UNIVERSITY of RWANDA

COLLEGE OF MEDICINE & HEALTH SCIENCES

SCHOOL OF MEDICINE & PHARMACY

PROFILE AND OUTCOME OF PATIENTS WITH TRAUMATIC BRAIN INJURY IN RWANDA

A dissertation submitted in partial fulfillment of the requirements for the degree of Master of Medicine in Neurosurgery

By Dr Paulin Munyemana, MBChB

SUPERVISORS:

Dr Sévérien Muneza, MD, MMed (Neurosurgery), FCS (ECSA)

Associate Professor Dr NKUSI AE, MBChB, MMed (Neurosurgery), FCS (ECSA), IFAANS

May, the 31st, 2019

DECLARATION

The researcher:

I hereby declare that this dissertation is my own work and it has not been submitted by me to other University for the award of a degree.

Signed ……

Date: May, the 31st 2019

Dr Paulin Munyemana

The supervisor:

I hereby declare that this dissertation entitled:'' **Profile and Outcome of Patients with Traumatic Brain Injury in Rwanda**'' was submitted by Dr Paulin Munyemana with my approval

Signed ……...

Date: May, the 31st 2019

Dr Sévérien Muneza

Acknowledgement

Prima facie, I thank my mentors: Dr Sévérien Muneza and Associate Professor NKUSI AE for having taught me everything I know about neurosurgery. I extend special thanks to all neurosurgery consultants for their aspiring guidance, invaluably constructive criticism and friendly advice during my residency training.

I am using this opportunity to express my gratitude to colleague residents and the entire staff of Centre Hospitalier Universitaire de Kigali, King Faisal Hospital, Centre Hospitalier Universitaire de Butare and Rwanda Military Hospital for their positive collaboration.

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List of abbreviations

AE: Accident and Emergency

ASDH: Acute Subdural Hematoma

BP: Blood Pressure

CHUK : Centre Hospitalier Universitaire de Kigali

CSDH: Chronic Subdural Hematoma

CT: Computed Tomography

DAI: Diffuse Axonal Injury

DC: Decompressive Craniectomy

DH: District Hospital

EDH: Epidural Hematoma

ETT: Endotracheal Tube

EVD: External Ventricular Drainage

GCS: Glasgow Coma Scale

GOSE: Glasgow Outcome Scale Extended

HI: Head Injury

HIC: High Income Countries

HR: Heart Rate

ICU: Intensive Care Unit

IRB: Institutional Review Board

IVH: Intraventricular Hemorrhage

KFH: King Faisal Hospital

LMIC: Low and Middle Income Countries

MMed: Master of Medicine

MCA: Motor Cycle Accident

MVA: Motor Vehicle Accident

RMH: Rwanda Military Hospital

RR: Respiratory rate

RTA: Road Traffic Accident

SPO_2: Saturation of Peripheral Oxygen

TBI: Traumatic Brain Injury

TICH: Traumatic Intracerebral Hematoma

TSAH: Traumatic Subarachnoid Hemorrhage

UR: University of Rwanda

USA: United States of America

WHO: World Health Organization

List of tables and graphs

ABSTRACT

Introduction: Traumatic Brain Injury (TBI) is one of the most severe types of injury and constitutes a significant public health problem globally. Road Traffic Accident is the most common cause of TBI mainly in low and middle income countries. TBI can range from mild to severe TBI with the later causing long term overwhelming impairments. Although we continue to encounter the challenges of this devastating condition, available literature has not given due attention on TBI in our settings.

Objectives: the aim of this study was to provide the profile and outcome of Traumatic Brain Injury in Rwanda.

Methods: This is a prospective study from July 2018 to February 2019. This study was conducted at four referral hospitals in Rwanda (i.e. Centre Hospitalier Universitaire de Kigali, King Faisal Hospital, Rwanda Military Hospital and Centre Hospitalier Universitaire de Butare). This study was carried out in two phases. The first phase was two months' enrolment of patients. The second phase was a prospective outcome assessment of enrolled patients. Ethical clearance was obtained from the IRB of the School of Medicine and Health Sciences of the University of Rwanda and ethics committee of the respective hospitals.

Results and Analysis: There were 102 enrolled patients with TBI. The mean age was 28.6 years (range 1-70). Male to female ratio was 3:1. Road traffic accident was responsible for 70% of all TBI, bicycle and motorcycle accidents were by far the leading mechanism of injury accounting for 82.8% of all road traffic accidents. The time between 17:00' to 19:59'was by far the most frequent time to encounter RTA-related TBI. Majority of patients sustained mild TBI (65.7%), while moderate TBI and severe TBI accounted for18.6% and 15.7% respectively. The lesions found on CT scan were epidural hematoma in 25 patients (24.5%), brain contusion in 24 patients (23.5%) and acute subdural hematoma in 12 patients (11.7%).Patients from North and Western province were likely to have a delayed access to neurosurgical management. The mean duration of hospitalization was 8 days. The severity of TBI was an important determinant of length of hospitalization. The overall mortality rate was 11.1%. In addition, mortality increased with the severity of TBI, with mortality in severe TBI being 56.25% compared to 11% in moderate TBI and 0% in mild TBI respectively.

Conclusion: This is the only multicenter TBI study that has extensively explored the profile and outcome of TBI in Rwanda. Stricter regulations of road traffic and better access to neurosurgical care are of paramount significance to address the burden of TBI in Rwanda.

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Conflict of Interests: None

I. INTRODUCTION

I.1. BACKGROUND

Traumatic Brain Injury is a non-degenerative, non-congenital sudden damage to the brain characterized as an alteration in brain function caused by an external force[4].

Worldwide, ten million people are believed to sustain TBI resulting in death or extensive hospitalization each year[16].

TBI is considered as a clinical condition of young people with the average age at time of diagnosis ranging from 27 to 59 years and a peak at 15-30 years[4]. Males are at higher risk to sustain TBI, but the ratio approaches parity as the age increases[4].

Road traffic accidents, assaults and falls in elderly and children are the main risk factors for Traumatic Brain Injuries. TBI can have broad ranging physical and psychological effects lasting long past the initial injury[5]. Neuroimaging technique and most importantly the brain CT scan continues to influence therapy by reducing the time for detection of TBI, thus prompting adequate management of patients with TBI[6, 7].

Although medical advances have decreased significantly the mortality of patient with severe TBI, the largest number of those who survive TBI is likely to show physical and functional improvement. Nevertheless, they will remain with cognitive and psychosocial adjustment problems which are not always obvious[5].

I.2. RATIONALE

Traumatic Brain Injury is considered as a silent epidemic[16]. The WHO predicts that TBI will be the leading cause of mortality and disability in the World by the year 2020[3].In developing countries with rapidly changing environment, the estimates of TBI are considerably higher than in developed countries[12]. Furthermore, projected estimates of TBI in Africa in 2050 are estimated to be 6 to 14 million new cases with highest count in eastern Africa[14].

TBI is one of the most common conditions found at emergency departments at referral hospitals in Rwanda, but data on TBI in Rwanda are scarce and almost carried out at Centre Hospitalier Universitaire de Kigali (CHUK), the largest referral hospital in Rwanda. According to one hospital-based study, Twagirayezu et al retrospectively reviewed road traffic injuries and found that 29.4% of all patients admitted at emergency department presented head injury[15]. At the same center, emergent neurosurgical procedures were the second most performed procedure after emergent orthopedic procedures[21].The recent one hospital-based study in Rwanda; Elizabeth Krebs et al prospectively analyzed 670 patients with head injury and reported 80% of mild TBI, 10% of moderate TBI and 10% of severe TBI[17].

Considering the causes of TBI, the pattern of TBI is strongly associated with demographic characteristics of the population studied across the world. In US, MVA accounts for 50% of all

TBI, falls 20-30% of all TBI and firearms 12% of all TBI[4]. In Tanzania, road traffic crash was reported to be the leading cause of TBI (53%) [18].In one retrospective cohort study at primary trauma center in Rwanda from December 2012 to February 2015, blunt trauma from motor vehicle collisions involving young males constituted the majority of traumatic injury[19].

Available literature about the status of patients with TBI in Rwanda has not explored the outcome extensively after TBI. According to one study in rural referral hospital in Rwanda, Hitimana et al. have found that 47% of all head injury patients had mild TBI, 9% had moderate TBI, and 28% had severe TBI with mortality rates of 0%, 14%, and 52% respectively while Krebs et al have found that characteristic associated with death were GCS<13, hypoxia, bradycardia, tachycardia and age>50 years; death rate was 56.1% for patients sustaining severe TBI[20,17].There is a need to describe in-hospital mortality of the patients sustaining TBI in Rwanda. Certainly, the latter alone is not enough, there is also a need to know the outcome of the patients discharged from the hospital.

There is so far no multicenter study that has extensively explored the profile and outcome of TBI in Rwanda. Thus, the aim of this study is to fill the gaps of knowledge on TBI in Rwanda, to identify key demographics at risk; hence to elaborate strategies for prevention of TBI in Rwanda.

I.3. RESEARCH QUESTION

What is the profile and outcome of patients sustaining Traumatic Brain Injury in Rwanda?

I.4. OBJECTIVES OF THE STUDY

I.4.1. GENERAL OBJECTIVES

To provide the profile and outcome of patients with Traumatic Brain Injury in Rwanda

I.4.2. SPECIFIC OBJECTIVES

To determine the demographic pattern of patients with TBI in Rwanda

To determine the mechanism of injury of TBI in Rwanda

To determine the injury characteristics of TBI in Rwanda

To determine the treatment given to patients with TBI in Rwanda

To determine the outcome of patients with TBI in Rwanda

II. LITERATURE REVIEW

Traumatic Brain injury is one of the most severe types of injury and constitutes a significant public health challenge globally. Defining Traumatic Brain Injury has not been consistent with head injury (HI) used synonymously as TBI. Head Injury can be defined as a clinically evident external injury to the face, scalp and calvarium and may or may not be associated with TBI[1]. On the other hand, TBI can be defined as an alteration in brain function resulting from blunt or penetrating force to the head[1]. Accurate description of global burden on TBI is unknown due to: great variability to establish clear definition, various inclusion criteria, discrepancies in data collection and different methods used for classification of patients with TBI[1].

Worldwide, country-based estimates of TBI incidence ranges between 108-332 new hospitalized cases per 100000 populations per year[8].In US, an estimated 2.5 million people per year sustain TBI; mild TBI is estimated to account 131/100000 people, moderate TBI to account 15/100000 people and severe TBI to account 14/100000 people[9,4]. In Europe, Tagliaferri et al in a systematic review on TBI have found an aggregated incidence rate of 235/100000 per year and an average mortality rate of 15/100000[11]. However, this does not account mild TBI that do not present to hospitals and severe TBI with associated death at the scene and may not be completely recorded for data collection. There is virtually insufficient literature on the accurate magnitude of TBI in Africa. However, a study by Brown et al in 1991 estimated an average incidence of 316/100000 persons per year in South Africa[13].

TBI is more common in young adult, and is a leading cause of morbidity and mortality in those younger than 45 years[4]. The numbers of male with TBI are twice more than the numbers of the female. The male to female ratio approaches parity as the age increases[4]. Worldwide, gender difference ranges from 1.18:1 to 4.81:1[4]. Falls are the most common mechanism of injury in elderly and children while Motor Vehicle Accident (MVA) is the most common mechanism of injury in young adults[6]. Worldwide TBI incidence may be increasing due to the wider uses of motor vehicles in Low and Middle Income Countries (LMIC) and increase of falls among older peoples in High Income Countries (HIC) [4].

TBI can be divided into primary and secondary brain injury. The primary injury occurs as the consequence of the initial physical insult such as an impact loading, impulsive loading or a static loading[4]. Furthermore, this effect can result in neurobiological effects that vary in intensity, length and clinical manifestations[4]. Secondary TBI is the result of further physiological damage from intracranial and extracranial insults[4].TBI is an important socio-economic concern because the survivors are susceptible to irreversible neurological damage.

Clinical examination is the mainstay of TBI assessment. Glasgow coma scale described by Teasdale and Jennett is a widely used rapid neurologic assessment and as a clinical classification of TBI severity. It is based on patient eye opening (4 points), verbal response (5 points) and motor function (6 points). According to GCS, patients are stratified into 3 categories: patients with mild TBI (GCS range: 3-8), patients with moderate TBI (GCS range: 9-12) and patients with severe TBI (GCS range: 13-15).

Brain CT scan is the modality of choice in the acute settings of TBI as early detection and aggressive management circumvent secondary brain injury. Brain MRI is more sensitive for

brain tissue but it is less sensitive for fractures, not always available and its acquisition time is longer[7]. Brain arteriogram in brain trauma may be useful in cases of non-missile penetrating TBI. In addition, repeating brain imaging is useful when there is neurological deterioration and follow-up imaging can be important in the management of chronic TBI[6]. Newly developed structural and functional neuroimaging techniques, histological findings and molecular biomarkers are nowadays promising research tools. However, those modalities are cumbersome in daily clinical settings.

It is widely agreed that the fundamental aim of TBI management is to prevent secondary brain injury and prompt treatment of the original intracranial injury[1].Immediate assessment and stabilization seem to increase the survival rate[13].

There has been much interest in the long term outcome in those with TBI. After TBI, majority of patients show physical and functional improvement. Although medical advances have led to significant decrease in mortality of patient with severe TBI over the last decades, the survivor often remain with cognitive and psychosocial adjustment problems[5].Glasgow Outcome Scale Extended (GOSE) is widely used for the assessment of clinical status at 6 months after TBI; it consists of: death (1), vegetative state (2), lower severe disability (3), upper severe disability(4), low moderate disability (5), upper moderate disability(6), low good recovery (7), upper good recovery(8).

III. METHODS

III.1. DESIGN

This is a multi-center based prospective study from July 2018 to February 2019 to determine the profile and outcome of patients with TBI in Rwanda.

III.2. DESCRIPTION

This study was carried out in two phases. The first phase was two months' enrolment of patients. The second phase was a prospective outcome assessment of enrolled patients. Patients were enrolled on the day of initial assessment. The research assistants recorded the patient identifications, mechanism of injury, and severity classification of TBI. The research assistants were one intern doctor and postgraduates rotating in neurosurgery. After definitive treatment, the patients were followed up by the research team to record the treatment given. In hospital mortality was recorded after death. Glasgow Coma Scale Extended (GOSE) was recorded after 6 months for each patient.

III.3. SITE

This study was conducted at four referral hospitals in Rwanda (i.e. Centre Hospitalier Universitaire de Kigali, King Faisal Hospital, Rwanda Military Hospital and Centre Hospitalier Universitaire de Butare)

The patients were enrolled from Emergency departments.

Centre Hospitalier Universitaire de Kigali (CHUK) is a general public tertiary hospital in Rwanda; it is equipped with513 beds with a high volume trauma capacity. Emergency department has a capacity of 30 beds; the neurosurgical department has a capacity of 16 beds for adult patients and variable number of beds in pediatric wards. There are two neurosurgeons running the service.

King Faisal Hospital (KFH) is a tertiary hospital equipped with 160 beds. The emergency department has a capacity of sixteen beds. The surgical ward has a capacity of 40 beds. The hospital has 2 neurosurgeons running the service.

Rwanda Military Hospital (RMH) is a military tertiary hospital in Rwanda, has a capacity of 350beds, emergency department has a capacity of 25 beds, and the surgical department has a capacity of 90 beds. Neurosurgical patients are treated by one neurosurgeon and one visiting neurosurgeon on part time basis.

Centre Hospitalier Universitaire de Butare (CHUB) is a general public tertiary hospital, has a capacity of 500beds, emergency department has a capacity of 25 beds and the surgical department has a capacity of 113 beds. There was not a neurosurgeon available at the time of data collection.

III.4. POPULATION

All patients consulting four referral hospitals in Rwanda for Traumatic Brain Injury during the study period

III.5. INCLUSION CRITERIA

Patient who sustained TBI prior to medical visit at one of the four referral hospitals

III.6. EXCLUSION CRITERIA

Patients who presented isolated facial and scalp injuries

Patient who came for a second consultation for the same condition

Patients with preexisting brain dysfunctions before sustaining TBI

III.7. STUDY PERIOD

From July 2018 to February 2019

III.8. DATA COLLECTION

The research data assistant enrolled patients upon arrival at emergency departments.

He recorded following data using a questionnaire: the patient's demographic data, mechanism of injury, vital signs, type and severity classification of TBI.

Patients were followed up in ward/critical care unit by the research team to record the treatment given and the patient's clinical status on discharge.

After discharge, the patient or the next of kin were called after 6 months for GOSE assessment of the patient.

III.9. SAMPLE SIZE CALCULATION

The study population was calculated using the formula for sample calculation: SS= (Z^2xP (1-P)): e^2.

SS: sample size

Z: standard normal distribution corresponding to desired confidence level (Z=1.96% for 95% CI)

P: expected true proportion

E: desired precision (half desired CI)

SS=1.96^2 X 0.00316 (1-0.00316): 0.05^2 =1.96^2x0.0031500144: 0.00025= 48.4

III.10. ETHICS AND CONFIDENTIALITY

Research proposal was submitted to the neurosurgery training program meeting and to the Research Ethics Committee of the Faculty of Medicine at the University of Rwanda for review and approval.

Research proposal was presented to the ethics committee of the respective hospitals.

Informed consent was sought from each prospective subject or the subject's legally authorized representative.

Where patients may be in critical condition may not be able to respond to the questionnaire, data were collected from next of kin or the subject's legally authorized representative.

Consent and questionnaire were carried up in a quiet and calm environment in place to manage distress. There were no any respondents who rose up emotional reactions that needed mental health support.

Patient was given a number different from the hospital identification number.

Data collection records were kept in a secured password protected computer and hard copies were kept in a secured double locked drawer of the office of Rwanda Neurosurgical Center and will be kept for 5 years.

III.11. INFORMED CONSENT

An informed consent was obtained from all participants prior to their enrollment. The individual's consent was voluntarily provided after clear, concise and understandable explanations of the purpose, eventual risks, potential benefits of the study, and the right to abstain from participation or to withdraw consent to participate in the study at any time without penalties or reprisals. Patients that are below legal age of consent (<18years) were required to give an assent in addition to the consent from a parent or a legal guardian/representative. The

consents of patients who were having altered mental status were obtained when family members or legal representative arrived at the hospital. A statement verifying the clear provision of informed consent; in the language that the patient or the legal representative understands the most was visible on the first page of the questionnaire. Moreover, the informed consent document or patient real identification was attached to the questionnaire.

III.12. BENEFITS

There is no benefit to any individual patient involved in the research.
There was no compensation for patient or family members of the patient enrolled in the study.

III.13. CONFLICTS OF INTERESTS

The investigator and supervisors of this study declare to have no conflict of interests.

III.14. STUDY LIMITATION

As a prospective study, follow-up of free-living populations may subject to some missing data because patients or next of kin may change their contact information and can be difficult to track.

III.15. ANALYSIS PLAN

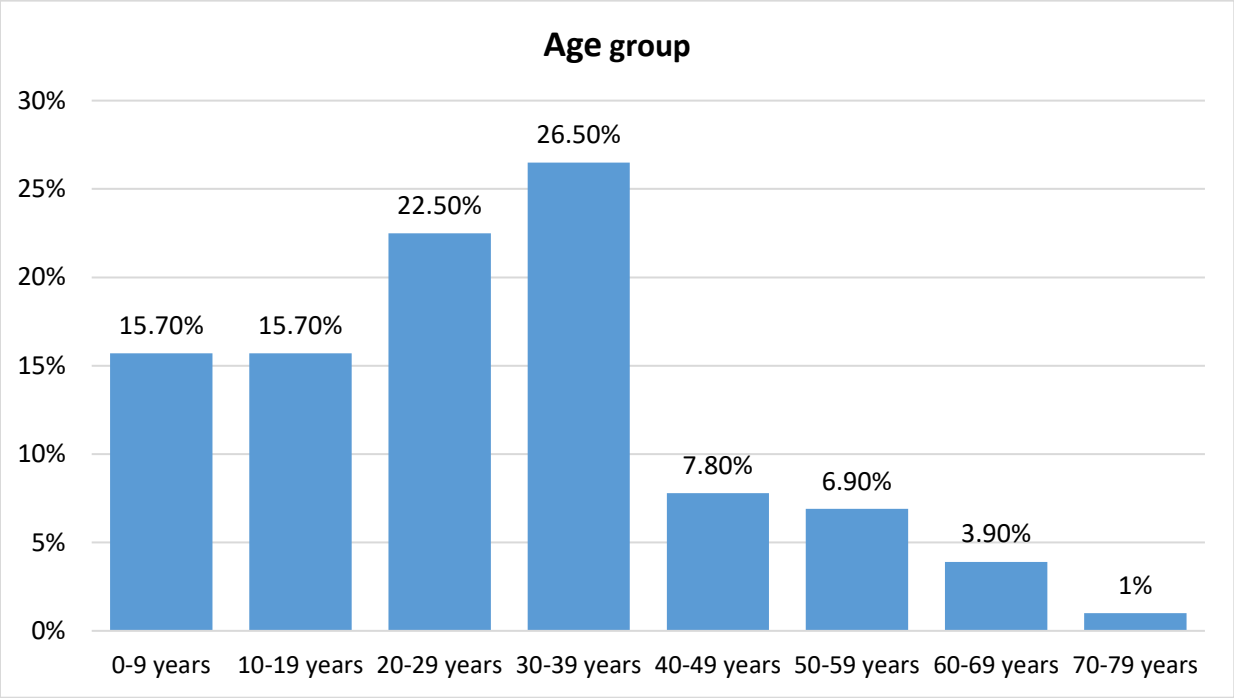
Descriptive statistics are used for prevalence, description of demographics and other baseline characteristics of the population in this study. Student t-tests and Chi-square tests are used to compare observed proportions. A p-value below 0.05 was considered significant for any association. Data were collected and adapted using EpiInfo 7.1, and analyzed using STATA 12. Not all parameters collected in the study forms are described in the conclusion; therefore, the proportion, demographic pattern, mechanism of injury, injury characteristics, treatment given and outcome are analyzed and presented for understanding TBI in Rwanda. The results are interpreted and discussed in comparison with other similar studies done in different countries.

IV. RESULTS and ANALYSIS

This study enrolled 102 patients identified as having TBI at four referral hospital in Rwanda. The age varied from 1 year to70 years with a mean age of 28.89 years. Men accounted for 75.49% of all enrolled patients during the study period. Road traffic accident was responsible for 70% of all traumatic brain injuries with bicycle and motor-cycle accidents by far the leading mechanism of injury accounting for 82.8% off all road traffic crashes. The mean duration of TBI admission at referral hospital was 8 days. Majority of patients sustained mild TBI (65.7%), moderate TBI (18.6%) and severe TBI (15.7%). The overall mortality rate was 11.1%. In addition, there was a higher mortality rate (56.25%) amongst patient sustaining severe TBI.

The total number of enrolled patients with TBI was 102 patients out of 318 trauma patients who consulted at four referral hospitals during the study period; which constitute a proportion of 32.07%

Graph 1. Age of patients with TBI



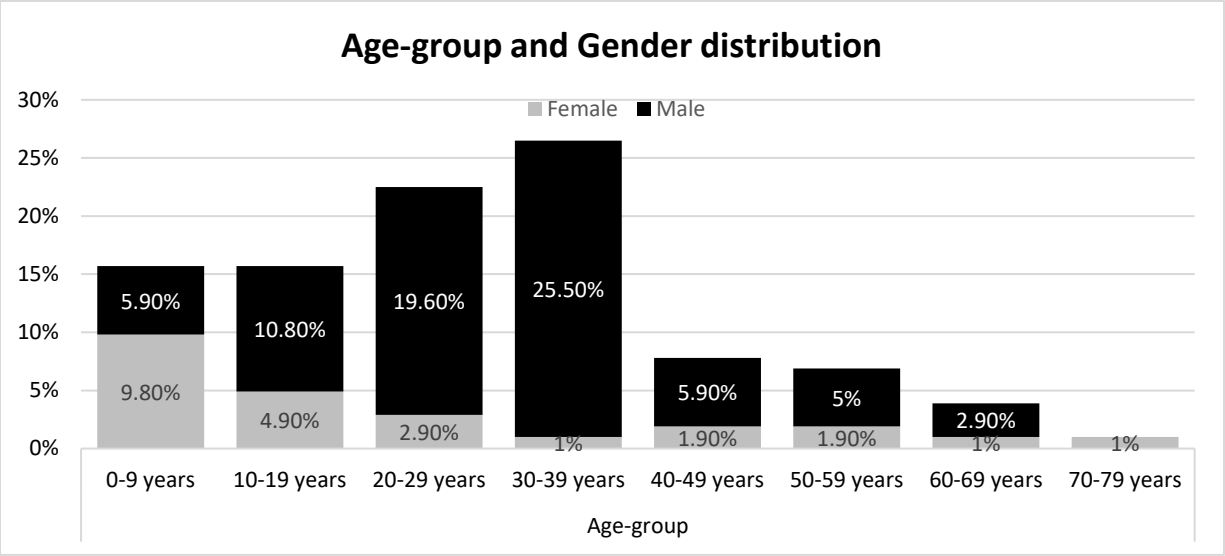
Mean age	Std. Dev.	Min	Max
28.9	16.6	2.5 months	70 years

The total number of patients enrolled with TBI was 102. The largest number of TBI patients were in the age-group of 30 to 39 years (26.5%) followed by the group-age of 20 to 29 years (22.5%).

Table 1. Age and gender of patients with TBI

Variable	Age group (years)								Total	p value
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79		
Gender										
Female n (%)	10 (9.8%)	5 (4.9%)	3 (2.9%)	1 (1%)	2 (1.9%)	2 (1.9%)	1 (1%)	1 (1%)	25 (24.5%)	
Male n (%)	6 (5.9%)	11 (10.8%)	20 (19.6%)	26 (25.5%)	6 (5.9%)	5 (5%)	3 (2.9%)	0 (0%)	77 (75.5%)	0.001*

Graph 2.Age and gender of patients with TBI



The ratio of male to female was 3.1:1. Female patients were more observed in the age group of 0-9 years and 10-19 years. Female patients were more observed in the age group of 0-9 years. Male patients were more observed in the age groups of 20-29 years and 30-39 years (p value: 0.001).

Table 2.1. Mechanism of injury of TBI

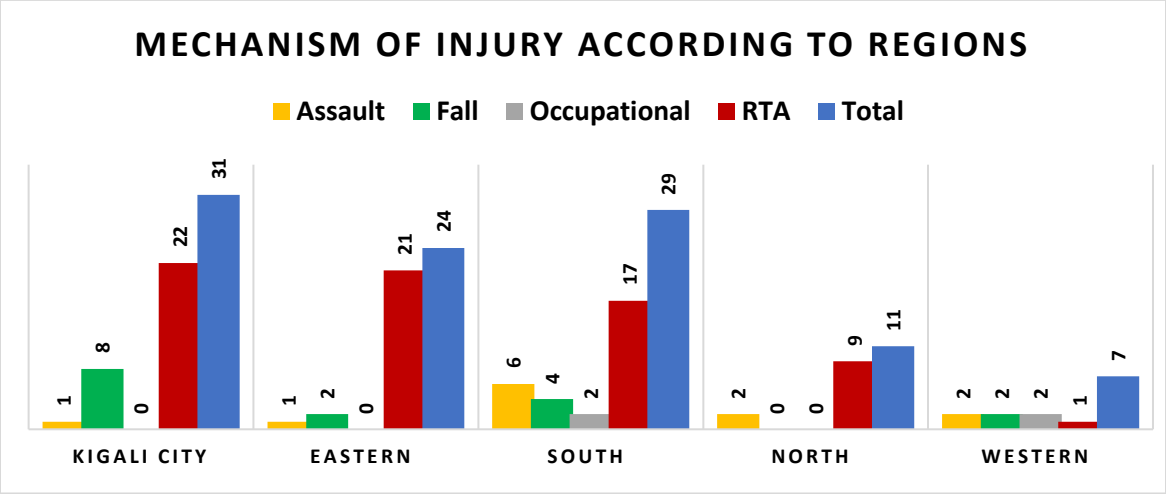
Variable	Mechanism of injury					P value
	Assault	Fall	Occupational	RTA	Total	
Profession						
Business	0	0	0	8 (100%)	8	0.009*
Construction	0	1 (25%)	1 (25%)	2 (50%)	4	
Bicycle driver	0	0	0	6 (100%)	6	
Driver Car	1 (100%)	0	0	0	1	
Driver motor cycle	0	0	0	9 (100%)	9	
Farmer	8 (29.6%)	3 (11.1%)	2 (7.4%)	14 (51.9%)	27	
Housekeeping	0	1 (100%)	0	0	1	
No job	2 (16.7%)	6 (50%)	0	4 (33.3%)	12	
Porter	0	1 (25%)	0	3 (75%)	4	
Retired	0	1 (50%)	0	1 (50%)	2	

Security	0	1 (50%)	0	1 (50%)	2	
Student	1 (4.3%)	2 (8.7%)	1 (4.3%)	19 (82.6%)	23	
Teacher	0	0	0	3 (100%)	3	
Total	12 (11.8%)	16 (15.7%)	4 (3.9%)	70 (68.6%)	102	
Injury time						
5:00-7:59	0	1 (6.2%)	0	5 (7.1%)	6	0.858
8:00-10:59	1 (8.2%)	1 (6.2%)	0	6 (8.6%)	8	
11:00-13:59	2 (16.7%)	4 (25%)	0	10 (14.3%)	16	
14:00-16:59	2 (16.7%)	2 (12.5%)	1 (25%)	11 (15.7%)	16	
17:00-19:59	2 (16.7%)	4 (25%)	2 (50%)	23 (32.9%)	31	
20:00-22:59	3 (25%)	3 (18.9%)	0	12 (17.1%)	18	
23:00-1:59	2 (16.7%)	1 (6.2%)	1 (25%)	3 (4.3%)	7	
2:00-4:49	0	0	0	0	0	
Total	12 (11.8%)	16(15.7%)	4 (3.9%)	70 (68.6%)	102	
Regions						
Kigali city	1 (3.2%)	8 (25.8%)	0	22 (71%)	31	0.002*
Eastern	1 (4.2%)	2 (8.3%)	0	21 (87.5%)	24	
South	6 (20.7%)	4 (13.8%)	2 (6.9%)	17 (58.6%)	29	
North	2 (18.2%)	0	0	9 (81.8%)	11	
Western	2 (28.6%)	2 (28.6%)	2 (28.6%)	1 (14.2%)	7	
Total	12 (11.8%)	16 (15.7%)	4 (3.9%)	70 (68.6%)	102	

TBI were related to road traffic accident in 68.6%, due to falls in 15.7%, related to physical violence in 11.8% of cases and due to occupational accident in 3.9% of cases.
Jobless persons were more prone to sustain falls (50% of jobless patients), farmers were more susceptible to sustain RTA (51.9% of farmers) and assaults (29% of farmers), while students, businessmen, porters and two wheels' drivers were more susceptible to sustain road traffic accidents (p value=0.009).

Peak hours of road traffic which coincide with poor light (17:00'-19.59') was by far the most common time to encounter TBI related to RTA (32.9%). The most frequent time of assaults was during 20:00'-22:29' (25%). The most common time of falls was during 11:00'-13:59' and 17:00'-19:59' (50%).

Graph 3. Mechanism of injury according to regions



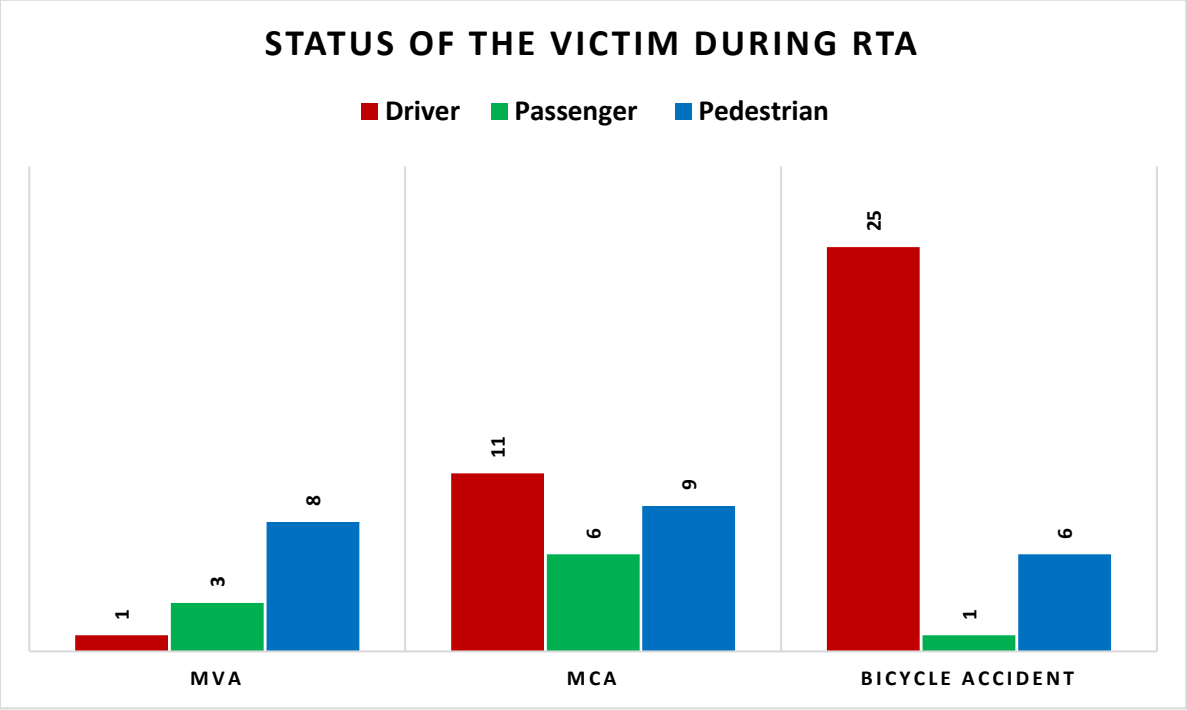
Road traffic accident was by far the most common cause of TBI in city of Kigali and three provinces (Eastern, Southern and Northern provinces). Falls were the second mechanism of TBI in Kigali city (25.8%) and East province (8.3%). Assaults were the second mechanism of TB in the South Province (20.7%). (p value=0.002).

Table 2.2.Status of the victim during RTA

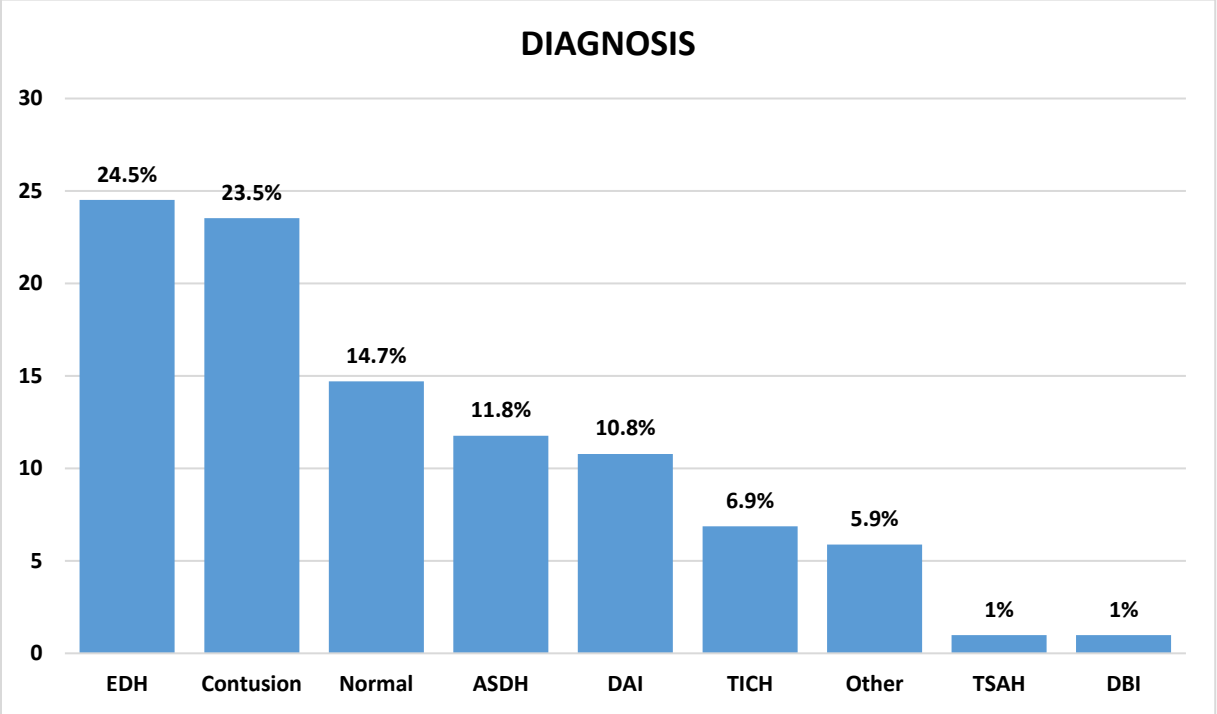
	MVA	MCA	Bicycle accident	Total	P value
Status of the victim					
Driver	1 (8.3%)	11 (42.3%)	25 (78.1%)	37	0.000*
Passenger	3 (25%)	6 (23.1%)	1 (3.1%)	10	
Pedestrian	8 (66.7%)	9 (34.6%)	6 (18.8%)	23	
Total	12 (17.1)	26 (37.2%)	32 (45.7%)	70	

The status of the TBI victim during motor-vehicle accident showed that 8.3% of the victims were drivers, 25% of the victims were passengers and **66.7%** of the victims were pedestrians in opposition to bicycle accident, where **78.1%** of the victims were drivers, 10% of the victims were passengers and 32.8% of the victims were pedestrians (p value=0.000).

Graph 4.Status of the victim during RTA



Graph 5. CT scan findings

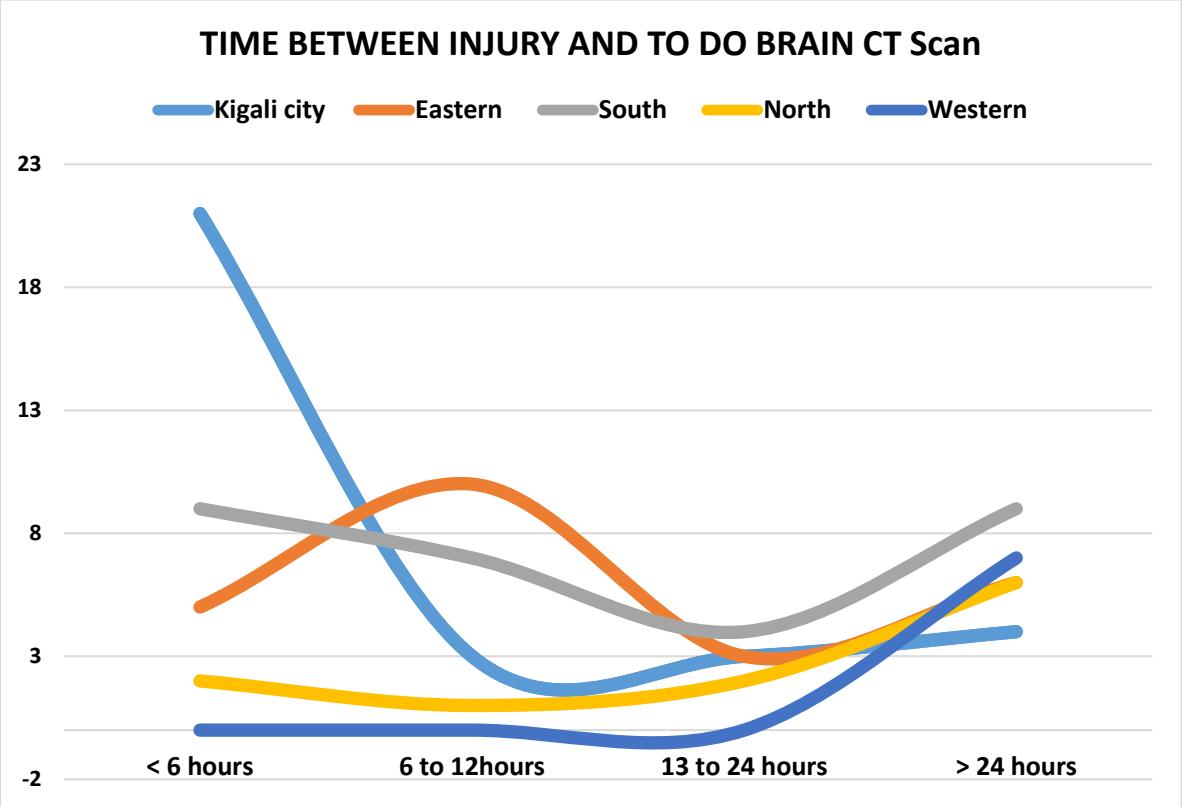


Intracranial hematoma collections represented 44.11% of the lesions sustained by TBI patients (EDH: 24.5%, ASDH: 11.8%, TICH: 6.9% and TSAH: 1%) followed by contusion (23.53%). The CT scan showed normal findings in 14.7%.

Table 3. Access to neurosurgical care

Variable	Administrative Region						P value
	Kigali city	Eastern	South	North	Western	Total	
Time between injury and to do CT scan							
< 6 hours	21 (67.7%)	5 (20.8%)	9 (31%)	2 (18.2%)	0	27	0.000*
6 to 12hours	3 (9.7%)	10 (41.7%)	7 (24.2%)	1 (9%)	0	21	
13 to 24 hours	3 (9.7%)	3 (12.5%)	4 (13.8%)	2 (18.2%)	0	12	
> 24 hours	4 (12.9%)	6 (25%)	9 (31%)	6 (54.6%)	7 (100%)	32	
Total	31 (30.4%)	24 (23.5%)	29(28.4%)	11(10.8%)	7 (6.9%)	102	
Time between injury and surgery							
< 6 hours	5 (33.3%)	0	0	0 (0%)	0	5	0.065
6 to 12hours	3 (20%)	4 (33.3%)	2 (28.5%)	1 (14.2%)	0	10	
13 to 24 hours	3 (20%)	2 (16.7%)	1 (14.3%)	0	0	6	
> 24 hours	4 (26.7%)	6 (50%)	4 (57.2%)	6 (85.8%)	5 (100%)	25	
Total	15 (32.7%)	12 (26.0%)	7 (15.2%)	7 (15.2%)	5 (10.9%)	46	

Graph 6. Lag time to accessneurosurgery management



Patients from Kigali city who got brain CT scan in less than 6 hours were 67.7% (21/31 patients), patients from Southern who got brain CT scan in less than 6 hours were 31% (9/29 patients), patients from Eastern who were able to get brain CT scan between 6-12 hours were 41.7% (10/24 patients), 54.6% (6/11) of patients from Western did theirs brain CT scan after 24 hours and all patients from Northern did theirs brain CT scan after 24 hours (0.000).

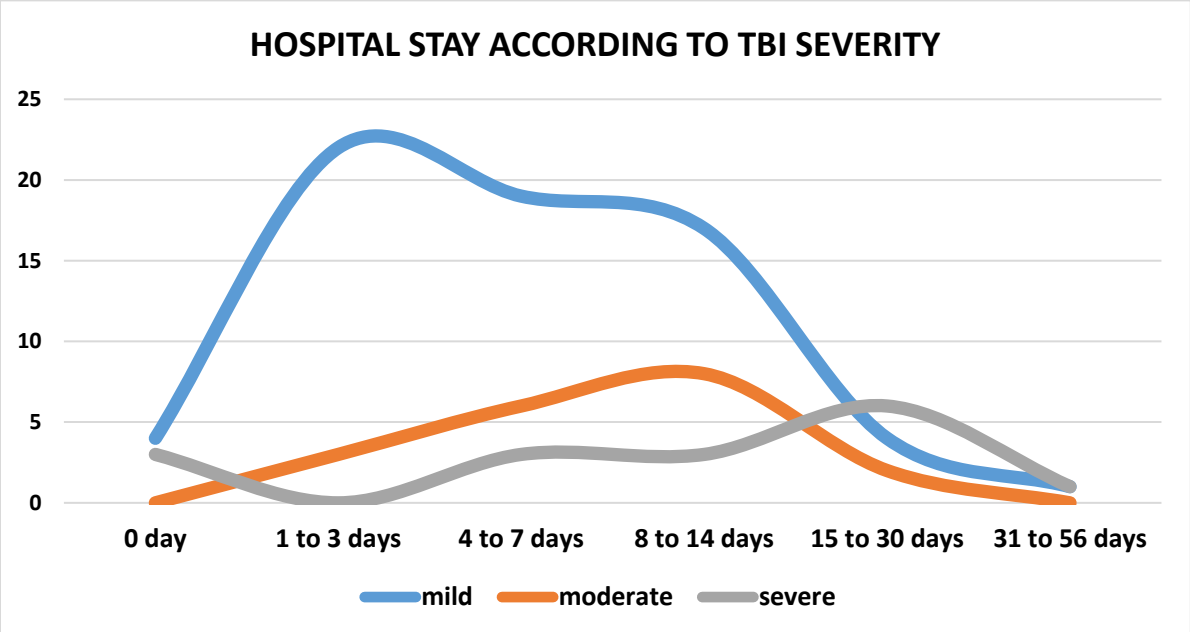
Patient from Kigali city who accessed neurosurgical care in less than 6 hours were 33.3%. There was no surgery performed in less than 24 hours for patient in need of surgery coming from the West province (0.065).

Table 4. Injury severity

The following table (Table 4) presents the association between severity of TBI and age-group, the severity of TBI and time to get surgery and the severity of TBI and the hospital stay. Only 4% of surgeries of patients with mild TBI were performed in less than 6 hours and 76% were performed after 24 hours while 18.2% of surgeries of patients with moderate TBI were done in less than 6 hours and 45.4% were done after 24 hours. However, 20% of surgeries of patients with severe TBI were done in less than 6 hours, 70% were done between 6-24 hours and 10% were done after 24 hours (p value=0.026).

Variable	Severity of TBI			P value
	Mild	Moderate	Severe	
Age group				
0-9 years	12 (11.8%)	0	4 (3.9%)	0.047*
10-19 years	12 (11.8%)	4 (3.9%)	0	
20-29 years	14 (13.7%)	6 (5.9%)	3 (3%)	
30-39 years	17 (16.6%)	5 (4.9%)	5 (4.9%)	
40-49 years	6 (5.9%)	0	2 (1.9%)	
50-59 years	6 (5.9%)	1 (1%)	0	
60-69 years	0	2 (1.9%)	2 (1.9%)	
70-79 years	0	1 (1%)	0	
Total	67 (65.7%)	19 (18.6%)	16 (15.7%)	
Injury to surgery				
< 6 hours	1 (4%)	2 (18.2%)	2 (20%)	0.026*
6 to 12hours	4 (16%)	2 (18.2%)	4 (40%)	
13 to 24 hours	1 (4%)	2 (18.2%)	3 (30%)	
> 24 hours	19 (76%)	5 (45.4%)	1 (10%)	
Total	25 (54.3%)	11 (23.9%)	10 (21.8%)	
Hospital stay				
0 day	4 (5.9%)	0 (0%)	3 (18.7%)	
1 to 3 days	22 (32.9%)	3 (15.8%)	0	0.003*
4 to 7 days	19 (28.4%)	6(31.6%)	3 (18.7%)	
8 to 14 days	17 (25.4%)	8 (42.1%)	3 (18.7%)	
15 to 30 days	4 (5.9%)	2 (10.5%)	6 (37.6%)	
31 to 56 days	1 (1.5%)	0	1 (6.3%)	
Total	67 (65.7%)	19 (18.6%)	16 (15.7%)	

Graph 7. <u>Hospitals stay according to TBI severity</u>



Duration of hospitalization was above 8 days for 62.6% of patient with severe TBI, 52.6% of patients with moderate TBI and 32.8% of patients with mild TBI(p value=0.003).

Table 5. Hospital stay

Variables	Hospital stay (days)							p value
	0	1-3	4-7	8-14	15-30	31-56	Total	
Gender								
Female	3 (12%)	8 (32%)	6 (24%)	5 (20%)	2 (8%)	1 (4%)	25	0.557
Male	4 (5.2%)	17(22%)	22(28.6%)	23(29.9%)	10(13%)	1(1.3%)	77	
Region								
Eastern	1(4.2%)	5(20.8%)	6 (25%)	6 (25%)	6 (25%)	0	24	0.06
Kigali cit	1 (3.2%)	6(19.3%)	7 (22.7%)	11(35.5%)	6(19.3%)	0	31	
Northern	0	2(18.2%)	3 (27.2%)	5 (45.4%)	0	1(9.1%)	11	
Southern	5(17.2%)	12(41.4%)	8 (27.6%)	4 (13.8%)	0	0	29	
Western	0	0	4 (57.1%)	2 (28.6%)	0	1(14.3%)	7	
	7 (6.8%)	25(24.5%)	28(27.4%)	28(27.4%)	12 (11.8)	2 (1.9%)	102	
GOSE at 6 months								
1	3(27.3%)	1 (9.1%)	1 (9.1%)	2 (18.1%)	3(27.3%)	1 (9.1%)	11	0.004*
3	0	0	1 (100%)	0	0	0	1	
4	0	0	0	1 (33.3%)	2(66.7%)	0	3	
5	0	6 (66.7%)	0	2 (22.2%)	0	1(11.1%)	9	
6	1(4.4%)	3 (13%)	7 (30.5%)	9 (39.1%)	3 (13%)	0	23	
7	1(4%)	4 (16%)	11 (44%)	7 (28%)	2 (8%)	0	25	
8	2(7.4%)	11(40.7%)	8 (29.7%)	5 (18.5%)	1 (3.7%)	0	27	
Total	7 (7%)	25(25.3%)	28(28.3%)	26(26.3%)	11(11.1%)	2 (2%)	99	

The mean of hospital stay was 8 days. Hospitals stay of less than 15 days was96.3%, 92%, 87%, 88.9% of patient with GOSE-8, GOSE-7, GOSE-6 and GOSE-5 respectively. Among patients who died before 6 months, 63.6% of them were hospitalized less than 15 days.

Table 6. Demographic data associated with Outcome of TBI patients

Variable	**Number**	**Percentage**	**In-hospital mortality**		**Mortality at 6 months**	
			number	**p value**	**number**	**p value**
Age group						
0-9 years	16	15.7%	0	0.001*	2 (12.5%)	0.001*
10-19 years	16	15.7%	0		0	
20-29 years	23	22.5%	4 (17.4%)		4 (17.4%)	
30-39 years	27	26.5%	1 (3.7%)		3 (11.1%)	
40-49 years	8	7.8%	0		0	
50-59 years	7	6.9%	0		0	

60-69 years	4	3.9%	1 (25%)		1 (25%)	
70-79 years	1	1%	1 (100%)		1 (100%)	
Total	102	100%	7 (6.8%)		11(11.1%)	
Gender						
Male	77	24.5%	6 (7.8%)	0.515	8(10.4%)	0.339
Female	25	75.5%	1 (4%)		3(12%)	
Total	102	100%	7 (6.8%)		11(11.1%)	
Region where occurred TBI						
Kigali city	31	30.4%	2 (6.5%)		2(6.5%)	0.740
Western Province	7	6.9%	0		0	
Eastern Province	24	23.5%	1 (4.2%)	0.436	3(12.5%)	
South Province	29	28.4%	4 (13.8%)		5(17.2%)	
North	11	10.8%	0		1(9.1%)	
Total	102	100%	7 (6.8%)		11(11.1%)	
Time of day						
5:00-7:59	7	6.9%	1(14.3%)		2 (28.6%)	0.688
8:00-10:59	5	4.9%	0		1 (20%)	
11:00-13:59	31	30.4%	2(6.5%)		2 (6.5%)	
14:00-16:59	9	8.8%	0		0	
17:00-19:59	29	28.4%	1(3.4%)	0.479	3 (10.3%)	
20:00-22:59	11	10.8%	1(9.1%)		1 (9.1%)	
23:00-1:59	10	9.8%	1(10%)		2 (20%)	
2:00-4:49	0	0%	0		0	
Total	102	100%	6 (5.8%)		11(11.1%)	
Mechanism of TBI						
RTA	70	68.6%	4(5.7%)		7 (10%)	0.622
Bicycle accident	32	31.3%				
Motor-cycle	26	25.5%				
MVA	12	11.8%				
Fall accident	16	15.7%	2(12.5%)	0.735	2 (12.5%)	
Assault	12	11.8%	1(16.7%)		2 (16.7%)	
Occupational	4	3.9%	0		0	
Total	102	100%	7(6.8%)		11(11.1%)	
Status of the victim during RTA						
Driver	37	36.3%	3 (8.1%)	0.583	3 (8.1%)	0.752
Passenger	10	9.8%	0		1(10%)	
Pedestrian	23	22.5%	1 (4.3%)		3 (13%)	
Total	70	100%	4 (3.9%)		7(10%)	

The in-hospital mortality and overall mortality rate at 6 months were 6.8% and 11,1% respectively. The in-hospital mortality and mortality at 6 months were significantly higher in patients with age group between 20-29 years (17.4%) and in patients aged more than 60 years.

There was a non-statistically significant association between outcome and gender, regions, status of the victim, mechanism of injury, status of the victim and time of injury.

Table 7. Clinical characteristics associated with Outcome of TBI patients

Variable	Number	Percentage	In-hospital mortality		Mortality at 6 months	
			number	p value	number	p value
Injury severity						
Severe	16	15.7%	5 (31.2%)	0.000*	9(56.25%)	0.000*
Moderate	19	18.6%	2 (10.5%)		2 (10.5%)	
Mild	67	65.7%	0		0	
Total	102	100%	7 (6.8%)		11	
Pupils shape						
Normal	90	88.2%	3 (3.3%)		5 (5.5%)	
Anisocoric	10	9.8%	2 (20%)		4 (40%)	0.013*
Bilateral midriasis	2	1.9%	2 (100%)	0.000*	2 (100%)	
Total	102	100%	7 (6.8%)		11	
Associated Cranial injuries						
Yes	40	39.2%	3 (7.5%)	0.314	6(15%)	0.534
No	62	60.8%	4 (6.5%)		5 (8%)	
Total	102	100%	7 (6.8%)		11	
Associated Extra-cranial injuries						
Spine	3	14.3%	0		0	
Chest	6	28.6%	0	0.126	0	
Abdomen	2	9.5%	1 (50%)		1 (50%)	0.126
Limbs	10	47.6%	0		0	
Total	21	100%	1 (4.7%)		1	
Time between injury and surgery						
< 6 hours	5	10.9%	1 (20%)	0.085	1 (20%)	
6 to12 hours	10	21.7%	2 (20%)		2(20%)	
12-24 hours	6	13%	0		1(16.7%)	0.642
> 24 hours	25	54.4%	0		1(4%)	
Total	46	100%	3(6.5%)		7 (15.2%)	
Hospital stay						
0 day	7	6.9%	2 (28.5%)	0.136	3(42.8%)	0.004*
1 to 3 days	25	24.5%	1 (4%)		1(4%)	
4 to 7 days	28	27.4%	1 (3.6%)		1(3.6%)	
8 to 14 days	28	27.4%	1 (3.6%)		2(7.2%)	
15 to30 days	12	11.8%	2 (16.7%)		3(25%)	
31 to 56 days	2	1.9%	0		1(50%)	
Total	102	100%	7		11	

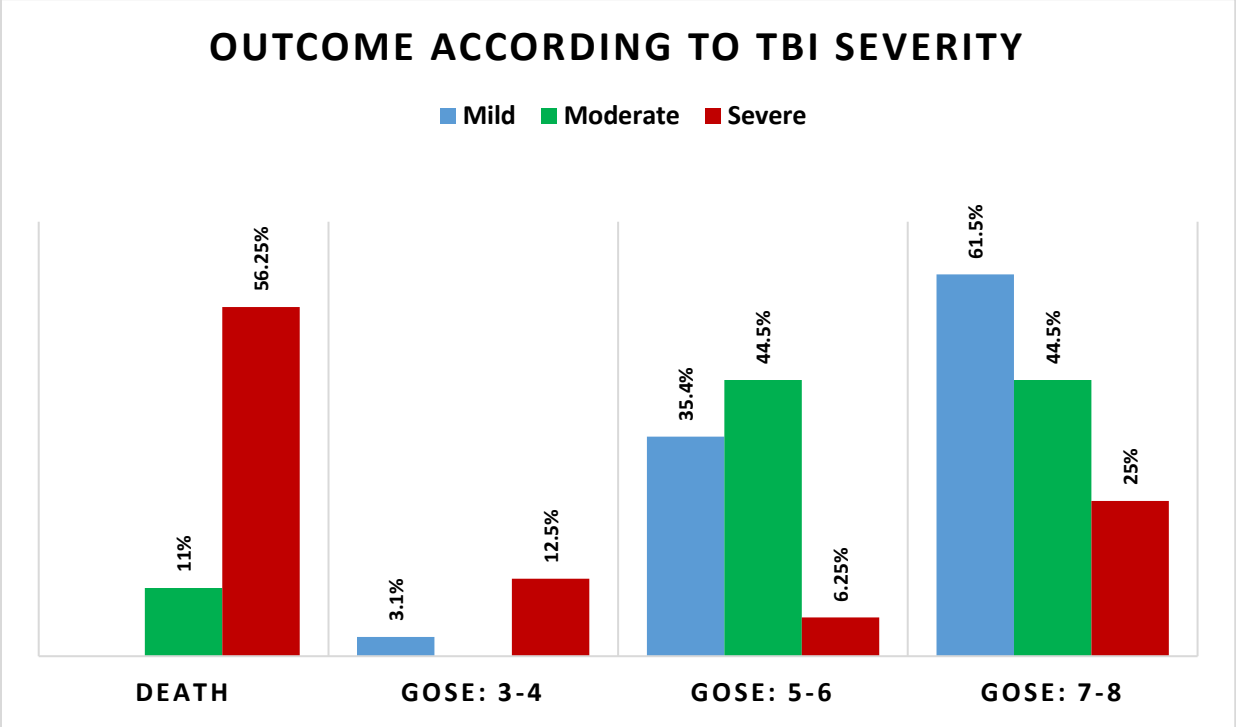
The most common cause of in hospital mortality and mortality at 6 months were the severity of TBI and the pupils' shape. The in-hospital mortality was31.2% among patients with severe TBI and 10.5% among patients with moderate TBI (p value = 0.000).

The distribution of in-hospital mortality showed that mortality was high on the first day of hospitalization (42.8%)and mortality was increasing as the patients stayed in hospital more than 15 days (p value = 0.004).

Table 8. Outcome according to TBI severity

	GOSE						
	GOSE:1	**GOSE:3**	**GOSE:4**	**GOSE:5**	**GOSE:6**	**GOSE:7**	**GOSE:8**
Mild TBI	0%	0%	3(3%)	6(9.2%)	17(26.2%)	18(27.7%)	22(33.9%)
Moderate TBI	2(11.1%)	0%	0%	3(16.7%)	5(27.8%)	4(22.2%)	4(22.2%)
Severe TBI	9(56.25%)	1(6.25%)	1(6.25%)	0%	1(6.25%)	3(18.75%)	1(6.25%)

Graph 8. Outcome according to TBI severity



The overall mortality rate at 6 months was 11.1 of the 102 enrolled patients. Among patients with mild TBI; 61.5% had good recovery, 35.4% had moderate disability. Among patients with moderate TBI; 44.5% had good recovery, 44.5% had moderate disability and 11% died. Among patients with severe TBI; 25% had good recovery, 6.25% had moderate disability, 12.5% had severe disability and 56.25% died (p value=0.000).

V. DISCUSSION

Traumatic Brain injury is one of the most severe types of injury and it is a major cause of disability and mortality of younger people. Accurate description of TBI has always been a challenge due to: great variability to establish clear definition, various inclusion criteria, discrepancies in data collection and different methods used for classification of patients with TBI[1]. This study aims to provide thorough understanding of the characteristics and outcome of TBI in Rwanda.

Of the 318 trauma patients who consulted at four referral hospitals during the study period, 102 patients (32.07%) were treated for TBI. This finding compares to that of JC Allen Ingabire et al. who found a proportion of 35.1% when evaluating 6713 trauma patients at one referral hospital in Rwanda[26].

The largest number of TBI patients were young male patients in their productive years. Majority of patients were male patients (75.5%); the ratio of male to female was 3.1:1 with the highest peak gender difference occurring in young adults during their 30-39 years. This is mostly attributed to the fact that men are more involved in RTA and the latter is the leading cause of TBI.
Our results confirm the findings by Elizabeth Krebs et al where TBI at one referral hospital in Rwanda was considered as a clinical condition of young male with the average age at time of diagnosis ranging between 20 and 40 years old[17]. According to Min Li et al., males are at higher risk to sustain TBI with a gender difference ranging from 1.18:1 to 4.81:1 worldwide, but the ratio approaches parity as the age increases[1].

In our study, Road Traffic Accident was by far the most common cause of TBI (68.6%), followed by falls (15.7%), physical violence (11.8%) and occupational accidents (3.9%). This is explained by the fact that Motor Vehicle Accident is the most common cause of TBI in LMIC due to an increased use of motor vehicles[4,6]. In a single center study done in Rwanda by J. Hitimana, Motor Vehicle crashes were responsible for 70.7% of all head trauma[20].
Of all road traffic accidents, bicycles were involved in 45.7%, motorcycle in 37.2% and motor vehicle with four wheels in 17.1%. We have found a significant association between the status of the victim and the mechanism of injury as during MVA-related TBI; most of the victims were pedestrian in opposition to bicycle accident where most of the victims were drivers.
A detailed analysis showed that the most frequent time to encounter TBI related to RTA was during peak hours of road traffic which coincides when light was poor (twilight), while most of assaults occurred from 20:00’ to 22:59’ (25%).
Various studies have described this pattern of injury in populations with lower socioeconomic background where bicycle is the commonest and economical mode of transport[23,24]. In India, Manisha et al. reported a proportion of 33.3% of bicycle accidents occurring between 15:00 to 21:00[24].
In addition, students, drivers and businessmen were sustaining more of Road Traffic Accidents while jobless were sustaining more off alls (50% of jobless cases) and farmers were more susceptible to Road traffic accidents(51.9%) and assaults (29.6% of farmers).

The distribution all over three severity levels of TBI indicated that TBI was mild in 65.7% patients, moderate in 18.6% patients and severe in 15.7% patients. The majority of lesions found

on CT scan were epidural hematoma (25, 24.5%), brain contusion (24, 23.5%) and acute subdural hematoma (12, 11.7%).
This is similar to what Respicious et al has found at Muhimbiri hospital in Tanzania where majority (64%) of TBI patients sustained mild TBI, 18.2% moderate TBI and 17.8% severe TBI[18]. This was not similar to what Hitimana et al. has found at CHUB where 47% of all head injury patients had mild TBI, 9% had moderate TBI and 28% had severe TBI[20].

The time intervals from injury to diagnosis and from injury to surgery were subdivided into four categories: < 6 hours, between 6 and 12 hours, between 12 and 24 hours and > 24 hours. Patients from North and Western province were likely to have a delayed access to neurosurgical management compared to patient from the city of Kigali; our findings reflect limitations of referral which restrict quicker neurosurgical care delivery. In our study we have found that 10% of severe TBI, 45.6% of moderate TBI and 76% of TBI had their surgery performed after 24 hours. This delay was too long and needs to be addressed to meet current evidence-based recommendations of timely access to care for patients with TBI to prevent secondary injury and improve outcome[22].
The mean duration of hospital stay was 8 days which was similar to what observed in Guinea-Conakry[25]. The length of hospitalization was above 8 days for 62.6% of patient with severe TBI, 52.6% of patients with moderate TBI and 32.8% of patients with mild TBI. This was in part due to the fact that TBI resulted in longer acute care and rehabilitation as it was severe.

One particular aim of this study was to establish the outcome of patients with TBI in Rwanda. The overall in-hospital mortality and mortality at six months were 6.8% and 11.1% of the 99 respondents out of 102 enrolled patients respectively. We have found a statistically significant association between the outcome of patient with TBI and the patient's age; the in-hospital mortality was significantly higher in patients with age group between 20-29 years (17.4%) and 70-79 years (100%). Also, there was an association between the length of hospital stay and mortality rate as the mortality rate was significantly lower in patients who stayed in the hospital between 1 day and 14 days. Similarly, Kézély Béavogui et al. have reported this significant relationship between prolonged hospital stay and in-hospital mortality[25].
Most importantly, we have found that TBI severity correlated with an increased disability and death. Among patients with mild TBI; 61.5% had good recovery, 35.4% had moderate disability. Among patients with moderate TBI; 44.5% had good recovery, 44.5% had moderate disability and 11% died. Among patients with severe TBI; 25% had good recovery, 6.25% had moderate disability, 12.5% had severe disability and 56.25% died (p value: 0.000). Similarly, Krebs et al reported death rate of 56.1% for patients sustaining severe TBI at one referral hospital in Rwanda.

Despite some limitations, this is the only multicenter TBI study that extensively explored the profile and outcome of TBI in Rwanda. We provided resourceful knowledge about TBI in Rwanda which can be useful as prevention strategies.

VI. CONCLUSION

The study enrolled 102 patients identified as having TBI at four referral hospital in Rwanda. The largest numbers of TBI patients were young male patients in their productive years. Road traffic accident was responsible of TBI for 70% of all TBI. Two wheels' transportation was by far the leading mechanism of injury accounting for 82.8% off all road traffic crashes. Majority of patients sustained mild TBI (65.7%), moderate TBI (18.6%) and severe TBI (15.7%). The severity of TBI was an important determinant of length of hospitalization. Delayed presentation is responsible for delayed surgical care in affected patients and lead to worse outcome. The overall mortality rate was 11.1%. In addition, mortality increased significantly with severe TBI (56.25%).

Stricter regulations of transportations and quicker access to neurosurgical care are of paramount significance to address the burden of TBI in Rwanda.

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VIII. APPENDICES

Data collection sheet: … Identification number (of the study) …/…… Date of enrollment…/…/……

N	VARIABLE NAME	CODES/RESPONSE	DIRECTIVES
	I. Demographic data		
1.1	Identification number (of the study)	…/……	Site's number/ patient's number
1.2	Age	…(years)	
1.4	Gender	0. Female 1. Male	
1.5	Profession	……	In words
1.6	District where injury occurred	1. Nyarugenge 2. Gasabo 3. Kicukiro 4. Bugesera 5. Burera 6. Gakenke 7. Gatsibo 8. Gicumbi 9. Gisagara 10. Huye 11. Kamonyi 12. Karongi 13. Kayonza 14. Kirehe 15. Muhanga 16. Musanze 17. Ngoma 18. Ngororero 19. Nyabihu 20. Nyagatare 21. Nyamagabe 22. Nyamasheke 23. Nyanza 24. Nyaruguru 25. Rubavu 26. Ruhango 27. Rulindo 28. Rusizi 29. Rutsiro 30. Rwamagana	Circle the number
1.7	When injury occurred	…/…/…… at … **:** …	Date and Time

1.8	Contact (telephone number)	……	Patient/caretaker
II. Pre-hospital data			
2.1	Time spent from injury to first consult	……(hours)	
2.2	Time spent at referring facility	……(hours)	
2.3.0	Mechanism of injury	1. MVA 2. MCA 3. Bicycle accident 4. Fall 5. Assault 6. Occupational	
2.3.1	If Motor vehicle accident	1. Driver 2. Passenger 3. Pedestrian	
2.3.2	If Motor cycle accident	1. Driver 2. Passenger 3. Pedestrian	
2.3.3	If Bicycle accident	1. Driver 2. Passenger 3. Pedestrian	
2.4	Mode of transport	1. SAMU 2. Ambulance 3. Private transport	
2.5	Primary survey and stabilization	0. documented 1. not documented	Look on referral note
III. Initial management			
3.1	Clinical presentation	1. Altered mental status 2. Dizziness 3. Seizures 4. Headaches 5. Vomiting 6. Blurred vision 7. Disturbed speech 8. Sided weakness 9. Sensory deficit 10. Cranial nerves deficit 11. CSF leak 12. Wounds 13. Other	Circle all that apply
3.2	Vital signs		
3.2.1	Blood pressure	…/…mmHg	
3.2.2	Heart rate	… beats per minute	
3.2.3	Respiratory rate	… breath per minutes	
3.2.4	Saturation of peripheral Oxygen	… %	

3.3	Laboratory		
3.3.1	Hemoglobin	… g/dl	
3.3.2	Platelet	……	
3.3.3	INR	……	If done
3.4	GCS	…	In number
3.5	ETT	0. YES 1. NO	
3.5	Pupils size	Right: … mm Left: …mm	Number
	Pupils shape	1. Normal bilaterally 2. Anisocoria 3. Midriasis bilaterally	Circle one
3.6	Pupils reaction	Right: 1. normal, 2. abnormal, 3. no reaction	Circle one
		Left: 1. normal, 2. abnormal, 3. no reaction	Circle one
3.9	CT scan findings	1. Normal CT scan 2. EDH 3. ASDH 4. TICH 5. Contusion 6. TSAH 7. IVH 8. DAI 9. Diffuse brain swelling 10. Other	Circle all that apply
3.10	Associated cranial injuries	0. NO 1. YES (If yes which): 1. Scalp laceration 2. Vault Skull fracture 3. Skull base fracture 4. Maxillo-facial injury 5. Other	Circle one Circle all that apply
3.11	Associated extra-cranial injuries	0. NO 1. YES: (If yes which): 1. Spine 2. Chest	Circle one Circle all that

		3. Abdomen 4. Limbs 5. Other	apply
3.12	Time spent from injury to arrival at AE		Hours
3.13	Time spent from arrival to diagnosis		Hours
3.14	Time spent from injury to diagnosis		Hours
	IV. Treatment given		
4.1	Supportive care only		
4.2	Medical management	0. NO 1. YES (If yes which) 1. Oxygenotherapy 2. Analgesia 3. Mannitol 4. Lasix 5. Mannitol+ Lasix 6. Anticonvulsants 7. Sedation 8. Other	Circle one Circle all that apply
4.3	Surgical management	NO YES	
4.4	Time spent from diagnosis to surgery	… hours	
4.5	Time spent from injury to surgery	…hours	
4.6	Type of surgical procedure	1. Burr hole 2. Craniotomy and evacuation 3. Decompressive craniectomy 4. Bone elevation 5. EVD 6. Skull base repair 7. Debridement and repair	Circle all that apply
	V. Post definitive management data		
5.1	Sent back immediately to referring facility	0. NO 1. YES	
5.2	Admission	1. Ward 2. ICU 3. Stayed at AE	Circle all that apply
5.3	ICU stay	… days	
5.4	Hospital stay	… days	
5.5	In hospital outcome	1. Death 2. Discharged	
5.6	Where the patient was discharged	1. Home	

		2. Rehabilitation facility	
5.7	Cranioplasty	0. NO 1. YES	
5.8	When cranioplasty done	… days	
5.9	GOSE (at 6 months)	1. Death 2. Vegetative state 3. Severe disability lower 4. Severe disability upper 5. Moderate disability lower 6. Moderate disability upper 7. Good recovery lower 8. Good recovery upper	Circle one

PROFILE AND OUTCOME OF PATIENTS WITH TRAUMATIC BRAIN INJURY IN RWANDA

Informed Agreement
Amasezerano yo kwemera kujya mu bushakashatsi

I, …… agree to participate in the study described above
Jyewe, ……... nemeye kujya mu ubushakashatsi bwavuzwe haruguru.

I am aware that participation in the study is voluntary and I will not be paid for the participation. In addition, all information provided will be treated with confidentiality and that my anonymity will be maintained.Nasobanuriwe ko kujya muri ubu bushakashatsi ari ubushake bwanjye, ko ntagihembo ntegereje guhabwa, kandi ko nzagirirwa ibanga kugiti cyanjye ndetse n'amakuru yose nzatanga.

I am aware that the result of this study may be published but I will not be identified as anindividual. I reserve the right to withdraw from the study at any time if I so wish.
Nasobanuriwe ko ibizava muri ubu bushakashatsi bizatangazwa ariko ko ntazerekanwa nk'umuntu ku giti cye. Mfite uburenganzira bwo kuva muri ubu bushakashatsi igihe cyose nabishakira.

…….. …… …….
Name of participant Signature of participant Date
Amazina n'umukono by'uwasobanuriwe Icyo apfana n'umurwayi Italiki

……. …….. …….
Name of researcher Signature of researcher Date
Amazinay'umushakashatsi Umukonow'umushakashatsi Italiki

PROFILE AND OUTCOME OF PATIENT WITH TRAUMATIC BRAIN INJURY IN RWANDA

ASSENT Agreement:
(for children aged 12 to 20 years)
Amasezerano yo kwemera kujya mu bushakashatsi
(y'abana bari mu kigero cy'imyaka 12-17)

I, …… agree to participate in the study described above.

Jyewe, ……..nemeye kwitabira ubu bushakashatsi bwavuzwe haruguru.

If you decide that you want to be part of this study, you will be asked by a clinician to answer some questions related to the study.

Niwemera kwitabira ubu bushakashatsi, umuganga azagira ibibazo akubaza bijyanye n'ubu bushakashatsi.

You can ask questions any time, now or later. You can talk to the doctors, your family or someone else. You do not have to be in this study. No one will be mad at you if you don't want to do this. We will also ask your parents if they would like you to be in the study. Even if you say yes now, you can change your mind later.

Ushobora kubaza ikibazo igihe cyose. Ushobora kubaza abaganga cyangwa umuryango wawe, cyangwa undi muntu uwo ariwe wese. Ntabwo ari itegeko kwitabira ubu bushakashatsi. Ntawe uzakurakarira mu gihe utabwitabiriye. Tuzabaza n'ababyeyi bawe niba bemera ko witabira ubu bushakashatsi. Nubwo wakwemera kwitabira muri uyu mwanya ,wemerewe kuva muri ubu bushakashatsi igihe cyose ushakiye.

When we will finish with this study, we will write a report about what was learnt. This report will not include your name or that you were in the study.

Nidusoza ubu bushakashatsi, tuzatangaza ibyavuyemo ariko izina ryawe ntaho rizagaragara.

ASSENT / KWEMERA

I want to take part in this study. I know I can change my mind at any time.

Nemeye kwitabira ubu bushakashatsi. Nshobora kuva mu bushakashatsi igihe cyose nabishakira.

Verbal assent given: Yes,**Date**: … /… /……
Kwemera mu magambo: Yego Italiki: …. / …. / …….

Name and Signature of the child: _____ Date: _____
Izina n'Umukono w'umwana Itariki

I confirm that I have explained the study to the participant to the extent compatible with the participant understands, and that the participant has agreed to be in the study.

Ndemeza ko nsobanuriye uwitabiriye ubu bushakashatsi kurwego abisobanukirwa bituma yemera kwitabira.

Name and Signature of Investigator: _____Date: _____
Izina n'imukono w'uhagarariye ubushakashatsi Itariki
Name and Signature of Tutor: _____Date: _____
Izina n'umukono w'uhagarariye umwana Itariki

(I may receive a copy of this form for my records)
(Nshobora kubona kopi y'iyi nyandiko nkayibikira)