have specifically analyzed this organization and its influence on the delay in accessing specialized care; the available data remain largely descriptive and rarely address the chain of care as a system amenable to improvement.

We hypothesized that access delays are principally associated with organizational factors of the prehospital chain, independently of initial neurological severity, and that they influence in-hospital outcome mainly through a selection bias related to prehospital mortality. This study had three objectives: to describe the prehospital chain and access delays; to identify the determinants of delayed access and of non-medicalized transport; and to explore the association between care-pathway characteristics and in-hospital outcome. This work is part of a program of analyses of a single cohort; two related manuscripts, addressing clinical prognostic factors and the AOSpine classification, have been disclosed to the editorial office (see Declarations).

METHODS

Study design, setting, and population: This analytical observational study was conducted in the Department of Neurosurgery of Bouaké University Hospital, a neurosurgical referral center serving several administrative regions of central and northern Côte d'Ivoire. Data collection combined a retrospective phase (January 1, 2017 to December 31, 2021) and a prospective phase (January 1, 2025 to June 30, 2026); the years 2022 to 2024 were not present in the audited database available for this study, and the exact distribution of the 366 patients between the two phases could not be documented from the date variables. Reporting follows the STROBE guidelines.[16] Patients hospitalized for a clinically and radiologically confirmed TSCI were included; non-traumatic conditions (disc herniation, myelomeningocele, tumors and metastases, infectious spondylodiscitis), duplicates, and non-conclusive records were excluded. Of 383 records identified, 17 were excluded on these grounds—9, 5, and 3, respectively—leaving 366 analyzable patients (Figure 1); these numbers were verified against the original registers.
The database underwent a formal quality audit: removal of non-traumatic conditions and duplicates, re-entry from source records, reconciliation of operative status, checking of extreme values, and internal-consistency controls. Missing data were handled by complete-case analysis, without imputation; none of the main care-pathway variables had missing data.

Variables and conceptual model: The variables characterizing the prehospital chain were the mode of admission (referred versus direct admission), the originating facility and its level, the means of transport, the time to reception (days elapsed between injury and arrival at the referral center), and insurance coverage. The raw labels of the originating facility (93 categories) were normalized into six

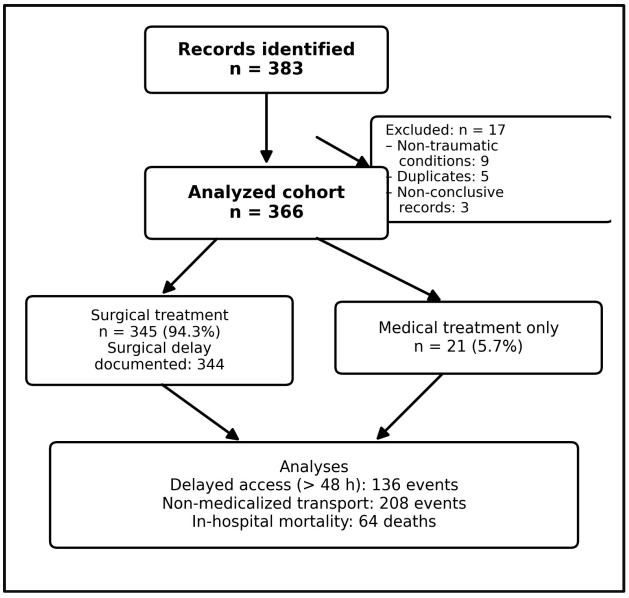


Figure 1. Participant flow diagram. Of 383 records identified, 17 were excluded (9 non-traumatic conditions, 5 duplicates, 3 non-conclusive records); the analyzed cohort comprised 366 patients, of whom 345 underwent surgery (94.3%) and 21 were treated medically. The surgical delay was documented for 344 of the 345 operated patients

levels: receiving university hospital, general hospital, regional hospital (CHR), first-level health center, private sector, and a residual category grouping facilities located outside the Ivorian health-care pyramid. Residence was dichotomized into the region of the referral center (Gbêkê) versus outside the region, as a proxy for geographic remoteness. Neurological severity at admission was coded on the ASIA scale.[17] In-hospital death was the primary outcome, and the time to surgery among operated patients a secondary outcome. The expected relationships among these variables were formalized before any analysis as a directed acyclic graph (DAG) (Figure S1), intended to identify the minimal set of confounders needed to estimate each association while avoiding adjustment for mediators.[18] The association between delayed access and mortality was therefore adjusted only for its presumed confounders—severity and age—without conditioning on intermediate care-pathway variables.

Definitions: Delayed access was defined a priori as a time to reception exceeding 48 hours. International recommendations favor management within the first 24 hours when feasible; the 48-hour threshold was chosen because it already substantially exceeds the recommended early-decompression window while isolating a sufficiently large stratum of patients.[7,8] Its robustness is examined by sensitivity analyses at thresholds of 24 and 72 hours. Non-medicalized transport denoted any public or private means not belonging to an organized emergency service (taxi, public transport, motorcycle, tricycle, or hired vehicle), as opposed to a medicalized ambulance and to fire-and-rescue or GSPM services. A personal vehicle constituted a distinct category when it was the private vehicle of the patient or family; this distinction was based on vehicle ownership and not on its level of medicalization. The four categories—ambulance, organized emergency services, personal vehicle, and non-medicalized transport—are mutually exclusive, and a sensitivity analysis merging the last two is reported.

Statistical analysis: Qualitative variables are described as counts and percentages, and quantitative variables as median and interquartile range (IQR) given their skewed distribution; comparisons of delays between subgroups used the Mann-Whitney or Kruskal-Wallis test. The primary analysis concerned the determinants of delayed access; the analyses of non-medicalized transport and of in-hospital mortality were secondary. Because the outcomes were dichotomous, logistic regression was used. Covariate selection was based on the a priori causal model, univariable results being used only as a complement and clinically essential variables (age, sex, severity) retained regardless of their significance. Collinearity was checked before model building (variance inflation factors all < 1.2), and the linearity of the age–logit relationship was examined before introducing age as a continuous variable ($p = 0.09$). Firth penalized regression was planned in case of separation or rare events.[19] Discrimination was assessed by the area under the ROC curve (AUC) with a confidence interval from nonparametric bootstrap over 2000 resamples, and calibration by the Hosmer-Lemeshow test. Odds ratios are interpreted as measures of association and not as estimates of relative risk. No correction for multiple testing was applied, the three components addressing distinct, prespecified questions. The significance threshold was 0.05 two-sided, and analyses were performed in Python (pandas, SciPy, statsmodels, scikit-learn).

Ethical considerations: The study was conducted in accordance with the principles of the Declaration of Helsinki. The protocol was approved by the Institutional Ethics Committee of Bouaké University Hospital (approval no. CEI/CHU-BKE/146/2026), which granted a waiver of individual consent for the retrospective use of anonymized routine records; patients included in the prospective phase, or their legal representatives, gave informed consent. The study was carried out within the Department of Neurosurgery of Bouaké University Hospital.

RESULTS

The cohort comprised 366 patients (Table 1). The median age was 35 years (IQR 26–47), with a marked male predominance (80.9%); road traffic crashes were the leading etiology (62.6%), and the injury was cervical in half of the cases.

Table 1. General characteristics of the cohort (n = 366)

Characteristic	n (%) or median (IQR)
Age, years	35 (26–47)
Male sex	296 (80.9)
Mechanism — road traffic crash	229 (62.6)
Mechanism — fall	95 (26.0)
Mechanism — assault or other	42 (11.5)
Level — cervical	183 (50.0)
Level — thoracic	124 (33.9)
Level — lumbar or sacral	59 (16.1)
ASIA grade A (complete)	147 (40.2)
ASIA grade B / C / D / E	51 / 60 / 65 / 43
Referred patient	263 (71.9)
Non-medicalized transport	208 (56.8)
Residence outside the region (Gbêkê)	281 (76.8)
Insurance coverage	56 (15.3)
In-hospital death	64 (17.5)

ASIA = American Spinal Injury Association; IQR = interquartile range. Percentages are calculated over the whole cohort (n = 366).

Profile of the prehospital chain: Of the 366 patients, 263 (71.9%) were referred and 103 (28.1%) directly admitted, the referred patients originating from 93 distinct facilities. Related to the whole cohort, the recorded originating facility was distributed among the receiving university hospital (133; 36.3%), the general hospital (96; 26.2%), the regional hospital (71; 19.4%), the first-level health center (44; 12.0%), the private sector (21; 5.7%), and a foreign border facility (1; 0.3%). The number of patients coded "receiving university hospital" exceeds the number of direct admissions; the origin of this coding discrepancy is set out in the limitations. Transport was non-medicalized for 208 patients (56.8%); ambulances (79; 21.6%) and organized emergency services (58; 15.8%) together accounted for only 137 conveyances (37.4%), and a personal vehicle for 21 (5.7%). Insurance coverage was marginal: only 56 patients (15.3%) were insured (Figure 2).

Access delays to the referral center: The median time to reception was 2 days (IQR 1–3), but the distribution was strongly right-skewed (mean 3.9 ± 7.5 days). One in three patients (136; 37.2%) was received beyond 48 hours, 11.7% at 7 days or more, and 6.0% (22 patients) at 14 days or more, with extreme values reaching 72 days (Figure 3). In bivariable analysis, the delay was significantly longer among patients transported by a non-medicalized means ($p = 0.001$), residing outside the region ($p = 0.034$), and referred ($p = 0.038$); it varied by the level of the originating facility (Kruskal-Wallis, $p = 0.010$). Insurance coverage and severity were not associated with the delay.

Determinants of delayed access: After mutual adjustment, two factors remained independent determinants of a delay exceeding 48 hours: non-medicalized transport (aOR 2.09; 95% CI 1.29–3.37; $p = 0.003$) and residence outside the region (aOR 1.76; 1.02–3.03; $p = 0.042$). Referred status showed an association in the same direction, at the margin of significance (aOR 1.62; 0.97–2.69; $p = 0.064$) (Table 2, Figure S2). In univariable analysis, passage through a referring tier was associated, at any level, with excess delay relative to direct admission (regional hospital: OR 2.95; first-level health center: OR 2.53; private sector: OR 3.64); these values do not describe a monotonic gradient by position in the health-care pyramid but indicate that any additional link lengthens the delay, without an established hierarchy among tiers. The model discriminated modestly (AUC 0.64; 95% CI 0.58–0.69) with satisfactory calibration (Hosmer-Lemeshow $\chi^2 = 1.68$; 8 df; $p = 0.990$). Delayed access was therefore determined mainly by organizational factors rather than by the patient's clinical characteristics.

Determinants of non-medicalized transport: Recourse to non-specialized transport was less frequent in situations that spontaneously mobilized organized emergency services. In multivariable analysis, it was less likely for road traffic crashes (aOR 0.23; 95% CI 0.14–0.38; $p < 0.001$) and for the most severe patients (ASIA A: aOR 0.55; 0.35–0.86; $p = 0.009$), with insurance coverage showing a protective trend (aOR 0.56; 0.30–1.04; $p = 0.067$) (Table 3; AUC 0.71; Hosmer-Lemeshow $\chi^2 = 2.14$; 8 df; $p = 0.976$). Medicalized transport thus remained reserved for the most overt presentations and the most severely injured patients, leaving the less spectacular presentations—no less at risk of cord injury—to non-medicalized means.

Prehospital chain and in-hospital outcome: In-hospital mortality was 17.5% (64/366). The dominant determinant of death was neurological severity, ASIA A patients having a

greatly increased risk (aOR 11.0; 95% CI 5.50–22.0; p < 0.001), with good discrimination (AUC 0.81; 95% CI 0.75–0.87; Hosmer-Lemeshow χ^2 = 11.54; 8 df; p = 0.173). No prehospital care-pathway variable was associated with excess mortality after adjustment (Table 4). One apparently paradoxical result deserves emphasis: delayed access was associated with lower in-hospital mortality. Estimated according to the predefined causal framework, this association was aOR 0.27 (0.13–0.55; p < 0.001); it persisted in the full model (aOR 0.29; 0.14–0.60) and within the ASIA A subgroup itself. This relationship has no protective causal plausibility and most likely reflects depletion of susceptibles. Mortality was indeed early: median time to occurrence of 5 days after admission (IQR 3–11), with 40 of the 64 deaths (62.5%) occurring within the first 7 days. The presumed mechanism of this early lethality is respiratory, through involvement of the respiratory muscles in high cervical lesions; the records did not allow an exhaustive, standardized collection of the immediate causes of death, but a targeted review found that approximately 70% of deaths were compatible with respiratory failure in patients with a cervical lesion. This information was not treated as an analysis variable, and the interpretation remains a pathophysiological hypothesis. Figure 4 details the gradient: mortality was 5.6% (1/18) below 24 hours, 26.4% (34/129) between 24 and 48 hours, 20.5% (17/83) between 48 and 72 hours, 8.6% (8/93) from 3 to 6 days, and 9.3% (4/43) at 7 days or more.

The relationship is therefore not monotonic; the earliest stratum, comprising only 18 patients and a single death, cannot be interpreted in isolation, and it is the decline observed beyond 48 hours that carries the result. The composition of the cohort at admission was stable across strata: the proportion of ASIA A remained between 38 and 44%, and that of high cervical lesions was 31, 34, 36, 33, and 35% across the five strata, respectively, without a decreasing trend. Late recruitment of less severe patients is therefore an implausible explanation for the fall in mortality at long delays, including on the dimension of lesion level. Overall, in-hospital mortality was governed by neurological severity rather than by care-pathway characteristics. Finally, among the 345 operated patients—344 with a documented surgical delay—the median time to surgery was 3 days (IQR 2–4). This delay was not correlated with the prehospital time to reception (Spearman ρ = −0.01; p = 0.84), suggesting that operative delay stems from intrahospital constraints independent of the upstream trajectory.

Sensitivity analyses: The main associations were robust. The association between non-medicalized transport and delayed access persisted regardless of the threshold used (> 24 h: aOR 2.13; 95% CI 1.32–3.42; > 72 h: 1.79; 1.04–3.08). The inverse association between delay and mortality persisted after excluding extreme delays (≤ 14 days: aOR 0.28; 0.13–0.59; ≤ 7 days: aOR 0.23; 0.10–0.54).

Table 2. Factors associated with delayed access (> 48 h): univariable and multivariable logistic regression (n = 366; 136 events)

Factor	Crude OR (95% CI)	Adjusted OR (95% CI)	Adjusted p
Non-medicalized transport	1.86 (1.20–2.88)	2.09 (1.29–3.37)	0.003
Residence outside the region (Gbêkê)	1.68 (0.99–2.86)	1.76 (1.02–3.03)	0.042
Referred patient	1.64 (1.01–2.69)	1.62 (0.97–2.69)	0.064
Mechanism — road traffic crash	0.95 (0.61–1.47)	1.18 (0.73–1.92)	0.491
ASIA grade A	1.12 (0.73–1.73)	1.23 (0.79–1.94)	0.362
Insurance coverage	1.02 (0.57–1.83)	1.13 (0.62–2.09)	0.686
Age (per year)	1.01 (0.99–1.02)	1.012 (0.995–1.029)	0.176
Male sex	0.74 (0.44–1.26)	0.70 (0.40–1.21)	0.196

95% CI = 95% confidence interval; OR = odds ratio. Adjusted ORs are from the final multivariable model. Discrimination: AUC 0.64 (0.58–0.69); calibration: Hosmer-Lemeshow χ^2 = 1.68; 8 df; p = 0.990. The gradient by level of referring facility is presented univariably in the text to avoid collinearity with referred status.

Table 3. Factors associated with non-medicalized transport: multivariable logistic regression (n = 366; 208 events)

Factor	Adjusted OR (95% CI)	p
Mechanism — road traffic crash	0.23 (0.14–0.38)	< 0.001
ASIA grade A	0.55 (0.35–0.86)	0.009
Insurance coverage	0.56 (0.30–1.04)	0.067
Referred patient	0.95 (0.58–1.57)	0.853
Residence outside the region (Gbêkê)	1.10 (0.65–1.87)	0.722
Age (per year)	1.00 (0.98–1.01)	0.919
Male sex	1.16 (0.66–2.02)	0.614

An OR below 1 reflects a lower probability of non-medicalized transport, hence more frequent recourse to medicalized transport or organized emergency services. Discrimination: AUC 0.71 (0.65–0.76); calibration: Hosmer-Lemeshow χ^2 = 2.14; 8 df; p = 0.976.

Table 4. Factors associated with in-hospital mortality: logistic regression (n = 366; 64 deaths)

Factor	Crude OR (95% CI)	Adjusted OR (95% CI)	Adjusted p
ASIA grade A	9.44 (4.82–18.5)	11.0 (5.50–22.0)	< 0.001
Delayed access (> 48 h)	0.33 (0.17–0.65)	0.27 (0.13–0.55)	< 0.001
Age (per year)	0.99 (0.97–1.01)	0.99 (0.96–1.01)	0.191

Model specified a priori in accordance with the causal graph (Figure S1), adjusted for confounders (severity, age) without conditioning on intermediate care-pathway variables. The inverse association between delay and mortality must be interpreted as a selection artefact (depletion of susceptibles, left truncation) and not as a protective effect of delay. Discrimination: AUC 0.81 (0.75–0.87); calibration: Hosmer- Lemeshow χ^2 = 11.54; 8 df; p = 0.173.

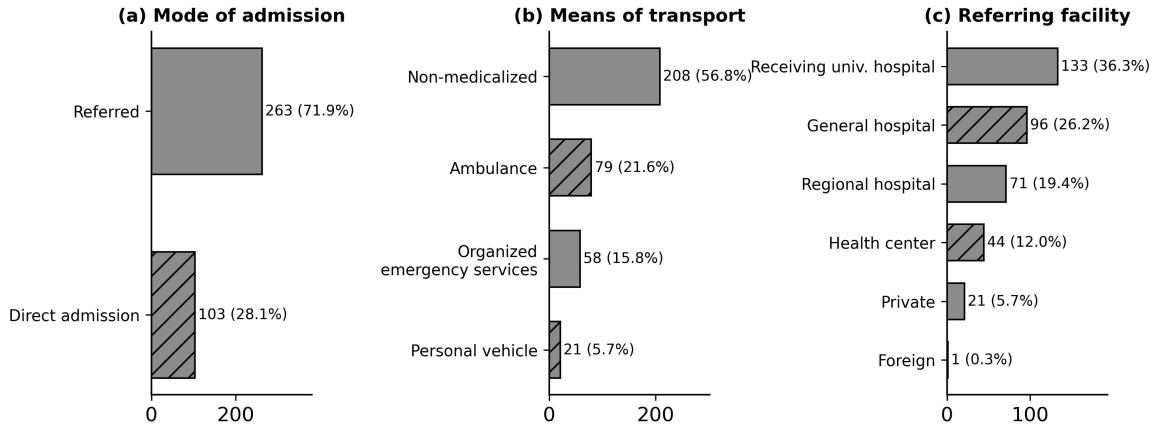


Figure 2. Profile of the prehospital chain (n = 366): (a) mode of admission; (b) means of transport; (c) level of the originating facility within the health-care pyramid. In (c), the "Foreign" category corresponds to a single patient referred from a foreign border facility, outside the Ivorian health-care pyramid

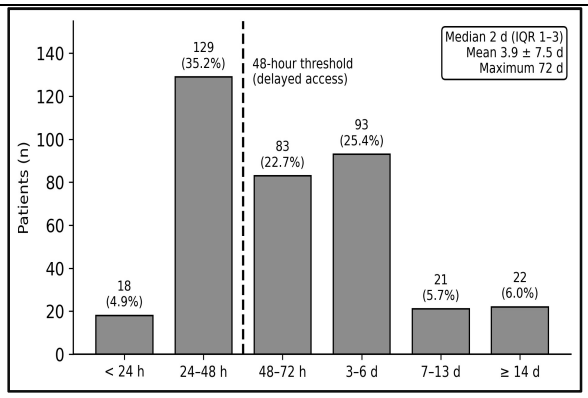


Figure 3. Distribution of the time to reception at the referral center. Central tendency is short (median 2 days), but the distribution has a long right tail, a minority of patients reaching the specialized facility after several weeks. The vertical line coincides with the 48-hour analytical threshold defining delayed

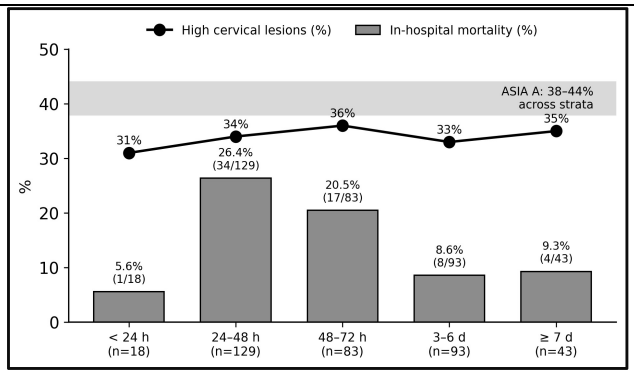


Figure 4. In-hospital mortality (bars) and proportion of high cervical lesions at admission (curve) by access delay; the shaded band shows the range of ASIA A proportions (38 to 44%), stable across strata. The decline in mortality beyond 48 hours, without a parallel decrease in the proportion of ASIA A or of high cervical lesions, illustrates depletion of susceptibles: patients destined to die do so early, so that late arrivals are selected survivors

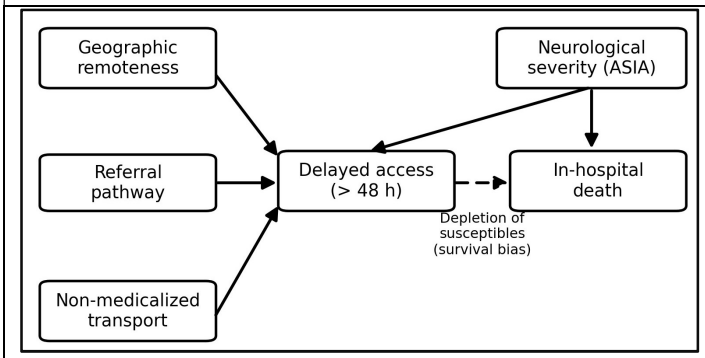


Figure S1. Conceptual model of the prehospital pathway (directed acyclic graph). Geographic remoteness, the referral pathway, and non-medicalized transport contribute to delayed access; initial neurological severity is the dominant determinant of death and acts as a confounder. The dashed arrow depicts depletion of susceptibles, the source of survival bias

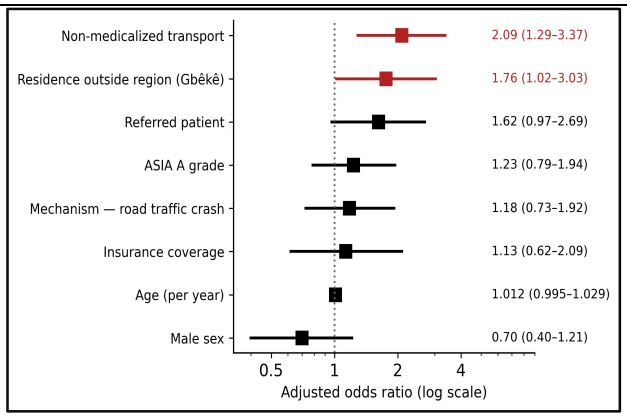


Figure S2. Independent determinants of delayed access (> 48 h): adjusted odds ratios and 95% CI. Statistically significant variables are shown in red

Finally, an analysis reclassifying the 21 personal-vehicle conveyances into the "non-medicalized transport" category (229/366; 62.6%) yielded results very close to the main analysis (aOR 2.01; 95% CI 1.26–3.22; p = 0.004), without changing the factors independently associated with delayed access.

DISCUSSION

This study, focused on the care pathway of a cohort of 366 TSCIs in a low-resource setting, highlights three findings. The upstream pathway is dominated by a fragmented referral network—93 originating facilities for a single referral center—

and by predominantly non-medicalized transport, in a population very largely without insurance coverage (84.7%). Delayed access is not random: it preferentially affects remote patients and those conveyed without medicalization. Finally, in-hospital mortality is governed by initial neurological severity and not by delays, the inverse association between delay and mortality reflecting a selection of survivors rather than a benefit of delay.

Comparison with the literature: The demographic and etiological profile of our cohort is consistent with regional syntheses—male predominance, dominance of road traffic crashes, and a high proportion of complete injuries.[1–3,5] The observed profile illustrates the repeated observations on the immaturity of prehospital emergency systems in sub-Saharan Africa, where organized and medicalized transport remains the exception.[9–12] The specificity of this work lies in its object—the care pathway rather than clinical description alone—and in the quantitative characterization of the determinants of delay, still little documented for TSCI in West Africa. Whereas most of the literature on delays concerns maternal health, our results extend the relevance of the three-delays framework to a time-sensitive neurosurgical condition.[15] Several mechanisms may underlie these associations. The frequent recourse to non-medicalized transport likely reflects the low availability and cost of ambulances, the absence of organized-emergency coverage in rural areas, and the assumption of transport by families. The excess delay among referred patients probably reflects repeated evaluations, initial diagnostic wandering, the search for financial means, and the multiplication of transfers. These delays therefore stem more from the organizational capacities of the health system than from patients' individual characteristics.

Depletion of susceptibles and left truncation: The association between delayed access and lower mortality might, taken at face value, wrongly suggest that timeliness of access matters little; a rigorous epidemiological reading leads to the opposite conclusion. TSCI mortality here is early, the presumed dominant mechanism being respiratory in high cervical injury; the most vulnerable patients die within the first hours or days, frequently before reaching the referral center or during transfer. Patients received late are therefore, by construction, survivors who have passed the most critical lethal window—a phenomenon of left truncation well described in trauma cohorts of LMICs.[10] The competing explanation of late referral of less severe patients is implausible: the proportion of ASIA A does not decrease at long delays, and the paradox persists within the ASIA A subgroup itself. This objection was examined on the dimension that the ASIA grade does not cover, lesion level: the proportion of high cervical lesions did not decrease at long delays either (31 to 36% across strata), so that the injury composition of arrivals did not change with delay. The related manuscript on the clinical prognostic factors of the same cohort reports concordant observations: a shorter time to reception among patients who died (1 day versus 2; $p = 0.006$) and the loss of significance of cervical level after adjustment for severity. The major consequence is that the hospital cohort offers an incomplete representation of the epidemiological reality of TSCI: prehospital deaths, invisible in the referral center's registers, likely belong to the most delayed trajectories. This reading, far from downplaying the importance of delays, reinforces their public-health significance and illustrates the importance of distinguishing statistical association from causal effect in observational studies subject to left truncation.[18]

Clinical and public-health implications: A substantial proportion of the observed delays stems from potentially avoidable organizational factors—absence of medicalized transport, multiplication of successive referrals—as opposed to the irreducible delays related to distance alone. The progressive development of medicalized transport, adapted to local constraints and including spinal immobilization, appears to be a priority, all the more so because non-medicalized transport concentrated both delay and the least alarming presentations. Structuring the pathway, with protocols for direct routing of suspected TSCI to the neurosurgical center, and training the staff of peripheral facilities in the early recognition of cord injuries, are its natural complements. These directions align with international recommendations on strengthening emergency and trauma systems in LMICs[13,14,20] and with the global surgery and neurosurgery agenda.[21,22] Notably, the intrahospital surgical delay is independent of the prehospital delay: acting upstream will not suffice if downstream specialized-care constraints are not simultaneously lifted.

Strengths and limitations: The strengths of the study lie in an audited cohort of appreciable size for the region, a multivariable approach guided by an explicit causal framework, and a transparent interpretation of survival bias rather than its concealment. Several limitations must be underlined. The observational nature precludes any causal conclusion; the single-center and partly retrospective design exposes to selection and information biases. Above all, the hospital nature of the cohort induces the left truncation discussed above. It should be emphasized that the selection induced by survival to admission does not concern the mortality analysis alone: because survival to arrival is a common effect of delay and severity, conditioning on it may also attenuate the association between severity and delayed access, whose lack of statistical significance cannot therefore be read as established independence. The absence of information on the delay between injury and first consultation is another limitation, as is the expression of the time to reception in days, which restricts resolution for the shortest trajectories, and the absence of data on care received before arrival. The time to reception aggregates, without distinguishing them, the decisional, transport, and referral delays. Finally, a coding discrepancy between the mode of admission and the originating facility coexisted in the database—133 patients of "receiving university hospital" origin for 103 direct admissions. It results from the historical coding of the variable: patients transferred after a very brief or administrative initial evaluation were recorded as originating from the receiving university hospital although they were classified as referred. In accordance with the analysis plan, the mode of admission, which is more reliable, was retained as the reference variable for the multivariable analyses, the originating facility being used only for descriptive and univariable purposes. These limitations open perspectives: prospective multicenter studies, a national registry documenting the entire continuum of care—including the currently uncaptured prehospital deaths—, evaluation of the impact of strengthened medicalized transport, and health-economic analyses.

CONCLUSIONS

Access delays for traumatic spinal cord injuries in Côte d'Ivoire stem mainly from organizational factors: non-medicalized transport and geographic remoteness. The observed association between delayed access and lower in-hospital mortality reflects a survival bias linked to early deaths occurring before arrival at the referral center and must not be interpreted as a protective effect of delay. Strengthening prehospital systems, improving medical transport, and organizing regional trauma pathways are public-health priorities. In such settings, the development of neurosurgery will yield its full effect only if accompanied by a parallel strengthening of emergency and referral systems.

ETHICS APPROVAL

Study conducted in accordance with the principles of the Declaration of Helsinki; anonymized data. Protocol approved by the Institutional Ethics Committee of Bouaké University Hospital (approval no. CEI/CHU-BKE/146/2026), which granted a waiver of individual consent (retrospective study of anonymized routine records); informed consent from patients or their legal representatives for the prospective phase. Study carried out within the Department of Neurosurgery of Bouaké University Hospital.

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CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest concerning the materials or methods used in this study or the findings reported herein.

AUTHOR CONTRIBUTIONS

Conception and design: Ablé, Teti. Acquisition of data: Djondé, Simaga, Teti. Analysis and interpretation of data: Teti, Koffi Jean-Jacques. Drafting the article: Ablé, Teti. Critically revising the article: Koffi Jean-Jacques, Haidara. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Teti. Statistical analysis: Teti. Study supervision: Haidara.

RELATED MANUSCRIPTS AND DATA OVERLAP

This manuscript is part of a program of analyses of a single cohort of 366 traumatic spinal cord injuries. Two related manuscripts—one addressing the clinical prognostic factors of in-hospital mortality and neurological recovery, the other the AOSpine classification—are based on the same population and share the descriptive data and the in-hospital mortality outcome; they have been disclosed to the editorial office and their copies can be provided to the editorial office on request. The present manuscript is the only one addressing the prehospital chain and access delays; its main analyses (determinants of delayed access and of non-medicalized transport, care-pathway–mortality association) are reported in none of the related manuscripts.

PRIOR PRESENTATION: No part of this work has been previously presented.

DATA AVAILABILITY: Anonymized data may be made available upon reasonable request to the corresponding author, subject to ethical and regulatory requirements.

LIST OF ABBREVIATIONS

ASIA = American Spinal Injury Association; AUC = area under the ROC curve; aOR = adjusted odds ratio; CHR = regional hospital (centre hospitalier régional); DAG = directed acyclic graph; GSPM = military fire-and-rescue service (Groupement des sapeurs-pompiers militaires); IQR = interquartile range; LMIC = low- and middle-income country; TSCI = traumatic spinal cord injury.

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