

Complications after Surgery for Traumatic Spinal Cord Injury in Côte D’Ivoire: A Cohort of 345 Operated Patients

Serge Konan Yao

Department of Neurosurgery, Bouaké Teaching Hospital (CHU de Bouaké); Faculty of Medical Sciences (UFR des Sciences Médicales), Alassane Ouattara University, Bouaké, Côte d’Ivoire.

ABSTRACT

Background. Complications after surgery for traumatic spinal cord injury (SCI) remain poorly documented in sub-Saharan Africa.

Objective. To describe postoperative complications (pressure sores, superinfection, reoperation) at an Ivorian referral centre and to look for a link with in-hospital mortality. **Methods.** Single-centre cohort (Bouaké Teaching Hospital), reported according to STROBE: 345 operated patients out of 366 with confirmed SCI. We extracted complications recorded before death or discharge; onset dates were not always known. The primary outcome was in-hospital mortality, analysed with Firth penalised logistic regression. **Results.** Median age was 35 years (IQR 25–48); 80.9% were men; median time to surgery was 3 days. In-hospital mortality reached 17.7% (61/345). At least one complication affected 59.4% of operated patients: neurological 25.5% (including 34 neurological worsenings), respiratory 21.4%, urinary 13.0%, pressure sore 12.5%, thromboembolic 4.1%; superinfection 17.4%. Reoperation concerned 6.7% (fixation or decompression revision:

4.6%). All deaths occurred in patients with a complication (61/205 vs 0/140). Pressure sores did not differ significantly by severity (16.0% vs 10.0%; $p = 0.10$). After adjustment for age and complete injury (adjusted OR 7.03), pressure sore (5.58) and urinary (7.26), neurological (5.89) and respiratory (4.23) complications remained associated with mortality ($p < 0.001$). **Conclusion.** Complications are frequent and associated with mortality. Our data cannot tell whether they cause death, result from an already unfavourable course, or merely mark it. Prospective studies with dated complications, care-process indicators and fuller adjustment are needed before judging quality of care.

KEYWORDS: Traumatic Spinal Cord Injury; Pressure Ulcer; Postoperative Complications; Surgical Revision; In-Hospital Mortality

1. INTRODUCTION

Traumatic spinal cord injury (SCI) leaves young adults with lasting disability. In sub-Saharan Africa it also kills: in-hospital mortality was 24.8% in an East African series of cervical spine injuries [1]. Incidence ranges from 13 to 75.6 cases per million inhabitants depending on the country [2]. In an Ethiopian cohort of spine trauma, 22.2% of patients died within 30 days [3]. The causes recur: severe injuries, delayed care, non-medicalised transport, limited technical facilities, and difficult access to rehabilitation [1]–[3].

Once the spinal cord injury is established, complications of prolonged bed rest weigh on outcome: pressure sores, urinary and respiratory infections, thromboses, and surgical site infections [4]–[6]. In a multicentre cohort of 1,282 cervical injuries, hospital-acquired pressure sores were accompanied by poorer motor recovery at one year and excess mortality [4]. They are considered largely preventable [4] [7]. In the acute phase, 37.5% to 49.2% of patients develop one, depending on the series [5] [6] [8]. Unlike injury severity, these complications are in principle modifiable.

In French-speaking West Africa, data are lacking on these complications after surgery for traumatic spine injury, on reoperations, and on superinfections. We describe them in patients operated on for SCI at the Bouaké Teaching Hospital and look for their link with in-hospital mortality. Our hypothesis: this link persists after accounting for initial neurological severity.

2. MATERIALS AND METHODS

2.1. Setting and population

We conducted a cohort study in the Neurosurgery Department of the Bouaké Teaching Hospital, the referral centre for SCI in central Côte d’Ivoire. It follows the STROBE recommendations [9]. A retrospective phase covers patients hospitalised from 1 January 2017

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to 31 December 2021, and a prospective phase covers the period from 1 January 2025 to 30 June 2026. The years 2022 to 2024 are missing from the database. We could not retrieve from the registers the exact distribution of patients between the two phases. Of 383 records identified, 17 were excluded (9 non-traumatic conditions, 5 duplicates, 3 inconclusive records): 366 patients with confirmed SCI remain. We kept the 345 operated patients. The 21 patients treated medically or orthopaedically were set aside to obtain a homogeneous population (Figure 1).

2.2. Definitions

We classified complications by main category (neurological, respiratory, urinary, cutaneous, thromboembolic, or combination) and then by clinical detail. Definitions follow the department’s clinical, biological or radiological criteria:

- **Pressure sore:** documented decubitus skin lesion (always sacral in our series).
- **Pneumonia:** lower respiratory tract infection, with clinical or radiological signs.
- **Respiratory sepsis:** respiratory infection with systemic involvement.
- **Urinary infection:** documented infection of the urinary tract, often related to catheterisation.
- **Deep vein thrombosis:** thrombosis documented clinically or by imaging.
- **Superinfection:** documented secondary infection, defined a priori as a urinary infection or respiratory sepsis.
- **Reoperation:** revision of fixation or decompression, pressure sore debridement, no reoperation, or reoperation indicated but not performed because of early death.

Neurological complication: deficit worsening (34), neuropathic pain (25), spasticity (18), other (11), i.e. 88 patients.

Complications come from the institutional database, coded by category. We retained only those recorded before death or discharge. None was coded after the fact from the cause of death.

Their date of onset was not always recorded. We therefore cannot separate complications present from admission from those acquired during the stay, although 71.9% of the 366 cohort patients had been referred from another facility. “Postoperative” here means a complication documented during the stay of an operated patient. Length of stay was not available. We graded initial neurological severity with the ASIA/AIS grade (ISNCSCI) [10]; complete injury corresponds to grade A. Decubitus prevention corresponded to its mere mention in the nursing record. The primary outcome was in-hospital mortality: any death between admission and discharge, whatever the cause.

2.3. Statistical analysis

We present categorical variables as counts and percentages and quantitative variables as median and interquartile range (IQR). No analysis protocol was registered before the data were exploited. The Shapiro–Wilk test rejected normality for all quantitative variables ($p < 0.001$):

we used non-parametric tests. Bivariate comparisons rely on Fisher’s exact test or χ^2 (categorical variables) and on the Mann–Whitney test (quantitative variables).

We estimated factors associated with mortality by Firth penalised logistic regression [11] (Jeffreys penalisation, Newton–Raphson solution). This method limits bias when events are rare and handles separation problems. The multivariable model contains the variables associated with mortality at $p < 0.20$ in univariable analysis, plus age, retained for its clinical relevance: 61 deaths for 6 variables, i.e. about 10 events per variable. We excluded thromboembolic complications, which were too rare. The model contains neither respiratory distress at admission, nor polytrauma, nor spinal shock, nor time to surgery, nor corticosteroid therapy. Cervical level was tested only in a sensitivity analysis. We checked for the absence of collinearity (maximum correlation 0.20; maximum variance inflation factor 1.08). Odds ratios (OR) are given with their 95% confidence interval. Missing data ($< 1\%$) were not imputed.

We measured discrimination by the area under the ROC curve (AUC), calibration by the

Hosmer–Lemeshow test, and McFadden’s pseudo- R^2 . These performances are apparent: we calculated them on the cohort used to build the model, without optimism correction or external validation. Three sensitivity analyses were performed: (i) exclusion of deaths before day 7 (18 deaths excluded; 327 patients and 43 deaths retained); (ii) replacement of urinary and respiratory complications by the composite superinfection; (iii) addition of cervical level.

On an exploratory basis, we built a simple score (one point per factor: complete injury, pressure sore, respiratory, urinary, neurological complication) to describe the cumulative burden. We also compared, in univariable analysis, time to surgery dichotomised (≤ 3 versus > 3 days) with complications and mortality. These analyses remain exploratory. Complications are recorded during the stay: their link with death carries an element of temporality that rules out any predictive or causal reading. Our vocabulary therefore remains associative. Analyses were performed with Python 3.12 (pandas, statsmodels, scipy), at a two-sided threshold of 0.05.

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3. RESULTS

3.1. Operated population

Of the 366 patients in the cohort, 345 (94.3%) were operated: they form the analysed population (Figure 1). Median age was 35 years (IQR 25–48); 80.9% were men. A complete injury (ASIA A) affected 41.7% of patients. Surgery took place a median of 3 days after admission (IQR 2–4). The record mentioned decubitus prevention in all patients (100%). For lack of variability, we cannot estimate its effect. This mention informs neither the quality of the measures nor whether they were carried out.

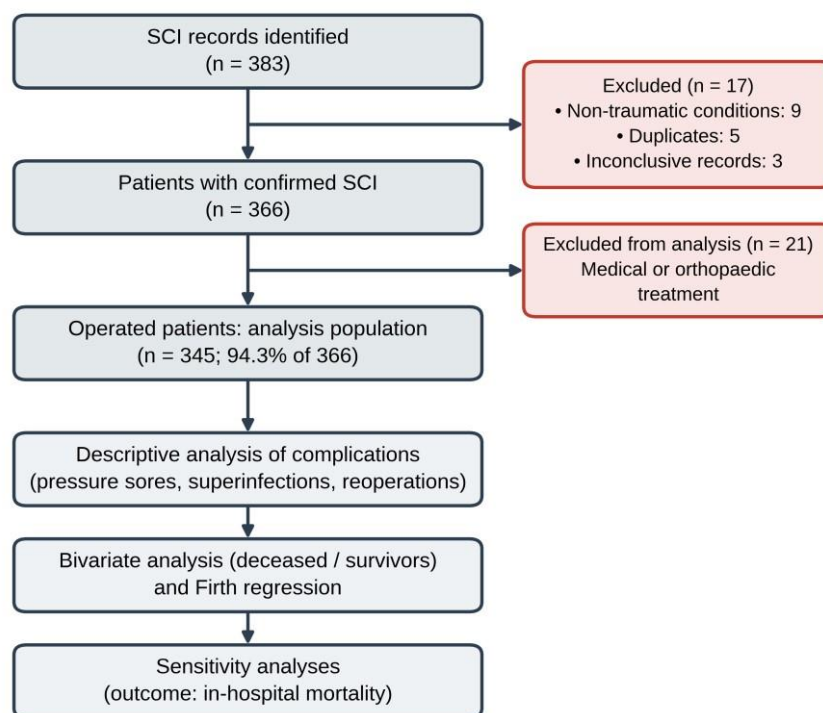


Figure 1. Flow diagram of patient selection (STROBE): 383 records identified, 17 excluded, 366 confirmed SCI, 345 operated patients analysed.

3.2. Observed complications

In total, 205 patients (59.4%) had at least one complication documented during the stay (Table 1, Figure 2). Neurological complications dominated: a quarter of operated patients. They comprised 34 deficit worsenings, 25 cases of neuropathic pain, 18 cases of spasticity and 11 other complications. Respiratory and urinary complications followed. The 43 pressure sores (12.5%) were all located at the sacrum.

Table 1. Postoperative complications documented in the 345 operated patients. Categories overlap: the sum of percentages exceeds that of patients with at least one complication. The neurological category groups 34 deficit worsenings, 25 cases of neuropathic pain, 18 cases of spasticity and 11 other (n = 88). The detailed respiratory subcategories (36 + 17 = 53) do not cover the 74 respiratory complications; the remaining 21 are obtained by difference. Superinfection (urinary infection or respiratory sepsis: 45 + 17 = 62) concerns 60 patients, 2 having both.

Complication (n = 345 operated patients)	n	%
At least one complication	205	59.4
Neurological	88	25.5
of which deficit worsening	34	9.9
of which neuropathic pain	25	7.2
of which spasticity	18	5.2
of which other	11	3.2

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Respiratory	74	21.4
of which bronchial congestion pneumonia	36	10.4
of which respiratory sepsis	17	4.9
of which other respiratory forms (by difference)	21	6.1
Urinary (urinary infection)	45	13.0
Cutaneous — sacral pressure sore	43	12.5
Thromboembolic (deep vein thrombosis)	14	4.1
Superinfection (urinary or respiratory sepsis)	60	17.4

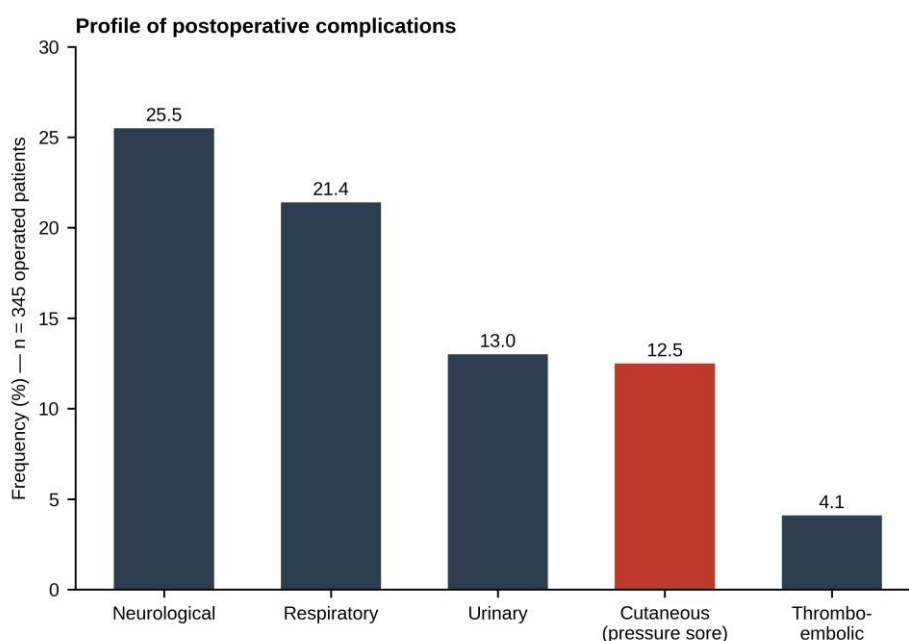


Figure 2. Principal postoperative complications in the 345 operated patients.

3.3. Pressure sores and neurological severity

Pressure sores did not vary significantly with neurological severity (16.0% in complete injury versus 10.0%; OR 1.72; 95% CI 0.91–3.27; $p = 0.10$), sex ($p = 0.22$) or age (median 33 versus 35 years; $p = 0.55$). The time between admission and surgery was the same with or without a pressure sore (median 3 days; $p = 0.60$). A multivariable model restricted to pressure sore retained no factor. Nevertheless, we cannot conclude that there is no link with severity. The estimate points towards a higher risk in complete injury, and the interval is wide: there are only 43 pressure sores. Mobilisation, nursing, duration of bed rest, nutritional status and overall clinical severity were not measured.

3.4. Reoperations

Twenty-three patients (6.7%) were reoperated: 16 for revision of fixation or decompression (4.6%) and 7 for pressure sore debridement (2.0%). As pressure sore debridement is not a spinal reoperation, reoperation of the operative site concerns 16 patients. In 11 patients (3.2%), reoperation was indicated but could not take place: they died too early. Mortality reached 26.1% in reoperated patients (6/23) and 17.1% in the others ($p = 0.26$). The time to reoperation was not always recorded; we did not analyse it.

3.5. Complications and mortality

In-hospital mortality of operated patients was 17.7% (61/345). All deaths occurred in patients with at least one documented complication (61/205), whereas no death occurred among the 140 patients without a complication. We recorded complications before death or discharge, without after-the-fact coding based on the cause of death. This complete separation nevertheless calls for caution. In bivariate analysis (Figure 3), mortality was higher with a pressure sore (37.2% versus 14.9%; $p < 0.001$), a superinfection (40.0% versus 13.0%; $p < 0.001$), a respiratory complication (35.1% versus 12.9%), a urinary complication (35.6% versus 15.0%) or a neurological complication (35.2% versus 11.7%). Complete injury weighed the most: 34.7% died versus 5.5% ($p < 10^{-12}$).

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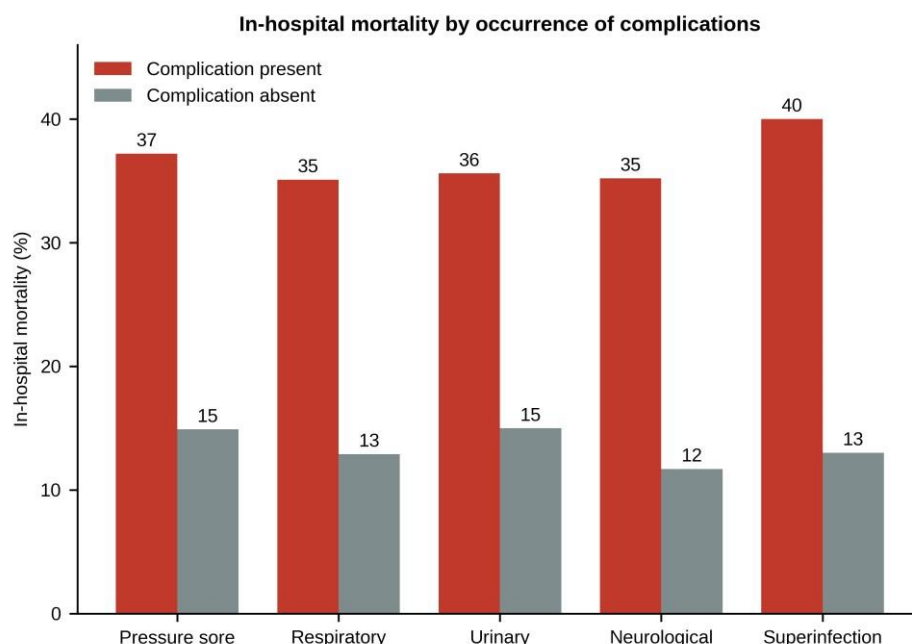


Figure 3. In-hospital mortality according to the presence or absence of each complication (n = 345).

In the Firth regression (Table 2, Figure 4), complete injury and each category of complication remained associated with death after mutual adjustment and adjustment for age. This adjustment is limited: respiratory distress at admission, polytrauma and spinal shock are missing, which exposes the respiratory complication in particular to residual confounding. Recorded during the stay, complications may be a cause, a consequence or a mere sign of an unfavourable course. Apparent discrimination was 0.89 (AUC, without optimism correction).

The Hosmer–Lemeshow test showed no major calibration defect ($p = 0.62$); McFadden’s pseudo- R^2 was 0.35.

Table 2. Factors associated with in-hospital mortality (Firth logistic regression; n = 345, 61 deaths). Model variables: age, complete injury (ASIA A), respiratory, urinary, neurological and cutaneous (pressure sore) complications. AUC = 0.89; Hosmer–Lemeshow $\chi^2 = 6.3$; 8 df; $p = 0.62$; McFadden pseudo- $R^2 = 0.35$. OR: odds ratio; CI: confidence interval.

Variable	Adjusted OR	95% CI	p
Complete injury (ASIA A)	7.03	3.32–14.92	< 0.001
Pressure sore (cutaneous)	5.58	2.31–13.45	< 0.001
Urinary complication	7.26	2.92–18.03	< 0.001
Neurological complication	5.89	2.83–12.22	< 0.001
Respiratory complication	4.23	2.01–8.92	< 0.001
Age (per year)	0.98	0.96–1.01	0.18

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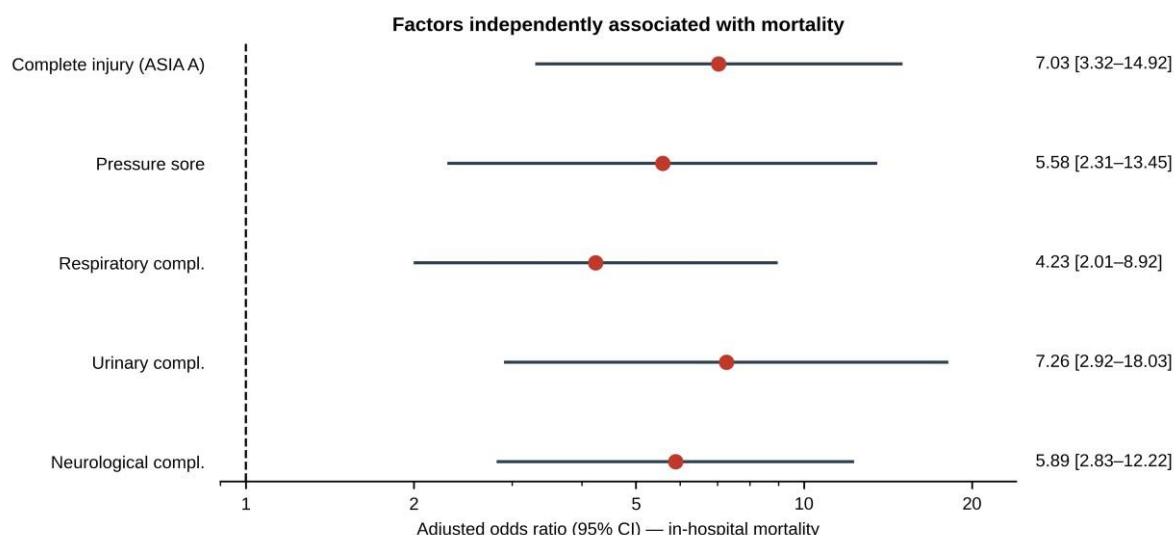


Figure 4. Adjusted odds ratios of factors associated with in-hospital mortality (Firth regression). Bars represent the 95% CI; logarithmic scale.

3.6. Sensitivity analyses

Once early deaths (before day 7) were excluded, pressure sore (OR 5.18; 95% CI 1.58–16.97; $p = 0.007$), urinary complication (OR 9.57) and neurological complication (OR 3.44) remained associated with death. The respiratory complication no longer was ($p = 0.054$). This restriction removes 18 deaths and keeps 43, in 327 patients: about 7 events per variable, hence limited scope. Among these 43 deaths, 35 involved a complete injury, 15 a pressure sore, 16 a urinary complication, 21 a neurological complication and 17 a respiratory complication. Substituted for the urinary and respiratory complications, the composite superinfection remained associated with mortality (OR 7.63; 95% CI 3.37–17.25). Adding cervical level did not change the estimates; this level was not independently associated with death.

3.7. Exploratory analyses

The cumulative score (one point per factor: complete injury, pressure sore, respiratory, urinary, neurological complication) shows a clear mortality gradient (Figure 5): 0% for a score of 0 ($n = 104$), 5.6% for 1 ($n = 126$), 39.0% for 2 ($n = 77$) and 63.2% for 3 ($n = 38$). No patient accumulated more than three factors (trend $p < 0.001$). This score describes a cumulative burden. Its components being recorded during the stay, it is in no way a prognostic tool and remains partly circular.

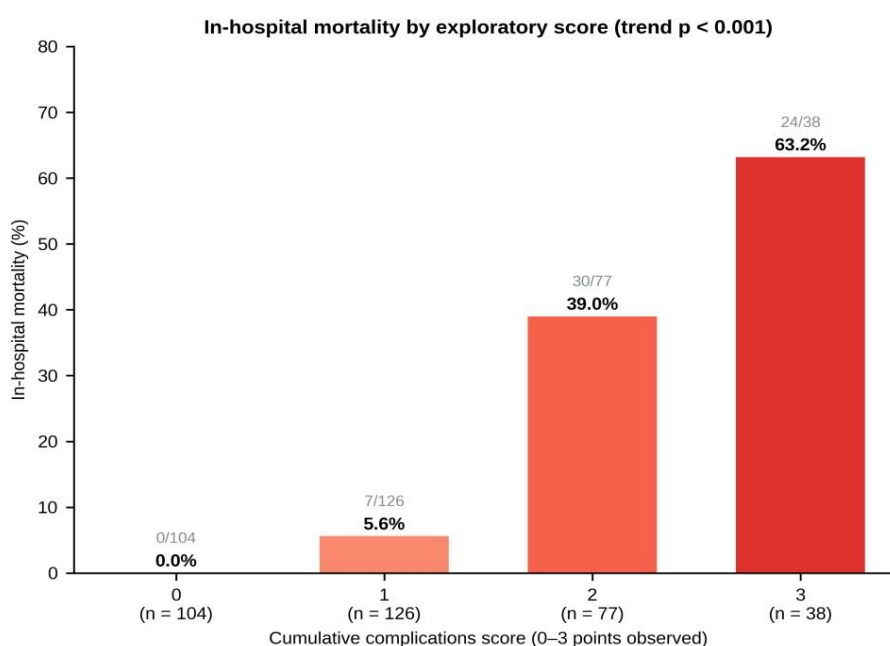


Figure 5. In-hospital mortality according to the exploratory cumulative complications score (0 to 3 points observed). Numbers per stratum under the bars; trend $p < 0.001$.

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Beyond 3 days after admission, crude mortality was higher (26.3% versus 14.2%; $p = 0.012$) and reoperations tended to be as well (11.1% versus 4.9%; $p = 0.053$). Pressure sores (13.1% versus 12.2%; $p = 0.86$) and superinfections (19.2% versus 16.7%; $p = 0.64$) did not differ. Time to surgery did not enter the multivariable model: we did not test this crude association after adjustment. It is counted from admission, not from the trauma. A complication or clinical instability may also delay surgery: reverse causality is plausible, and the question remains open.

4. DISCUSSION

Several complications documented during the stay remain associated with in-hospital mortality after surgery for SCI, even after adjustment for age and complete injury. Prognosis is therefore not reducible to the severity of the initial injury. But the study does not say whether these complications cause death, result from an already unfavourable course, or are merely its sign.

4.1. Key points

Ivorian data on complications after surgery for traumatic spine injury are scarce. This series of 345 operated patients gives a first profile, with the limitations of a partly retrospective collection. It contrasts non-modifiable factors (severity, age, lesion level) with possibly preventable complications (Figure 6). Our data do not prove that they are.

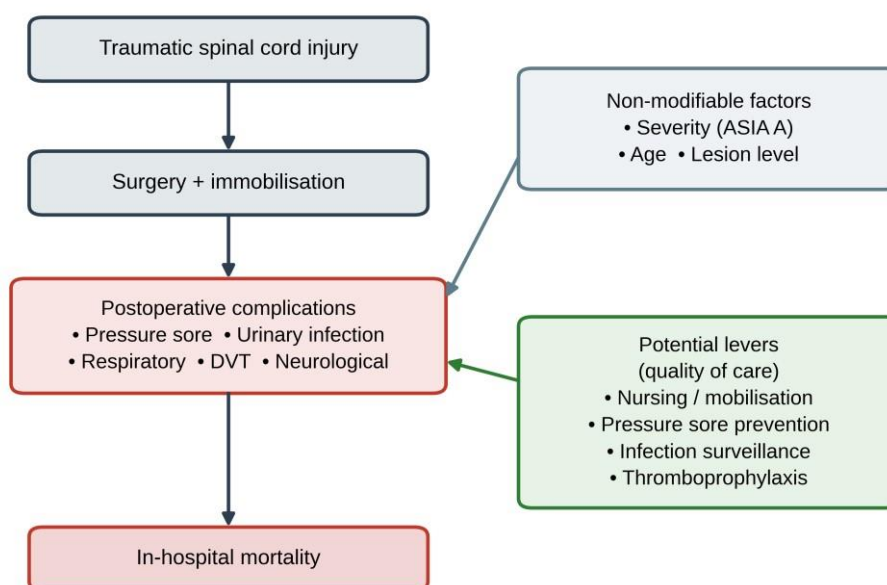


Figure 6. Diagram of possible links between postoperative complications and in-hospital mortality, and of levers to be evaluated (hypotheses not demonstrated by the study).

4.2. Pressure sores

Our pressure sores are less frequent (12.5%) than those described in the acute phase: 37.5% in an American cohort that included rehabilitation [6], 49.2% in a Swiss cohort [5], 45.7% in a large cohort of cervical injuries [4]. Several reasons are possible: better prevention, early stages not reported, shorter stay in patients who died early, different definitions. In the American series, complete injury and pneumonia were associated with pressure sore [6]. We find no significant difference by severity, but our confidence interval is wide. Decubitus prevention appeared in 100% of records: this says nothing about its intensity or adherence. The source cohort shows a gap of the same order for rehabilitation. The mobilisation instruction appears in 98.9% of the 366 patients, but a physiotherapist visited only 58.3% of the 302 survivors. A mention in the record does not prove that the care was given. Finally, we cannot distinguish pressure sores already present at admission from those acquired during the stay.

4.3. Complications and death

Pressure sore, superinfection and respiratory, urinary and neurological involvement remained associated with death after adjustment for age and complete injury. Several mechanisms are plausible, without our data demonstrating them: prolonged immobilisation, pneumonia and sepsis in cervical patients or those in respiratory distress, prolonged catheterisation, pressure sore as a portal of entry for germs. Three reservations temper this reading. An undated complication may precede death without having caused it, or reflect an already unfavourable course. All deaths carry at least one complication; as none was coded from the cause of death, this complete separation remains to be explained, and it may come from documented terminal complications rather than from an early onset.

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Adjustment is limited to age and complete injury: respiratory distress present from admission may explain both the respiratory complication and death. Excluding the 18 deaths occurring before day 7 does not lift these reservations. The analysis then rests on 43 events for six variables, and the respiratory complication does not remain significant. The neurological category is heterogeneous: deficit worsening (34 cases), neuropathic pain (25), spasticity (18), other (11). Pain and spasticity usually appear after the acute phase and relate poorly to in-hospital death. The association could therefore be mainly due to deficit worsenings, which reflect extension of the injury or a mechanical complication rather than a complication of the stay. A subcategory analysis is needed. These results are consistent with work showing that hospital-acquired pressure sore modifies prognosis after SCI [4] [7].

4.4. Comparison with Africa

Our in-hospital mortality (17.7% in operated patients) is lower than those from East Africa: 24.8% in a series of cervical injuries [1] and 22.2% at 30 days in an Ethiopian cohort of spine trauma [3]. The populations are nevertheless not comparable. In these two series, complete injury was strongly associated with death (OR 11.75 [1]; adjusted OR 6.49 [3]), as in ours (adjusted OR 7.03). A South African cohort of 2,204 patients defined early mortality at one year: the number of complications was associated with death in simple analysis; after adjustment, only complete injury, ventilation and age remained significant [12]. African data on the weight of complications after surgery remain scarce, and differences in definitions and populations limit comparisons.

4.5. Corticosteroid therapy, infections and respiratory complications

In the cohort of 366 patients, 72.4% received corticosteroids, but only 20.2% within the eighthour window recommended for methylprednisolone. A quarter of prescriptions concerned dexamethasone. Guidelines advise against corticosteroid therapy outside this window and point to an excess of infections and respiratory complications [13]. This exposure is in the database but not in the model. It could partly explain the link between infectious or respiratory complications and mortality. It needs to be analysed.

4.6. Reoperations

Reoperations of the operative site concerned 4.6% of operated patients (revisions of fixation or decompression), and 6.7% with pressure sore debridements. We cannot compare them directly with the rates of deep surgical site infection after thoracolumbar surgery, which vary with indication and technique [14]–[16]. Our database does not isolate these infections. In 3.2% of patients, an indicated reoperation could not take place: death too early. Thromboembolic complications are infrequent (4.1%). This may reflect under-detection, for lack of systematic Doppler ultrasonography screening.

4.7. Suggestions for practice

These results test no intervention; they suggest avenues. A set of simple, low-cost measures (“care bundle”) could be proposed: early mobilisation, regular repositioning, daily assessment of skin risk, respiratory physiotherapy, screening for urinary infection in catheterised patients, thromboprophylaxis according to guidelines, review of complications at multidisciplinary meetings. It will have to be evaluated before being presented as a means of improving prognosis: before/after study, process indicators, dates of onset of complications, full adjustment. Complication indicators could also feed local quality improvement efforts.

4.8. Strengths and limitations

Strengths: an operated cohort of notable size for the context (345 patients), to our knowledge without published equivalent in Côte d’Ivoire, subject to unindexed academic work; a previously audited database; a homogeneous population of operated patients; a Firth regression suited to the small number of events per category; sensitivity analyses.

Limitations. Single-centre study in a referral centre: selection bias is possible. The partly retrospective collection exposes to under-documentation of complications. Complications are not dated. Those present at admission (71.9% of cohort patients were referred) cannot be distinguished from those acquired in hospital; length of stay is missing; time at risk is not taken into account, hence an immortal time bias for slow-onset complications. The absence of any death without a complication remains to be interpreted, as does the heterogeneity of the neurological category, not analysed by subcategory. Adjustment is limited to age and complete injury: respiratory distress at admission, polytrauma, spinal shock, corticosteroid therapy and time to surgery are not included. The sensitivity analysis without early deaths rests on 43 events for six variables. Model performances are apparent. No care-process variable was analysed; decubitus prevention, mentioned in all, has no variability. The analysis plan was not registered. Unreliable dates ruled out any survival analysis. Long-term functional data, detailed microbiological analysis and postoperative rehabilitation are missing. Other manuscripts from the department rely on the same cohort (see Declarations).

4.9. Perspectives

Multicentre prospective studies are needed, with microbiological data, care quality indicators and long-term functional outcomes, and a before/after evaluation of a standardised prevention protocol. A national Ivorian, or even West African, SCI registry would make it possible to harmonise definitions, track postoperative complications and build prognostic models suited to resource-limited settings.

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5. CONCLUSIONS

In this Ivorian cohort of 345 patients operated on for SCI, 59.4% had at least one complication documented during the stay. Several of them (pressure sore, respiratory, urinary and neurological complications) remained associated with in-hospital mortality after adjustment for age and complete injury. But complications are not dated, and adjustment covers neither initial respiratory distress nor polytrauma. The study therefore does not say whether these complications cause death, result from an already unfavourable course or are merely its sign, and it does not allow judging quality of care. Multicentre prospective studies are needed, with dates of onset, process indicators and full adjustment.

DECLARATIONS

Data availability. Data are available from the corresponding author on reasonable request, subject to institutional agreement and confidentiality. Analysis scripts can be provided on request.

Consent for publication. The manuscript contains no data allowing identification of a patient.

Conflicts of interest. The authors declare no conflicts of interest.

Funding. No specific funding.

Ethics approval. The Bouaké Teaching Hospital did not have a constituted ethics committee during the study period; the study was conducted after authorisation from the head of the neurosurgery department and the hospital administration, in accordance with the principles of the Declaration of Helsinki. It has since received approval from the Institutional Ethics Committee of the Bouaké Teaching Hospital (approval no. CEI/CHU-BKE/135/2026).

Related manuscripts. This study draws on the same cohort of 366 patients and the same database as other manuscripts from the department: general prognosis and mortality, AOSpine classification, prehospital chain, surgical delay, neurological recovery, cervical versus thoracolumbar level, complete injuries (ASIA A), return to walking, injury mechanisms, polytrauma. It differs from them by its population (345 operated patients), its subject (postoperative complications and in-hospital mortality) and its model: it is the only one to include complications as covariates of the mortality model. The primary outcome (in-hospital mortality) and part of the descriptive data are shared. The related manuscripts will be attached to the submission.

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