

Publication n°06

[6]	[Luphin Hode, Soumaila Madougou (2), Holden O. Fatigba, Phileas Hounnou2, Karl Ebassa, A. Aristote Hans Moevi, Pamphile Assouto	[The Direct Cost of Treatment of Traumatic Brain Injury in a Sub-Saharan African Country (Benin)]	[Neuroscience Sugery, 99]	[pp. 210 - 213]	[2016]
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The Direct Cost of Treatment of Traumatic Brain Injury in a Sub-Saharan African Country (Benin)

Luphin Hode¹, Soumaïla Madougou², Holden O. Fatigba³, Phileas Hounnou², Karl Ebassa⁴, A. Aristote Hans Moevi², Pamphile Assouto¹

■ **OBJECTIVES:** This is the first socioeconomic study on traumatic brain injury (TBI) undertaken to determine the sociodemographic factors implicated in the occurrence of TBI and to assess the value of the direct cost of the management of TBI at the initial phase in the Hubert Koutoukou Maga National Teaching Hospital of Cotonou.

■ **METHODS:** This was a prospective study with descriptive and analytic aim that took place from January 1 to July 31, 2014. An individual approach of each patient's expenditure was undertaken via the use of a questionnaire on which all expenses were identified systematically. The dependent variable was the global direct cost of care. The independent variables were the type of accident, severity of the TBI, the structures of care, the stay in the resuscitation unit, the duration of hospitalization.

■ **RESULTS:** There were 297 patients with TBI: 258 men (86.9%) and 39 women (13.1%), with a sex ratio of 6.61. The average age of patients was 34.3 ± 12.39 years. The average direct cost of care for TBI was $\text{€}285.67 \pm 310.15$. The average cost for severe TBI was $\text{€}522.08 \pm 439.91$ versus $\text{€}188.19 \pm 164.83$ for mild TBI (odds ratio 5.52; standard deviation: 0.0527–0.6222). The average cost was increased significantly more when the patients went through a peripheral hospital (odds ratio 3.65; standard deviation: 1.819–7.3245).

■ **CONCLUSIONS:** The organization of Benin's health system did not allow for the optimum management of TBI. It seems imperative to develop an insurance system that will

allow a proper and effective support for victims of traffic accidents.

INTRODUCTION

The internationalization, the urbanization, and the motorization of transportation as known in sub-Saharan Africa expose its population to a multitude of traumatic disorders, including traumatic brain injury (TBI). TBI is a major problem in public health. Its social and economic impact is especially important because it is one of the most frequent reasons of death, morbidity, and invalidity in young adults.¹⁻³ In France, the management of some TBIs represents a cost of approximately €60,000 for each patient at the initial phase, whereas further aid provided could be greater than €150,000, without taking into account the domestic and social consequences of such a situation.⁴

This is the first socioeconomic study on TBI undertaken to determine the sociodemographic factors implicated in the occurrence of TBI and to assess the value of the direct cost of the management of TBI during the initial phase at the Hubert Koutoukou Maga National Teaching Hospital (CNHU/HKM) of Cotonou.

PATIENTS AND METHODS

Benin is a French-speaking, low-income West African country. Its population was, in 2014, 10.6 million inhabitants and its gross domestic product €8.71 billion. In 2014, the annual income per capita was €811.31. The local currency is the franc

Key words

- Africa
- Benin
- Cost
- Traumatic brain injury

Abbreviations and Acronyms

CNHU/HKM: Hubert Koutoukou Maga National Teaching Hospital

TBI: Traumatic brain injury

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Citation: *World Neurosurg.* (2017) 99:210-213.
<http://dx.doi.org/10.1016/j.wneu.2016.11.083>

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

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(1.00 XOF = 0.00152449 EUR). Life expectancy was 59 years in 2012. The potentially active population (15–64 years) accounted for 52.5% of the population. In 2012, the urban population was estimated to 45.7%.^{5,6} The guaranteed minimum wage was €61 per month, and the rate of poverty was 36.2%. There is limited rate of social coverage. Cotonou is the economic capital of Benin, with a population of 700,000 residing inhabitants, but this population increases to approximately 2 million during working hours. Urban transportation is provided mainly by motorcycle taxis. Cotonou's road density is estimated on average to 6.3 km for 10,000 inhabitants on a national level. During the study period, the law on the mandatory wearing of helmet motorcycles was not yet in effect.

The health system is 3-level pyramid: the peripheral level, represented by the communal or district health centers; the departmental level, represented by the departmental hospitals; and the national level, represented by CNHU/HKM. CNHU/HKM has a capacity of 642 beds and comprises an emergency care department, 2 multiskilled resuscitations units, and a total capacity of 24 beds and 12 respirators.

Until now, there has been no systematic emergency care system in place for the admitted patients in Benin. Patients receive medical prescription, they pay in retail pharmacy before the care is provided. Biologic and radiologic tests are performed after a patient's siblings or family has paid. All care services must be prepaid by the victim's family outside the hospitalization fees. The cost of the day at hospital is €9.90 and for a cerebral computed tomography scan is €122.

We conducted an economic-themed prospective study, which took place from January 1 to July 31, 2014, in which we aimed to describe and analyze the direct cost of medical care of a TBI. According to the formula of Schwartz, the size of the sample was estimated to 207 patients. We included in the study all patients older than 15 years of age admitted to the emergency department of the CNHU for a TBI. The patient or parents involved in the filling out of the questionnaire were aware of the study and provided their consent. Thirty-five patients or related parents refused to participate in the study. The data were collected via a standardized questionnaire. The dependent variable was the global direct cost of care. The independent variable was the type of accident, the severity of the TBI, the structure of care, length of stay in the resuscitation unit, and the length of hospitalization.

The data collection technique adopted was the bottom-up approach, which consists of an individual approach on each patient's expenditure via the use of a questionnaire, where all expenses were identified systematically. The cost assessment was done in societal terms. The cost assessment was done during the patient's hospitalization period.

All collected data were computerized and analyzed by Epi Info software, version 6.04d (Centers for Disease Control and Prevention, Atlanta, Georgia, USA) and SPSS, version 20 (IBM Inc., Armonk, New York, USA). The quantitative variables are expressed as mean average and standard deviation; qualitative data and percentage are indicated by a 95th percentile confidence interval. The comparison of qualitative variables was made with the χ^2 test (or the exact Fischer test as appropriate) and the comparison of averages by the Student t test, Mann-Whitney U and Wilcoxon, or analysis of variance, as appropriate. For multivariate analysis, multiple linear regression was used by conducting successive iterations, step by step type, and simultaneously introducing all

variables significantly associated to the cost. The odds ratio was calculated with standard deviation. They were considered valid when the standard deviation did not contain 1. A P value less than 0.05 is considered likely statistically significant.

RESULTS

During the study period, 840 trauma patients older than 15 years of age were admitted to the emergency department of CNHU-HKM, of whom 297 had a TBI. There were 258 men (86.9%) and 39 women (13.1%), for a sex ratio of 6.61. The mean age of the patients was 34.3 ± 12.39 years and ranged from 15 to 80 years. The majority of patients (88.9%) did not have insurance, 5.4% had insurance, and 5.7% did not answer this question. The majority of patients (26.6%) were unemployed, craftsman (23.2%) or commercial workers (18.2%), pupils or students (12.1%), civil servants (10.4%), and "taxicab-motorcycle" drivers (9.4%); 46.2% of patients were unschooled or had a primary level education.

Traffic accidents were the main cause identified among 256 patients (86.2%), followed by assaults (6.7%), workplace injury (4.4%), and domestic accidents (1%). In 1.7% of the cases, the reasons were not determined. Among the 256 victims of traffic accidents, 177 (69.1%) were motorcycle drivers, 20 (7.8%) were passengers on a motorcycle, 46 (18%) were pedestrians, 9 (3.5%) were drivers of cars, and 4 (1.6%) were passengers sitting in the rear of these cars. Among the 197 patients on motorcycle, 5 (2.5%) wore a protective helmet. The majority of the accidents occurred at night, with a peak incidence between 6 PM and 9 PM (Figure 1).

Patient's transportation to the first center was assumed by firemen in 66.7% of the cases, by motorcycle drivers in 13.1% of the cases, by private vehicles in 9.8% of the cases, by taxi drivers in 2.4% of the cases, by ambulances in 1.3% of the cases, and by paramedics in 0.3% of the cases. In 6.4% of the cases, this information had not been collected. The CNHU-HKM was the first place of arrival in 70% of the cases, peripheral hospitals in 20.2% of the cases, medical restrooms in 5.1% of the cases, and herbalist

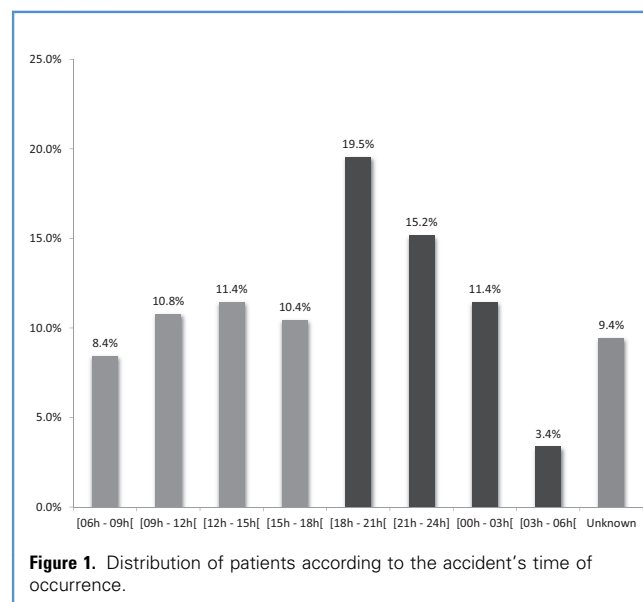


Figure 1. Distribution of patients according to the accident's time of occurrence.

practitioners in 0.3% of the cases. In 4.4% of the cases, this information could not be collected.

Among the 89 patients who first visited another place to receive care, their transfer toward the CNHU-HKM was by taxicabs in 40.4% of the cases, by medical ambulances in 21.3% of the cases, by nonmedical vehicles in 13.5% of the cases, and by firemen in 2.2% of the cases. In 22.5% of the cases, this information could not be collected.

The admission time delay was less than 6 hours for 85.2%, 6–24 hours for 13.8%, and from 1 to 7 days for 1% of patients. Of the patients, 138 (46.5%) had an open head injury and 159 (53.5%) had a closed head injury. Two hundred four (68.7%) had an initial loss of consciousness, and 12 (4%) had seizures. There were 26 cases (8.8%) of multiple injuries.

The emergency intervention on TBI victims consisted of the establishment of: 1) an intravenous tube access in 286 cases (96.3%); 2) oxygen therapy in 77 cases (25.9%), via endotracheal tube (41 cases), via high concentration mask (29 cases), or via nasal cannula (7 cases); 3) an installation of a urethral catheter in 58 cases (19.5%); 4) nasogastric tube in 41 cases (13.8%); and 5) a neck brace in 50 cases (17.1%).

Admission to the intensive care unit was required in 70 cases (23.5%). Radiography of the skull was performed in 154 cases (51.85%) and cerebral computed tomography scan in 94 cases (31%). Sixty-five patients (21.88%) underwent both radiologic examinations. Thirteen patients (4.3%) required neurosurgical treatment, and 56 patients (18.85%) received a skin suture under general anesthesia.

Hospital stay ranged from 0 to 54 days, with an average of 4.4 ± 6.67 days. The overall mortality was 16.18%, and the disease evolution was favorable in 81.1% of cases. The direct cost of TBI management ranged from €56.97 to €2055.21 with an average of $€285.67 \pm 310.15$ and a median of €164.25. In case of multiple injuries with TBI, this average cost increased to $€391.04 \pm 256.07$ versus $€275.12 \pm 297.83$ for TBI alone ($P = 0.015$). The total cost of expenses related to TBI was €84,845.50, of which 89.45% (€75,896.20) were due to TBI by traffic accidents, 2.79% (€2,370.59) TBI by workplace accidents, 5.73% (€4,867.81) TBI by aggression, and 0.09% TBI by domestic accidents and other causes that could not be determined. The largest expenditure items with greatest cost were treatment (39.2%), hospitalization (21.5%), and diagnostic tests (20.8%) (Table 1). The univariate analysis of the costs according to the independent variables

reveals that the middle cost was increased significantly more when the patients went through a peripheral hospital ($P < 0.001$), whereas it was least for those that passed in through a medical private office. The mean cost also increased according to the severity of trauma ($P < 0.001$), of the length of hospitalization stay, and among the patients admitted in resuscitation ($P < 0.001$).

The logistic regression analysis by considering other risk factors revealed that neither the length of hospitalization nor the stay in the intensive care unit significantly influenced the total cost. The real risk factors on the cost of TBI were severity of trauma and transit from peripheral hospitals; then, severe TBI had 5.52 times greater risk of high-cost expenses. In the same way, when a patient with a TBI initially was admitted in a peripheral hospital, he or she had a 3.65 times greater risk ($1.8190 < CI < 7.3245$) of paying a greater cost than that if he or she was admitted into CNHU/HKM directly.

DISCUSSION

This study determined the direct economic cost of management of TBI at initial phase in Benin. For this prospective study, we were able to identify the caregiving and resources required for the management of TBI at the initial phase; however, the indirect costs and the cost of treatment of sequels could not be analyzed. It would be necessary to conduct additional studies to assess the indirect costs and the cost of treatment after care to better understand the cost of TBI in Benin.

TBI is a major concern in CNHU-HKM because they constituted 35.36% of all trauma patients admitted during our study period. The mean age of our patients was 34.3 ± 12.39 years with a peak incidence in the age groups of 20–40 years and a sex ratio of 6.61. This confirms the fact that TBI affects much more active male population.^{1,7-9} Traffic accidents were the main etiology (86.2%) as the 85.1% reported by Fatigba in Parakou¹⁰ and motorcycle riders were especially involved in 69.1% of cases, which is close to the 75.2% reported by Fatigba in Parakou¹¹ and the 64.5% reported by Chiu et al. in Taiwan.¹²

The motorcycle–taxi, which are particularly exposed to traffic accidents, accounted for only 9.4% of patients. The peak incidence time of traffic accidents was between 6 PM and 9 PM, which corresponds to the time people return home from work. The number of patients who received surgery was low, 4.3%, which is similar to the 5% reported by Fatigba et al.,⁸ due to the low rate of brain scan fulfillment: 31% in our study and 13.9% in Parakou.⁸ The inaccessibility of this radiologic procedure imposed a systematic hospital surveillance of all TBI admitted to CNHU/HKM, even the mild cases.

The low rate of insurance coverage in Benin (5.3% in our study and 12% reported by Gnonlonfoun et al.¹³), and the prepaid care provision system were delaying factors in the management of patients admitted to CNHU/HKM. The average cost of the initial management of TBI was $€285.67 \pm 310.15$ (€56.97–€2055.21) a little more than one third of the gross domestic product per capita and more than 4 times the guaranteed minimum wage in Benin. The average cost of TBI treatment ranged from €2500 to €3000 in Europe¹⁴ at the initial phase of the treatment in 2004. At this early stage, there was no difference in cost of initial

Table 1. Breakdown of TBI Costs by Expense Item

	Average	Min–Max	Total Cost %
Transportation	€2.04 ± 6.25	0–45.73	0.7
Consultations	€21.34 ± 0	21.34–21.34	7.5
Paraclinical tests	€59.35 ± 70.25	0–287.19	20.8
Hospitalization	€61.46 ± 106.73	0–692.07	21.5
Treatment	€111.99 ± 148.99	7.77–945.15	39.2
Accompanying	€29.46 ± 29.6	3.81–167.68	10.3
TBI, traumatic brain injury.			

management of TBI in men and women, nor was there a significant difference according to the age of patients or the cause of TBI.

Berga et al.¹⁴ reported a 16% increase in the average cost of care during the first year of the TBI in men compared with women and an increase in the average cost depending on the patient's age. In this study, the real risk factors of high cost were the severity of the brain injury and the initial admission into peripheral hospitals. It is thus important to study TBI care protocols in these hospitals to determine how to make them more efficient; however, these peripheral hospitals have a technical platform of lower quality and less qualified staff than CNHU/HKM.

The actual organization of the health system in Benin is not fit to the recommended norms for the management of TBI that remain a diagnostic and therapeutic emergency. These patients were confronted by 2 issues: the impossibility at admission to receive some care without having paid for and the high cost of medical prescriptions compared with the incomes of the patients

or the one who pay for the patient's care. In addition, we were confronted to the lack of beds in the resuscitation unit.

Universal insurance would be necessary to guarantee an optimum treatment to all patients admitted to the emergency centers. Traffic accidents, which represented the major reason of TBIs, cost €75.89.20, and thus are 89.45% of all expenses due to TBI. Classic conventional road safety measures remain one of the most effective ways to reduce the number and severity of TBIs.

CONCLUSIONS

TBI, and its consequences, was a frequent traumatic emergency whose direct cost far exceeded the average population's income. The organization of Benin's health system did not allow for the optimum management of TBI. It seems imperative to develop an insurance system that would allow a proper and effective support for victims of traffic accidents. Conventional measures of road safety, however, remain one of the most effective ways to reduce the number, severity, and cost of management of TBI.

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Conflict of interest statement: The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received 13 February 2016; accepted 15 November 2016

Citation: *World Neurosurg*. (2017) 99:210-213.

<http://dx.doi.org/10.1016/j.wneu.2016.11.083>

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