Scientific Research Publishing

Open Journal of Modern Neurosurgery, 2026, 16(1), 148-155
https://www.scirp.org/journal/ojmn
ISSN Online: 2163-0585
ISSN Print: 2163-0569

Severe Traumatic Brain Injury: The Contribution of Neurosurgery to Treatment and Economic Costs at the CNHU-HKM in Cotonou

Thierry Alihonou[1,2*], Bikono Enestine Renée Atangana[3,4], Nawaliatou Djibril Abdoulaye[1,2], Abdias Gbaguidi[1,2], Martial Agbo Panzo[1]

[1]Department of Neurosurgery, Hubert Koutoukou Maga National University Hospital Center (CNHU-HKM), Cotonou, Benin
[2]Faculty of Health Sciences, University of Abomey-Calavi, Cotonou, Benin
[3]Department of Neurosurgery, Yaoundé Central Hospital, Yaoundé, Cameroon
[4]Faculty of Medicine and Biomedical Sciences, University of Yaoundé I, Yaoundé, Cameroon
Email: *alihonouthierry@yahoo.fr

How to cite this paper: Alihonou, T., Atangana, B.E.R., Djibril Abdoulaye, N., Gbaguidi, A. and Agbo Panzo, M. (2026) Severe Traumatic Brain Injury: The Contribution of Neurosurgery to Treatment and Economic Costs at the CNHU-HKM in Cotonou. *Open Journal of Modern Neurosurgery*, **16**, 148-155.
https://doi.org/10.4236/ojmn.2026.161014

Received: October 14, 2025
Accepted: January 26, 2026
Published: January 29, 2026

Abstract

Introduction: Severe Traumatic Brain Injury (TBI) is a major public health problem in Low- and Middle-Income Countries (LMICs). **Objective**: The objective of this study is to evaluate the role of neurosurgery in the management of severe TBI in adults and its economic impact in 2022 in a tertiary hospital in Benin. **Methods**: We conducted a retrospective cohort study (2017-2021) at the CNHU-HKM in Cotonou. Patients aged 15 years and older with a Glasgow Coma Scale score of ≤ 8 were included. Sociodemographic, clinical, paraclinical, therapeutic and economic data were collected from medical records and analysed using Epi Info (chi^2 tests, $p < 0.05$; Firth's penalized logistic regression used for indefinite ORs). **Results**: Sixty-four records were analysed. The mean age was 36.25 ± 13.41 years. The sex ratio was 6.1. Road traffic accidents were involved in 92.2% of cases. Brain computed tomography was performed in 39.1% of cases. Surgery was performed in 18.8% of cases. Mortality was 81.3%. Mortality was associated with a low Glasgow Coma Scale score, mydriasis, absence of pre-hospital care and absence of surgery. The average cost of treatment was estimated at 490,977 XOF (~818 USD). **Conclusion**: Severe TBI in this population is marked by high mortality and a significant economic burden. Neurosurgery improves outcomes when feasible. The economic burden of managing severe head injuries highlights the need for subsidies and prevention.

Keywords

Severe TBI, Neurosurgery, Cost, Traffic Accidents, Benin

1. Introduction

Traumatic Brain Injury (TBI) is a major cause of disability and death worldwide, particularly in developing regions where road traffic accidents are prevalent [1]. Severe TBI, defined as a Glasgow Coma Scale (GCS) score of 8 or less, poses significant challenges due to its potential for secondary brain injury and its high resource requirements [2]. In sub-Saharan Africa, limited neurosurgical infrastructure and financial barriers amplify these problems, resulting in high mortality rates and an economic burden on families [3] [4]. Previous studies in similar contexts have highlighted the predominance of young men in TBI cases and the role of motorcycles in the aetiology [5]. This study analyses the neurosurgical management of severe TBI in young patients and adults (≥15 years) and its economic implications at the Centre National Hospitalier Universitaire Hubert Koutoukou Maga (CNHU-HKM), the main referral centre for neurosurgery in Benin. By analyzing care patterns and providing estimates of direct medical costs, we aim to inform policies for better outcomes in resource-limited settings.

2. Materials and Methods

2.1. Type of Study

This was a retrospective cohort study (2017-2021) at the CNHU-HKM in Cotonou, which serves as the national reference centre for neurosurgery and intensive care.

2.2. Participants

Patients aged 15 years or older admitted with severe TBI (GCS ≤ 8) between 1 January 2017 and 31 December 2021 were included (N = 64 out of 109 severe TBIs, or 58.7% after exclusions). Patients without incomplete medical records, patients lost to follow-up and those presenting with a history of severe neurological problems that may interfere with prognostic assessment were excluded from the study.

2.3. Data Collection and Statistical Analysis

Sociodemographic, clinical, paraclinical, therapeutic and economic data were extracted from medical records. The analysis used Epi Info 7.2 (chi-square tests, $p < 0.05$, OR with 95% CI). For variables exhibiting complete separation (zero count in one of the cells of the 2 × 2 table) and leading to undefined ORs, the ORs and their 95% CIs were recalculated using Firth penalized logistic regression.

3. Results

The mean age was 36.25 ± 13.41 years, with a predominance of males (85.9%).

Road traffic accidents accounted for 92.2% of cases, mainly collisions between motorcycles. 63% of motorcyclists were not wearing helmets. Admission within 6 hours occurred in 56.3% of patients (Table 1).

The GCS was centred around groups 3 - 4 (42.2%), 5 - 6 (20.3%) and 7 - 8 (37.5%). Computed tomography (performed in 39.1% of cases) showed contusions (72%), skull fractures (52%) and subarachnoid haemorrhages (44%). Pupillary abnormalities were present in 59.4% of cases, hypotension in 21.9% and hypoxia in 60.9%. Table 1 shows the socio-demographic characteristics and main traumatic circumstances.

Table 1. Socio-demographic characteristics and main traumatic circumstances.

	Frequency	Percentage (%)
Male	55	85.9
Professions involving high mobility	40	62.5
Road traffic accident	59	92.2
Not wearing a helmet (motorcyclists)	24/38	63
Admission < 6 hours	36	56.3

Treatment involved neurosurgery in 18.8% (12 patients). Surgical procedures included evacuation of extradural (33.3%) and subdural (33.3%) haematomas, with a delay of > 24 hours in 66.7% of cases.

Mortality was 81.3%, mainly due to cerebral hernia and septicemia. Significant associated factors were: GCS 3 - 4 vs 7 - 8 (OR 39.83; 95% CI 2.06 - 769.65; $p < 0.001$), areactive mydriasis (OR 5.23; 95% CI 0.84 - 32.46; $p = 0.022$), absence of CT scan (OR 73.15; 95% CI 3.90 - 1372.38; $p < 0.001$), absence of prehospital care (OR 8.68; 95% CI 1.72 - 43.87; $p = 0.003$), and absence of surgical treatment (OR 49.0; 95% CI 8.51 - 282.28; $p < 0.001$). Table 2 presents the significant prognostic factors for mortality (N = 64).

Table 2. Significant prognostic factors for mortality (N = 64).

	OR (95% CI)	p-value
GCS 3 - 4 vs 7 - 8	39.83 (2.06 - 769.65)*	<0.001
Reactive mydriasis	5.23 (0.84 - 32.46)*	0.022
Chest trauma	9.42 (0.47 - 186.95)*	0.028
Absence of CT scan	73.15 (3.90 - 1372.38)*	<0.001
Absence of pre-hospital care	8.68 (1.72 – 43.87)	0.003
Absence of surgical treatment	49.0 (8.51 – 282.28)	<0.001

* = Calculated via Firth penalized logistic regression.

The average cost was 490,977 XOF (~818 USD), dominated by intensive care hospitalisation (52.3%).

4. Discussion

This retrospective, descriptive and analytical cohort study covers a continuous series of 64 patients admitted to CNHU-HKM between 2017 and 2021 for severe TBI (GCS ≤ 8). As a retrospective cohort study, it allows the complete patient pathway to be reconstructed from existing medical records, without prospective intervention, by analysing both descriptive characteristics (epidemiology, clinical, paraclinical) and analytical associations (prognostic factors for mortality). This design is particularly suited to resource-limited hospital settings, where prospective studies are often constrained by logistical and financial factors, although it is susceptible to selection bias and incomplete information [6]. The exclusion criteria, although likely to introduce selection bias, were retained in order to improve the homogeneity of the studied population and to limit confounding biases, allowing a more reliable analysis of the impact of the factors studied on the evolution of severe traumatic brain injuries.

The results highlight the high burden of severe TBI in a young adult population in a West African tertiary centre, with epidemiology aligned with regional trends in sub-Saharan Africa: predominance of young men (85.9%, mean age 36.25 years) affected by road traffic crashes (92.2%), mainly motorcycle-motorcycle collisions (23.7%) [3] [5]. This demographic profile reflects the epidemiological transition in sub-Saharan Africa, where road traffic injuries surpass infectious or traditional causes as the leading cause of mortality among young people and adults in Low- and Middle-Income Countries (LMICs) [7] [8].

The high rate of helmet non-use (63%) is consistent with recent observations in Benin and neighbouring countries (Nigeria), where enforcement of road safety laws remains low due to regulatory and socio-economic gaps [9] [10]. Studies from 2023-2025 in Sub-Saharan Africa indicate that helmet use could reduce TBI mortality by 30% - 40%, highlighting the urgency of awareness campaigns and strict enforcement [11].

The prolonged admission delay (43.7% > 6 hours) highlights the weaknesses of pre-hospital systems, with a lack of pre-hospital care in 84.4% of cases, contributing to secondary injuries (hypoxia, hypotension) and aggravating clinical severity (GCS 3 - 4: 42.2%). In severe TBI, the lack of prehospital care has a decisive impact on the worsening of clinical severity, primarily through the increase in secondary injuries. Uncorrected cerebral hypoxia and untreated hypotension are also contributing factors. A single episode of hypotension doubles the risk of mortality in severe TBI [12] [13]. This reality is emblematic of Low- and Middle-Income Countries (LMICs), where transport infrastructure and emergency services are underdeveloped, resulting in average admission times of 8 - 12 hours for severe TBI, compared to less than 2 hours in high-income countries [14]. The low use of CT scans (39.1%) and delays often exceeding 48 hours reveal structural diagnostic limitations, similar to recent reports from Sub-Saharan Africa where access to advanced imaging is restricted to 20% - 50% of cases, limiting the early detection of evacuable lesions such as extra-dural haematomas (24%) [4] [15].

These diagnostic delays are associated with a 20% - 30% increase in mortality, highlighting the need for simplified algorithms for resource-limited settings, such as those proposed by the World Health Organisation (WHO) guidelines adapted for LMICs in 2020-2023 [15] [16].

With regard to therapeutic management, neurosurgical interventions were underutilised (18.8%, often delayed >24 hours in 66.7% of cases), mainly due to financial and technical barriers, reflecting resource gaps in low-income settings [17] [18]. In our series, interventions were associated with a significant reduction in mortality (OR 49.0, 95% CI: 8.51 - 282.28, $p < 0.001$), corroborating recent studies in sub-Saharan Africa (2021-2025) which demonstrate that early surgery improves outcomes in 50% - 70% of selected cases, despite the absence of Intracranial Pressure (ICP) monitoring [19] [20]. However, the systematic absence of ICP monitoring and advanced mechanical ventilation limits the optimisation of intensive care, as highlighted in the guidelines for resource-limited settings, which advocate an approach prioritising haemodynamic stabilisation and osmotherapy [21]. Compared to Western protocols, this hybrid approach reflects a pragmatic adaptation to local constraints, but highlights the need for increased training in emergency neurosurgery and neuroreanimation to reduce treatment abandonment rates.

The overall mortality rate of 81.3% far exceeds the rates in high-income countries (20% - 30%) but remains comparable to recent African studies (40% - 80% for severe TBI in LMICs), with the main causes being brain injury and sepsis [22] [23]. Our prognostic factors (GCS 3 - 4; unresponsive mydriasis; chest trauma; absence of CT scan; absence of pre-hospital care; no surgery) are consistent with global predictors, validated by meta-analyses in LMICs (2020-2025), where these factors double the risk of death. Among survivors, good functional outcomes are encouraging, but sequelae highlight the long-term impact that is often underestimated in LMICs due to limited post-hospital follow-up [24]. The lack of pre-hospital care and surgery is emerging as aggravating factors, in line with recent Ugandan cohorts where these interventions reduce mortality by 25% - 35% [21] [25].

Burden in a context where GDP per capita is approximately 1300 USD, exceeding average monthly incomes by more than 12 times [3]. Hospitalisation in intensive care (52.3%) dominated expenditure, similar to recent findings in Benin and India (2021-2024), where the direct costs of severe TBI reach 500 - 1000 USD, often forcing families into debt or abandoning care [24]. In LMICs, the overall economic burden of TBI is estimated at 400 billion USD annually (2023), amplified by indirect costs [25] [26]. This financial burden leads to systemic undertreatment, as observed in analyses of tree fall injuries in Türkiye (2022) [27] [28].

Limitations of this study include its retrospective design, small sample size, and lack of indirect costs. Prospective multicentre studies are needed.

5. Conclusion

Severe TBI in this young and adult population at CNHU-HKM is marked by high

mortality and substantial economic costs, mainly due to road traffic accidents and limited resources. This study highlights the critical contribution of neurosurgery despite persistent barriers. Based on our limited findings, multicentre studies are needed to validate the results and guide policy. Recommendations include strengthening pre-hospital care, enforcing helmet laws, subsidising hospital care, and training neurosurgeons and neuro-resuscitators to improve equity in the management of TBI.

Conflicts of Interest

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

References

[1] Iaccarino, C., Carretta, A., Nicolosi, F. and Morselli, C. (2018) Epidemiology of Severe Traumatic Brain Injury. *Journal of Neurosurgical Sciences*, **62**, 535-541. https://doi.org/10.23736/s0390-5616.18.04532-0

[2] Geeraerts, T., Velly, L., Abdennour, L., Asehnoune, K., Audibert, G., Bouzat, P., *et al.* (2018) Management of Severe Traumatic Brain Injury (First 24 Hours). *Anaesthesia Critical Care & Pain Medicine*, **37**, 171-186. https://doi.org/10.1016/j.accpm.2017.12.001

[3] Hode, L., Madougou, S., Fatigba, H.O., Hounnou, P., Ebassa, K., Hans Moevi, A.A., *et al.* (2017) The Direct Cost of Treatment of Traumatic Brain Injury in a Sub-Saharan African Country (Benin). *World Neurosurgery*, **99**, 210-213. https://doi.org/10.1016/j.wneu.2016.11.083

[4] Adegboyega, G., Zolo, Y., Sebopelo, L.A., Dalle, D.U., Dada, O.E., Mbangtang, C.B., *et al.* (2021) The Burden of Traumatic Brain Injury in Sub-Saharan Africa: A Scoping Review. *World Neurosurgery*, **156**, e192-e205. https://doi.org/10.1016/j.wneu.2021.09.021

[5] Fatigba, O.H. and Padonou, J. (2010) Epidemiology of Cranio-Encephalic Traumas in Parakou (Benin). *African Journal of Neurological Sciences*, **29**, 25-33. https://ajns.paans.org/epidemiologie-des-traumatismes-cranio-encephaliques-a-parakou-benin/

[6] Dewan, M.C., Rattani, A., Fieggen, G., Arraez, M.A., Servadei, F., Boop, F.A., *et al.* (2019) Global Neurosurgery: The Current Capacity and Deficit in the Provision of Essential Neurosurgical Care. Executive Summary of the Global Neurosurgery Initiative at the Program in Global Surgery and Social Change. *Journal of Neurosurgery*, **130**, 1055-1064. https://doi.org/10.3171/2017.11.jns171500

[7] Solagberu, B.A., Ofoegbu, C.K.P., Nasir, A.A., Ogundipe, O.K., Adekanye, A.O. and Abdur-Rahman, L.O. (2006) Motorcycle Injuries in a Developing Country and the Vulnerability of Riders, Passengers, and Pedestrians. *Injury Prevention*, **12**, 266-268. https://doi.org/10.1136/ip.2005.011221

[8] World Health Organization (2023) Global Status Report on Road Safety 2023. WHO. https://www.who.int/publications/i/item/9789240086517

[9] Hode, L., Mewanou, S., Deffon, Y.B.P., Agbo-Panzo, M., Ouangre, A. and Madougou, S. (2018) Traitement chirurgical des traumatismes crânio-encéphaliques à Cotonou: Problèmes, résultats et perspectives. *Neurochirurgie*, **64**, 410-414. https://doi.org/10.1016/j.neuchi.2018.05.181

[10] Onyemaechi, N. (2020) Road Traffic Injuries in a Nigerian Referral Trauma Center:

Characteristics, Correlates, and Outcomes. *International Journal of Critical Illness and Injury Science*, **10**, 64-69. https://doi.org/10.4103/ijciis.ijciis_18_19

[11] Calvello, E., Reynolds, T., Hirshon, J.M., Buckle, C., Moresky, R., O'Neill, J., *et al.* (2013) Emergency Care in Sub-Saharan Africa: Results of a Consensus Conference. *African Journal of Emergency Medicine*, **3**, 42-48. https://doi.org/10.1016/j.afjem.2013.01.001

[12] Algattas, H. and Huang, J. (2014) Traumatic Brain Injury Pathophysiology and Treatments: Early, Intermediate, and Late Phases Post-Injury. *International Journal of Molecular Sciences*, **15**, 309-341. https://doi.org/10.3390/ijms15010309

[13] Butcher, I., Maas, A.I.R., Lu, J., Marmarou, A., Murray, G.D., Mushkudiani, N.A., *et al.* (2007) Prognostic Value of Admission Blood Pressure in Traumatic Brain Injury: Results from the IMPACT Study. *Journal of Neurotrauma*, **24**, 294-302. https://doi.org/10.1089/neu.2006.0032

[14] Muili, A.O., Kuol, P.P., Jobran, A.W.M., Lawal, R.A., Agamy, A.A. and Bankole, N.D.A. (2024) Management of Traumatic Brain Injury in Africa: Challenges and Opportunities. *International Journal of Surgery*, **110**, 3760-3767. https://doi.org/10.1097/js9.0000000000001391

[15] Bergquist, H.B., Burkholder, T.W., Muhammad Ali, O.A., Omer, Y. and Wallis, L.A. (2020) Considerations for Service Delivery for Emergency Care in Low Resource Settings. *African Journal of Emergency Medicine*, **10**, S7-S11. https://doi.org/10.1016/j.afjem.2020.07.002

[16] Spears, C.A., Adil, S.M., Kolls, B.J., Muhumza, M.E., Haglund, M.M., Fuller, A.T., *et al.* (2021) Surgical Intervention and Patient Factors Associated with Poor Outcomes in Patients with Traumatic Brain Injury at a Tertiary Care Hospital in Uganda. *Journal of Neurosurgery*, **135**, 1569-1578. https://doi.org/10.3171/2020.9.jns201828

[17] Rubiano, A.M., Carney, N., Chesnut, R. and Puyana, J.C. (2015) Global Neurotrauma Research Challenges and Opportunities. *Nature*, **527**, S193-S197. https://doi.org/10.1038/nature16035

[18] Carney, N., Totten, A.M., O'Reilly, C., Ullman, J.S., Hawryluk, G.W.J., Bell, M.J., *et al.* (2017) Guidelines for the Management of Severe Traumatic Brain Injury, Fourth Edition. *Neurosurgery*, **80**, 6-15. https://doi.org/10.1227/neu.0000000000001432

[19] Okon, I.I., Akilimali, A., Furqan, M., Precious, F.K., Gbayisomore, T.J., Atallah, O., *et al.* (2024) Barriers to Accessing Neurosurgical Care in Low- and Middle-Income Countries from Africa: Editorial. *Annals of Medicine & Surgery*, **86**, 1247-1248. https://doi.org/10.1097/ms9.0000000000001758

[20] Badhiwala, J.H., Wilson, J.R. and Fehlings, M.G. (2019) Global Burden of Traumatic Brain and Spinal Cord Injury. *The Lancet Neurology*, **18**, 24-25. https://doi.org/10.1016/s1474-4422(18)30444-7

[21] Rapp, A., Kobeissi, H. and Fahim, D.K. (2025) Updated Review of the Management of and Guidelines for Traumatic Brain Injury. *Journal of Clinical Medicine*, **14**, Article 6796. https://doi.org/10.3390/jcm14196796

[22] Naik, A., Bederson, M.M., Detchou, D., Dharnipragada, R., Hassaneen, W., Arnold, P.M., *et al.* (2023) Traumatic Brain Injury Mortality and Correlates in Low- and Middle-Income Countries: A Meta-Epidemiological Study. *Neurosurgery*, **93**, 736-744. https://doi.org/10.1227/neu.0000000000002479

[23] Hofman, K., Primack, A., Keusch, G. and Hrynkow, S. (2005) Addressing the Growing Burden of Trauma and Injury in Low- and Middle-Income Countries. *American Journal of Public Health*, **95**, 13-17. https://doi.org/10.2105/ajph.2004.039354

[24] Chandankhede, A. and Thombre, S.D. (2023) Advancements and Challenges in Neu-

rosurgical Practice in India: Where Do We Stand? *Cureus*, **15**, e37738. https://doi.org/10.7759/cureus.37738

[25] Allen, B.C., Cummer, E. and Sarma, A.K. (2023) Traumatic Brain Injury in Select Low- and Middle-Income Countries: A Narrative Review of the Literature. *Journal of Neurotrauma*, **40**, 602-619. https://doi.org/10.1089/neu.2022.0068

[26] Wesson, H.K.H., Boikhutso, N., Bachani, A.M., Hofman, K.J. and Hyder, A.A. (2013) The Cost of Injury and Trauma Care in Low- and Middle-Income Countries: A Review of Economic Evidence. *Health Policy and Planning*, **29**, 795-808. https://doi.org/10.1093/heapol/czt064

[27] Emre Taçyıldız, A., Çekmen, B., Uzun, A., Cevher Çiftçi, T., Berkay Uzuncu, H., Serdar, S., *et al.* (2022) A Retrospective Analysis of Spinal and Cranial Injury Patterns Caused by a Fall from a Tree in the Karabük Province. *Interdisciplinary Neurosurgery*, **30**, Article ID: 101628. https://doi.org/10.1016/j.inat.2022.101628

[28] Clarke, D., Ford, F., Stassen, W., *et al.* (2019) The Neurosurgical Workforce in South Africa: A Quantitative Analysis. *South African Medical Journal*, **109**, 338-343.