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Traumatic Brain Injury Related to Motor Vehicle Accidents in Guinea: Impact of Treatment Delay, Access to Healthcare, and Patient's Financial Capacity on Length of Hospital Stay and in-hospital Mortality

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Abstract

Background—Traumatic brain injury related to road traffic accidents poses a major challenge in resource-poor settings within Guinea.

Objective—To analyze the impact of treatment delay, access to healthcare, and patient's financial capacity on duration of hospital stay and in-hospital mortality.

Methodology—Data from patients with traumatic brain injury secondary to motor vehicle accident admitted to a reference hospital (public or private) in Guinea during 2009 were analyzed. The association between various factors (treatment delay, access to healthcare, and patient's financial capacity) and prolonged hospital stay (>21 days) and in-hospital mortality were analyzed using two multivariate logistic regression models.

Results—The mean (±standard deviation) duration of hospital stay was 8.0 (±8.1) days. The risk of prolonged hospital stay increased by 60% when the time interval between accident and hospital arrival was greater than 12 hours compared with those in whom the time interval was less than 6 hours (adjusted odds ratio [OR] = 1.6, 95% confidence interval [CI] = 1.0–2.6, $p = 0.03$). Compared with patients with low-financial capacity, patients with medium-financial capacity (adjusted OR = 0.6, 95% CI = 0.4–0.8, $p = 0.001$) and those with high capacity (adjusted OR = 0.6, 95% CI = 0.4–0.9, $p = 0.02$) were less likely to have a prolonged hospital stay. The risk of in-hospital mortality was 2.6 times higher in patients with time interval between accident and hospital arrival greater than 12 hours compared with those in whom the time interval was less than 6 hours (adjusted OR = 2.6, 95% CI = 1.1–6.2 $p = 0.03$). In-hospital mortality was not related to patient's financial capacity.

Conclusion—Prolonged hospital stay and higher in-hospital mortality was associated with longer time interval between accident and hospital arrival. This delay is attributed to inadequate condition of intercity roads and lack of emergency medical services.

Keywords

Ability to finance care; delay to access to healthcare; hospital mortality; length of hospital stay; traumatic brain injury

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Introduction

The incidence of traumatic brain injury (TBI) varies between 0.9 and 7% according to the place of study, years of study and types of study [1,2]. TBI predominantly affects young adults, with significant impact on the quality of life among survivors; at least 30 of patients having major neurological sequelae. TBI is often the result of a motor vehicle accident (MVA) with over 50% of TBI related to MVAs [3–5].

Mortality of patients suffering from severe TBI remains high and varies according to studies; 18.4 per 100,000 in the United States [6], 22 in Paris [7], and 27.2 to 30.0 in Austria [8]. Several studies identified important risk factors for in-hospital mortality that include the severity of clinical presentation [9,10], sepsis [11], advanced age, race, and multiple lesions [12–15]. In-hospital mortality rate and length of hospital stay increase significantly if the surgical treatment is carried out beyond the first 4 hours after the patient's admission [15]. In developing countries, particularly in Africa, mortality related to TBI remains very high and varies between studies; it was estimated at 16% in Nigeria [16], 17.4% in Tunisia [3], and 36–97% in Benin [10]. In developing countries, in-hospital mortality is high due to the inadequate management and care [10], in addition to the severity of TBI [10].

In the specific case of Guinea, the length of hospital stay and in-hospital mortality are not well documented at the national level. In a previous study on the same population, delay in access to care and inadequacy of available means for necessary intensive care were mentioned as probable causes of the high mortality [17]. This study aims to analyze the impact of time interval between accident and hospital arrival and patient's financial capability on length of hospital stay and mortality.

Methodlogy

Data Collection

Data from this study are those of a cross-sectional study on the MVAs that occurred between January 1 and December 31, 2009 in Guinea [17].

Guinea has a population of roughly 11.5 million (United Nations Statistics Division) people. Guinea's capital and largest city, Conakry, has a population close to 1.8 million (United Nations Statistics Division). A total of 2,576 cases of MVA-related TBI were admitted during the study duration. The data analyzed included sociodemographic characteristics, causes and mechanisms of TBI, time interval between accident and hospital arrival, length of hospital stay, general and clinical parameters at admission, diagnoses (primary or secondary) coded according to ICD-10 coding system, complications and comorbidities, and type of management (medical, orthopedic or neurosurgical). TBI (primary or secondary) was documented by the attending physician.

Operational Definition of Variables

The main outcome criteria were prolonged hospital stay and in-hospital mortality. The length of hospital stay was the number of days between the date of admission and discharge. The length of hospital stay was stratified into average duration (≤21 days) and prolonged hospital stay (>21 days) because 21 days is the average number of hospital days at the end of which a hospitalized patient should renew their billing statement. The main factors studied were the delay of access to healthcare and patient's financial capability. The time interval between accident and hospital arrival was stratified into three categories: < 6 hours, between 6 and 12 hours, and > 12 hours. Taking into consideration of the current occupational distribution in Guinea, patient's financial capability was classified into three modalities: patients with low-financial capacity for students, housewives, and those without occupation; medium-financial capacity for machine operators, farmers, and other professions; and normal financial capacity for civil servants and traders.

The covariates were selected based on their epidemiological and clinical relevance to TBI mortality [18,19]. Age (in years) was stratified into 0 to 15 years, 16 to 30 years, 31 to 45 years, and greater than 45 years. The type of vehicle involved (two wheels vs. four wheels), status of the accident victim (driver/passenger vs. pedestrian) and the mechanism of accident (0=collision between two or more vehicles or collision of a vehicle against an obstacle leading to an impact on the front of the car or the heavy truck, 1 = pedestrian knocked over by a vehicle, 2 = fall being the consequence of a maneuver to avoid an obstacle or fall of a vehicle, 3 = other mechanisms) were defined. The clinical signs of TBI collected by the medical team were categorized into a discrete variable expressing the number of major clinical signs (1, 2, 3, and ≥ 4). The major signs were as follows: brain concussion, meningeal signs, hemispheric syndromes, signs of brain stem dysfunction, signs of intracranial hypertension, anesthesia, and signs of mental impairment (impaired vigilance, psychomotor agitation, confusion, and disorientation). The severity of the TBI was defined based on Glasgow Coma Scale (GCS) score as follows: mild (14 to 15), moderate (9–13), and severe

(3–8). The severity of spinal cord injury was defined by the number of signs of spinal cord injury. The presence of other lesions (fracture or dislocation of limbs, fracture or dislocation of the mandible, fracture or dislocation of ribs, sore body, chest contusion, abdomen contusion) were translated into a discrete variable expressing the number of TBI-associated lesions (1 and ≥ 2). The type of care was coded as patients who underwent simple medical care, patients who underwent orthopedic care, and patients who underwent neurosurgical care, in addition to medical or orthopedic care.

Statistical Analysis

The sociodemographic and clinical characteristics were summarized by outcome criterion (length of hospital stay and in-hospital mortality), using frequencies and percent for categorical variables, and mean (±standard deviation) for continuous variables. Pearson's Chii-squared test and Student's *t*-test were used to compare the frequencies and means, respectively.

All univariable associations with prolonged hospital stay (binary variable, 0 = duration ≤21 days, 1 = duration >21 days) and in-hospital mortality were assessed using method of maximum likelihood from univariate logistic regression models. Subsequently, the relationship between prolonged hospital stay and in-hospital mortality and the two interest variables (time interval between accident and hospital arrival and patient's financial capability) adjusted on other predictors (defined previously) was analyzed using two separate multivariate logistic regression models. The results were expressed as adjusted odds ratio with corresponding 95% confidence interval.

Because a strong correlation existed between age and the patients financial capability, and between severity of TBI and the number of TBI clinical signs, interaction terms were created, and their relationships with the outcome variables were tested. Only in-hospital mortality demonstrated a significant relationship with the two interaction variables, thus the final multivariate model analyzing the relationship between in-hospital mortality and independent factors were extended to these two interaction terms. All analyses were carried out using STATA version 11 (College Station, TX).

Results

The sample included a total of 2,576 patients with a mean age (±SD) of 26.8 (±12.8) years (range: 7.5–46.1 years). The study population consisted predominantly of men (76.8%); the mean age was higher among men compared with women (27.3 ± 12.5 years versus 24.9 ± 13.7 years, *p* = 0.0001). The proportion of men (29.3%) with low-financial capacity was significantly lower than the proportion of women (62.3%, *p*<0.0001). The proportion of patients with a time interval between accident and hospital arrival<12 hours was similar between men and women (17.7% vs. 18.6%, *p* = 0.35). The sociodemographic characteristics of the patients are presented in Tables 1 and 2.

The mean (±standard deviation) duration of hospital stay was 8.0 (±8.1) days. A total of 505 (19.6%) of 2,576 patients had a prolonged hospital stay (>21 days). The relationship between the length of hospital stay and strata defined by time intervals between TBI and hospital arrival and patients financial capability are shown in Figure 1. The variation in the mean length of hospital stay according to the administrative region is shown in Figure 2. The distribution of the proportion of patients with prolonged hospital stay, according to sociodemographic and clinical characteristics are summarized in Table 1.

Univariate analysis showed an increased risk of prolonged hospital stay in patients with a time interval of 6–12 hours (unadjusted OR = 5.1, 95% CI = 3.9–6.6, *p* <0.0001) or > 12 hours after TBI (unadjusted OR = 10.9, 95% CI = 8.5–14.0, *p*<0.0001). Similarly, this risk was higher in patients treated in the Conakry region compared to patients treated in the Boké region (unadjusted OR = 149.6, 95% CI = 20.7–1080.9, *p*<0.0001). The risk was also higher among patients older than 15 years (*p*<0.0001) in patients with two or three clinical signs of TBI (*p*<0.0001), moderate coma (*p* = 0.03), or severe coma (*p* = 0.01). The risk of having a prolonged hospital stay was reduced by 40% in patients with moderate financial capacity compared to patients with low-financial capacity (unadjusted OR = 0.6, 95% CI = 0.5–0.8, *p*<0.0001). Gender, number of signs of spinal injury and the number of associated lesions were not significantly associated with prolonged hospital stay in univariate analysis (Table 1).

The multivariate logistic regression model was constructed based on 2,249 of 2,576 patients, 327 patients (12.7%) were excluded from the final model due to missing data for one or more covariates) including 447 patients with prolonged hospital stay. The increased risk of having prolonged hospital stay was observed for patients with a time interval >12 hours (adjusted OR = 1.6, 95% CI = 1.0–2.6, *p* = 0.03). Similarly, the risk was increased in patients treated in the administrative regions of Conakry and Kindia; in patients older than 15 years;

Table 1. Factors associated with prolonged hospital stay and in-hospital mortality (Guinea 2009)

	Prolonged hospital stay				In-hospital mortality			
	Yes (*n* = 504) Number (%)	**No (*n* = 2072) Number (%)**	**Odds tatio [95% CI]**	***p* value**	**Yes (*n* = 99) Number (%)**	**No (*n* = 2477) Number (%)**	**Odds ratio [95% CI]**	***p* value**
Treatment delay								
<6H	138(8.2)	1536(91.8)	Reference	Reference	47(2.8)	1627(97.2)	Reference	Reference
6 to 12H	138(31.3)	303(68.7)	5.1[3.9, 6.6]	<0.0001	20(4.5)	421(95.5)	1.6[1.0, 2.8]	0.07
>12H	228(49.5)	233(50.5)	10.9[8.5, 14.0]	<0.0001	32(6.9)	429(93.1)	2.6[1.6, 4.1]	<0.0001
Patient's financial capacity								
Low	222(23.3)	730(76.7)	Reference		29(3.1)	923(96.9)	Reference	
Medium	192(15.8)	1020(84.2)	0.6[0.5, 0.8]	<0.0001	48(4.0)	1164(96.0	1.3[0.8, 2.1]	0.26
Normal	90(21.8)	322(78.2)	0.1[0.7, 1.2]	0.55	22(5.3)	390(94.7)	1.8[1.0, 3.2]	0.04
Administrative region								
Boké	1 (0.8)	121(99.2)	Reference		12(9.8)	110(90.2)	Reference	
Conakry	230(55.3)	186(44.7)	149.6[20.7, 1080.9]	<0.0001	14(3.4)	402(96.6)	0.3[0.1, 0.7]	0.005
Faranah	2(0.4)	511(99.6)	0.5[0.0, 5.3]	0.54	11(2.1)	502(97.9)	0.2[0.1, 0.5]	<0.0001
Kankan	19(3.7)	492(96.3)	4.7[0.6, 35.2]	0.13	12(2.4)	499(97.6)	0.2[0.1, 0.5]	<0.0001
Kindia	234(44.2)	296(55.8)	95.7[13.3, 689.7]	<0.0001	30(5.7)	500(94.3)	0.5[0.3, 1.1]	0.09
Labé	5(7.6)	61(92.4)	9.9[1.1, 86.8]	0.03	5(7.6)	61(92.4)	0.8[0.3, 2.2]	0.60
Mamou	2(1.7)	113(98.3)	2.1[0.2, 23.9]	0.53	3(2.6)	112(97.4)	0.2[0.1, 0.9]	0.03
N'Zérékoré	11(3.6)	292(96.4)	4.6[0.6, 35.7]	0.14	12(4.0)	291(96.0)	0.4[0.2, 0.9]	0.02
Patient's age								
0-15	13 (2.6)	490(97.4)	Reference		18 (3.6)	485(96.4)	Reference	
16-30	284(25.2)	842(74.8)	12.7[7.2, 22.4]	<0.0001	36(3.2)	1090(96.8)	0.9[0.5, 1.6]	0.69
31-45	103(19.4)	428(80.6)	9.1[5.0, 16.4]	<0.0001	19(3.6)	512(96.4)	1.0[0.5, 1.9]	1.0
+45 years	104(25.0)	312(75.0)	12.6[6.9, 22.8]	<0.0001	26(6.2)	390(93.8)	1.8[1.0, 3.3]	0.06
Patient's gender								
Female	117(19.6)	480(80.4)	Reference		22(3.7)	575(96.3)	Reference	
Male	387(19.6)	1592 (80.4)	1.0[0.8, 1.3]	0.98	77(3.9)	1902 (96.1)	0.9[0.6, 1.5]	0.82
Type of vehicle involved*								
Two wheels	247(15.7)	1331(84.3)	Reference		45(2.9)	1533(97.1)	Reference	
Four wheels	216(26.5)	599(73.5)	1.9[1.6, 2.4]	<0.0001	50(6.1)	765(93.9)	2.2[1.5, 3.4]	<0.0001
Mechanism**								
Collision	68(20.5)	263(79.5)	Reference		23(7.0)	308(93.0)	Reference	
Reversal	351(24.1)	1106(75.9)	1.2[0.9, 1.6]	0.17	57(3.9)	1400(96.1)	0.5[0.3, 0.9]	0.01
Drop	59(11.2)	467(88.8)	0.5[0.3, 0.7]	0.000	12(2.3)	514(97.7)	0.3[0.2, 0.6]	0.001
Others	13(24.5)	40(75.5)	1.3[0.6, 2.5]	0.51	1(1.9)	52(98.1)	0.3[0.3, 1.9]	0.19
Status of the victim**								
Driver	161(18.2)	726(81.8)	Reference		27(3.0)	860(97.0)	Reference	
Passenger	232(26.1)	657(73.9)	1.6[1.3, 2.0]	<0.0001	47(5.3)	842(94.7)	1.8[1.1, 2.9]	0.01
Pedestrian	98(16.6)	493(83.4)	0.9[0.7, 1.2]	0.43	19(3.2)	572(96.8)	1.1[0.6, 1.9]	0.85
Type of TBI								
Closed	456(19.0)	1944(81.0)	Reference		76(3.2)	2324(96.8)	Reference	
Open	48(27.3)	128(72.7)	1.6[1.1, 2.3]	0.008	23(13.1)	153(86.9)	4.6[2.8, 7.5]	<0.0001
Number of clinical signs of TBI								
1	338(16.2)	1747(83.8)	Reference		60(2.9)	2025(97.1)	Reference	
2	127(35.8)	228(64.2)	2.9[2.3, 3.7]	0.000	15(4.2)	340(95.8)	1.5[0.8, 2.7]	0.17
3	25(34.7)	47(65.3)	2.7[1.7, 4.5]	<0.0001	13(18.1)	59(81.9)	7.4[3.9, 14.3]	<0.0001
≥4	14(21.9)	50(78.1)	1.4[0.8, 2.6]	0.23	11(17.2)	53(82.8)	7.0[3.5, 14.1]	<0.0001
Glasgow Coma Scale								
14–14 (Mild)	343(18.2)	1542(81.8)	Reference		21(1.1)	1864(98.9)	Reference	
9–13 (Moderate)	112(22.4)	388(77.6)	1.3[1.0, 1.7]	0.03	20(4.0)	480(96.0)	3.7[2.0, 6.9]	<0.0001
3–8 (Severe)	49(25.6)	142(74.4)	1.6[1.1, 2.2]	0.01	58(30.4)	133(69.6)	38.7[22.8, 65.7]	<0.0001
Number of clinical signs of associated spinal cord injury								
0	480(19.6)	1965(80.4)	Reference		88(3.6)	2357(96.4)	Reference	
1	0(0.0)	0(0.0)	.		0(0.0)	0(0.0)	.	
2	11(13.4)	71(86.6)	0.6[0.3, 1.2]	0.16	1(1.2)	81(98.8)	0.3[0.0, 2.4]	0.27
≥3	13(26.5)	36(73.5)	1.5[0.7, 2.8]	0.23	10(20.4)	39(79.6)	6.9[3.3, 14.2]	<0.0001
Number of others associated injuries								
0	444(19.2)	1868(80.8)	Reference		83(3.4)	2229(96.4)	Reference	
1	49(22.7)	167(77.3)	1.2[0.9, 1.7]	0.21	12(5.6)	204(94.4)	1.6[0.8, 2.9]	0.15
≥2	11(22.9)	37(77.1)	1.3[0.6, 2.5]	0.52	4(8.3)	44(91.7)	2.4[0.9, 7.0]	0.09
Care type								
Medical	362(18.4)	1608(81.6)	Reference		76(3.9)	1894(96.1)	Reference	
Medical and orthopedic	50(52.6)	45(47.4)	4.9[3.2, 7.5]	<0.0001	5(5.3)	90(94.7)	1.4[0.5, 3.5]	0.49
Medical and surgical	92(18.0)	419(82.0)	1.0[0.8, 1.3]	0.84	18(3.5)	493(96.5)	0.9[0.5, 1.5]	0.72

Prolonged hospital stay:

In-hospital mortality:

* **(N=2393, Yes=463);**

** **(N=2367, Yes=491)**

* **(N=2393, Yes=95);**

** **(N=2367, Yes=93)**

Table 2. Predictors of prolonged hospital stay and in-hospital mortality based on multivariable logistic regression modeling.

Variables	Prolonged hospital stay Adjusted OR [95% CI]	*p* value	In-hospital mortaliy Adjusted OR [95% CI]	*p* value
Treatment delay				
<6 hours	Reference		Reference	
6 to 12 hours	0.7[0.4, 1.1]	0.85	1.1[0.5, 2.5]	0.85
>12 hours	1.6 [1.0, 2.6]	0.03	2.6 [1.1, 6.2]	0.03
Patient's financial capacity				
Low	Reference		Reference	
Medium	0.6 [0.4, 0.8]	0.001	0.7 [0.3, 1.6]	0.36
Normal	0.6 [0.4, 0.9]	0.02	0.2 [0.3, 1.1]	0.06
Administrative region (Reference= Boké)				
Conakry	18.7 [7.5, 75.6]	<0.0001	0.2 [0.0, 0.6]	0.005
Faranah	0.7 [0.1, 8.4]	0.80	0.3 [0.1, 0.9]	0.03
Kankan	1.7 [0.5, 29.0]	0.20	0.3 [0.0, 0.8]	0.04
Kindia	16.3 [5.3, 66.3]	<0.0001	0.5 [0.1, 2.0]	0.34
Labé	1.8 [0.8, 74.8]	0.07	0.9 [0.2, 5.3]	0.75
Mamou	1.9 [0.2, 22.3]	0.06	0.2 [0.0, 1.0]	0.05
N'Zérékoré	1.6 [0.6, 40.4]	0.12	0.6 [0.1, 1.8]	0.40
Age (Reference=0-15years)				
16-30	16.1 [8.5, 30.5]	<0.0001	0.6 [0.2, 1.2]	0.15
31-45	18.0 [9.0, 35.9]	<0.0001	0.6 [0.2, 1.6]	0.30
+45years	29.9 [14.8, 63.3]	<0.0001	0.7 [0.2, 3.0]	0.69
Gender (Reference=Female)				
Male	1.0 [0. 7, 1.5]	0.98	0.9 [0. 5, 1.8]	0.83
Type of gear involved (Reference=Two wheels)				
Four wheels	0. 7 [0.5, 0.9]	0.01	1. 8 [1.0, 3.3]	0.04
Mechanism (Reference=Collusion)				
Reversal	1.2 [0. 8, 1.9]	0.34	0.5 [0. 3, 1.0]	0.06
Drop	0.9 [0.5, 1.7]	0.78	0.3 [0.1, 1.0]	0.05
Others	1.2 [0.4, 3.5]	0.68	0.5 [0.1, 4.5]	0.52
Status of the victim (Reference=Driver)				
Passenger	1.0 [0.7, 1.5]	0.92	2.2 [1.1, 4.4]	0.02
Pedestrian	0.8 [0.5, 1.2]	0.25	1.9 [1. 2, 4.6]	0.03
Type of traumatic brain injury (Reference=Closed Head Traumas)				
Open Head Traumas	0.8 [0. 5, 1.5]	0.54	2.6 [1. 3, 5.5]	0.009
Number of clinical signs of traumatic brain injury (Reference=1)				
2	1.9 [1.3, 2.7]	0.001	1.7 [1.1, 11.7]	0.04
3	1.0 [0.5, 2.0]	0.90	16.4 [5.3, 133.1]	<0.0001
≥4	0.7 [0.2, 1.9]	0.46	4.8 [1.4, 33.5]	0.03
Glasgow Coma Scale (Reference=14 – 14)				
9 – 13 (Moderate)	1.3 [0.9, 1.8]	0.22	3.0 [1.3, 6.9]	0.008
3 – 8 (Severe)	1.4 [0.8, 2.4]	0.17	63.4 [24.0, 167.8]	<0.0001
Number of clinical signs of spinal injuries associated (Reference=0)				
2	0.4 [0.2, 1.0]	0.06	1.3 [1.0, 2.4]	0.06
≥3	0. 9 [0.3, 2.5]	0.86	4. 7 [3.3, 8.2]	<0.0001
Number of others associated lesions (Reference=0)				
1	1.8 [1. 0, 3.0]	0.03	1.4 [0. 6, 3.3]	0.47
≥2	1.0 [0.4, 2.8]	0.98	2.2 [0.6, 8.0]	0.25
Care Type (Reference= Medical)				
Orthopedic	3.2 [1.6, 6.5]	0.001	1.8 [0.8, 10.3]	0.11
Surgical	1.1 [0.7, 1.7]	0.64	1.1 [0.5, 2.3]	0.82
Age* Ability to finance the care			1.3 [1.0, 2.4]	0.05
Number of clinical signs of traumatic brain injury *Glasgow Coma Scale			0.8 [0. 6, 1.1]	0.06

in patients with two clinical signs of traumatic brain injury in patients with another injury associated with TBI and in patients who received orthopedic treatment. Compared with patients with low-financial capacity, patients with moderate financial capacity (adjusted OR = 0.6, 95% CI = 0.4–0.8, $p = 0.001$) and those with normal financial capacity (adjusted OR = 0.6, 95% CI = 0.4–0.9, $p = 0.02$) had a lower risk of prolonged hospital stay by 40%. The results of the multivariate analysis are summarized in Table 2.

The overall in-hospital mortality was 99 (3.8%) of 2,576 patients. Of the 99 in-hospital mortality events, 37.4% occurred within the first 3 days of hospitalization, and 33.3% between the third and 10th day of hospitalization. The distribution of this in-hospital mortality by administrative regions is shown in Figure 2.

Multivariate logistic regression model was constructed based on 2,249 (93 in hospital mortality events) of 2,576 patients as mentioned previously. The risk of in-hospital mortality was 2.6 times higher in patients with time interval between accident and hospital arrival greater than 12 hours compared with those in whom the time interval was less than 6 hours (adjusted OR = 2.6, 95% CI = 1.1–6.2 $p = 0.03$). The risk of in-hospital mortality was similar in patients with time interval between accident and hospital arrival of 6–12 hours compared with those in whom the time interval was less than 6 hours (adjusted OR = 1.1, 95% CI = 0.5–2.5, $p = 0.85$). There

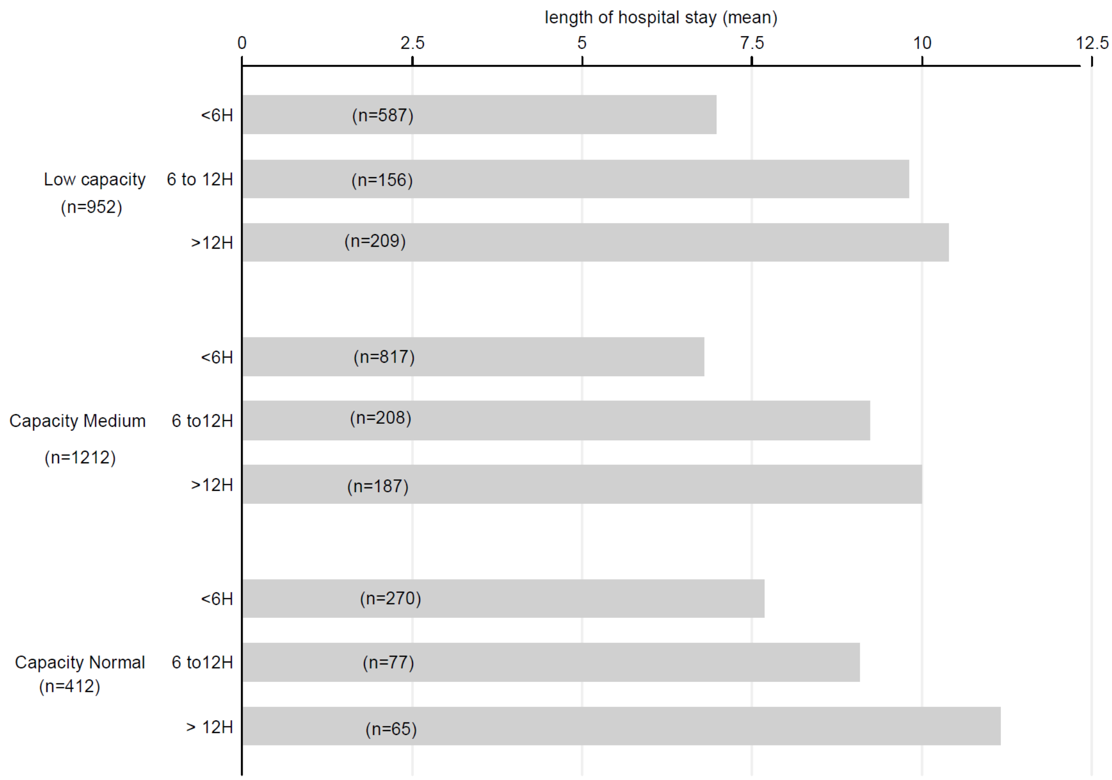

Figure 1. Length of hospital stay according to financial capability and strata based on time interval between TBI and hospital arrival.

was no significant association between medium-financial capacity: (adjusted OR = 0.7, 95% CI = 0.3–1.6, p = 0.36); and normal financial capacity (adjusted OR = 0.2, 95% CI = 0.3–1.1, p = 0.06) compared with low-financial capacity. A significant interaction was detected between financial capability and age (p = 0.05).

The in-hospital mortality was significantly related to the administrative region; the risk of death was lower in the administrative regions of Conakry (adjusted OR = 0.2, 95% CI = 0.0–0.6, p = 0.005), Faranah (adjusted OR = 0.3, 95% CI = 0.1–0.9, p = 0.03) and Kankan (adjusted OR = 0.3, 95% CI = 0.1–0.9, p = 0.03) compared to the administrative region of Boké. The patient's age, gender, and mechanism of injury were not significantly associated with in-hospital mortality in multivariate analysis (Table 2).

When TBI was open, the risk of death was 2.6 points higher (adjusted OR = 2.6, 95% CI = 1.3–5.5, p = 0.009) compared with closed TBI. This risk was 16 points higher in patients with three clinical signs of TBI compared to those with a single sign (adjusted OR = 16.4, 95% CI = 5.3–133.1, p<0.0001). Similarly, moderate coma (adjusted OR = 3.0, 95% CI = 1.3–6.9, p = 0.008) and severe coma (adjusted OR = 63.4, 95% CI = 24.0–167.8, p = 0.000), and the presence of at least three spinal injury signs (adjusted OR = 4.7, 95% CI = 3.3–8.2, p < 0.0001) were associated with increased in-hospital mortality.

Discussion

The characteristics of TBI patients secondary to MVA in our study was similar to other cohorts in in Benin [10], Cameroon, Tunisia [3], and Greece [20]. Mean length of hospital stay was 8 days which was lower than the 9.8 days observed in Turkey [21], but higher than the 6 days observed in Benin [10]. Certain unique attributes of the study population need to be recognized. In sub-Saharan Africa, the financial cost of care is predominantly borne by the patient. In Guinea, about 55% of the population lived below the poverty threshold in 2009 [22]. There is considerable paucity and regional variation in health care resources as discussed in later sections. In Guinea 2009, only a single specialized service of neurosurgery was located in the region of Conakry, for the manage-

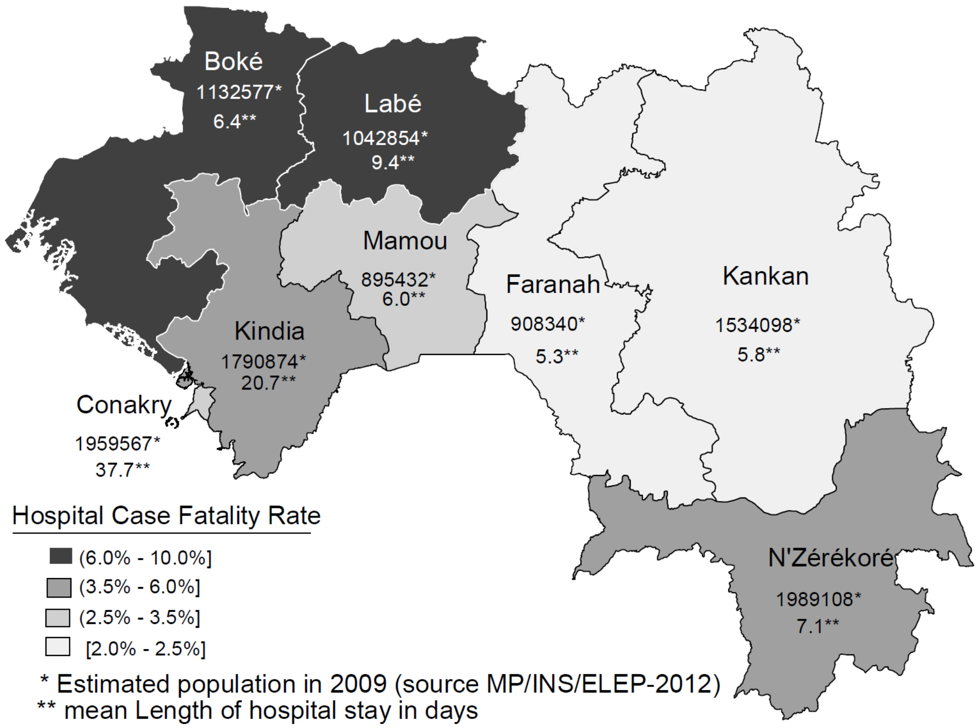

Figure 2. Distribution of in-hospital mortality, population, and mean length of hospital stay in days by administrative regions within Guinea.

ment of TBI. In other facilities, care is provided by orthopedic or trauma services or general surgery.

The time interval between accident and hospital arrival was an important determinant of length of hospitalization and of in-hospital mortality. The length of hospital stay was 60% higher in patients admitted after 12 hours post-TBI. Similarly, mortality increased significantly, with risk of death being 160% higher when patients were admitted 12 hours after the accident. Long time interval between accident and hospital arrival was in part due to difficulties in transporting the patient from the accident site to the nearest reference hospital using inadequate interior roads. There is also paucity of emergency medical services and few hospitals exist to provide adequate level of TBI care. The unequal distribution of healthcare workers in the country and the low rate of hospital equipment in Guinea (0.4 beds per 1000 inhabitants) has already been mentioned by Comolet in 2000 [23]. Intercity transportation of victims of MVA is necessary.

We found a significant relationship between prolonged hospital stay and in-hospital mortality and administrative region of admission. The hospital stay was longer when treatment was in a hospital within regions of Conakry and Kindia, which are probably the two regions with the highest density of medical personnel and medical facilities. The national mean duration of TBI admission is approximately 21 days. In administrative regions of Conakry and Kindia, almost all trauma services, orthopedics and neurosurgery have an official hospitalization deadline of 1 month. At the end of this official period of one month, the patient renews the payment of hospital fees. Also, the further away from the capital (Conakry), the more hospital therapy is substituted by traditional therapies. Indeed, for financial reasons, patients are often forced to stop their hospitalization for using traditional practices, which would significantly reduce the average length of hospital stay in some regions poorly equipped in hospital structures. Similarly, in-hospital mortality was higher in regions of Boké, Kindia, Labé, and Nzérékoré. This high risk of death could be explained by the severity of accidents occurring in these regions and shortage of health workers in the area [23].

We did not find any significant relationship between the mechanism of accident and prolonged hospital stay, or in-hospital mortality. In-hospital mortality was higher when a vehicle with four wheels was involved, whereas the length of hospital stay decreased for the same cause.

Indeed, accidents involving vehicles with four wheels most often occurs on the intercity highways. Also, being a passenger or pedestrian had no significant relationship with the long duration of hospital stay. However, the risk of death was two folds higher among passengers and pedestrians.

Issues Related to Data Interpretation

The exact sequence of events that led to TBI-related death was not documented. The mortality in our study may be an underestimate of actual rates because death before hospital admission was not ascertained or included in the study. Despite these limitations, this study has several strengths. This study was the first TBI study using national level data in Guinea including data from all reference hospitals for the management of highway accidents. The study sample was collected for the complete year allowing estimation of an annual rate of hospital deaths due to TBI.

Conclusion

Prolonged hospital stay and higher in-hospital mortality was associated with longer time interval incurred between accident and hospital arrival among TBI patients. This delay is attributed to inadequate condition of intercity roads and lack of emergency medical services. This may be an important modifiable factor in reducing in-hospital mortality and resource allocation for TBI in Guinea.

Acknowledgments

This study is a secondary analysis of data from a national survey. This survey is the result of a partnership between the Neurosurgery Department of the Teaching Hospital of Conakry, the National Road Traffic Accidents Control Program, and the World Health Organization to standardize and consolidate the management of Traumatic Brain Injuries and spinal cord trauma in Guinea.

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