A PROSPECTIVE STUDY OF FACTORS THAT INFLUENCE EARLY OUTCOME OF SEVERE TRAUMATIC BRAIN INJURY IN DIFFERENT AGE GROUPS AT THE KENYATTA NATIONAL HOSPITAL

A THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE DEGREE OF MASTER OF MEDICINE IN GENERAL SURGERY AT THE UNIVERSITY OF NAIROBI

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DECLARATION

INVESTIGATOR

I, Dr. Wafula Grace Taka, do hereby declare that this is my original work, and further, that I have not presented the same for the award of any other degree or to any other university.

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Date: .... 20TH   OCTOBER, 2010 ....

UNIVERSITY SUPERVISOR

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DEDICATION

To my dear parents, Francis and Felistas, my sisters Julie, Vicky, Betty, Anna and brothers, Godfrey and Paul without whose love, prayers and encouragement, I would not have come this far.

ACKNOWLEDGEMENT

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LIST OF ABBREVIATIONS/ACRONYMS

CT SCAN   COMPUTERISED TOMOGRAPHY SCAN

EDH   EXTADURAL HAEMATOMA

GCS   GLASGOW COMA SCALE

ICU   INTENSIVE CARE UNIT

ICH   INTRACEREBRAL HAEMORRHAGE

IVH   INTRAVENTRICULAR BLEED

KNH   KENYATTA NATIONAL HOSPITAL

RTA   ROAD TRAFFIC ACCIDENT

SDH   SUBDURAL HAEMATOMA

SAH   SUB ARACHNOID HAEMORRHAGE

STBI   SEVERE TRAUMATIC BRAIN INJURY

SUMMARY

Four factors influencing short term outcome of sixty seven patients with severe head injury managed at the Kenyatta National Hospital during the months of October and November 2009 were analyzed. These were patients with a Glasgow Coma Scale Score (GCS) of 3 to 8 whose outcome was reviewed after seventy two hours. Of the total number of patients in the study, 67% were adults and 33% were children. On admission majority of patients in this study were between 24-34 years (22.4%) and the least number of patients was seen in the 57 years and above at 3%. The 3-5 year age group was the commonest in pediatric age group at 11.9%. Poor outcome was seen in extremities of age, 87.5% in children between 3-5 years as well as with increasing age with 100% poor outcome in patients who were 57 years and above. The most frequent Glasgow Coma Scale Score (GCS) was of 3 (34.3%) while the least frequent score was 8 (4.5%).16 children had a GCS score of 6-8 compared to 25 adults while 6 children had a GCS Score of 3-5 compared to 20 of the adults. Patients with a GCS score of 3-5 had poorer outcomes compared to those with GCS Score of 6-8.Children had fewer poorer outcomes compared to adults with similar GCS Scores. The prognosis in three groups of intracranial pathologies due to head injury was assessed. Brain oedema was the commonest CT scan finding (55.2%) both in children and adults while contusion was the least(10.5%).41% of patients with brain oedema had poor outcome. Most patients had abnormal pupillary reactions to light (82%) and the most frequent abnormal pupillary reaction was dilated unresponsive pupils at 58.2%.Poor outcome with dilated unresponsive pupils was seen in 52.2% of the total number of patients. Overall poor outcome fifty four subjects (80.6%) compared to thirteen (19.4%) who had good outcome. 22.4% of pediatric subjects had poor outcome compared to 58.2% of the adult. From this study, the Glasgow Coma Scale score and pupillary reaction to light were found to significantly correlate to outcome with low GCS score value and abnormal pupillary reaction predicting poor outcome. Age and CT Scan features were associated with outcome but were not found to be statistically significant.

INTRODUCTION

Severe Traumatic head injury (STBI) is among the leading causes of admission in hospitals worldwide. It is associated with significant morbidity and mortality. [1][2] According to World Health Organization (WHO) STBI accounts for about 10% of all traumatic head injuries. [3] Similar findings have been reported in the United States of America.[4] Locally STBI also accounts for up to 10% of all pediatric and adult head trauma admissions at Kenyatta National Hospital. It has been associated with a mortality of up to 52.6% in adults, 1% in children and a morbidity of about 13%.[5][6]

The clinical spectrum and major causes of head injury are diverse and varied. In our set up 50% of the pediatric cases of head injury fall from a height and 42% are as a result of Road Traffic Accident (RTA) whereas in the adults RTA accounts for 55%,assault 30% and fall from a height only 7%.[5][6][7].Compared to the developed world, falls account for approximately 35% and RTA 24% in children whereas in adults 39% are firearm related injuries, 34% RTA and 10% falls.[8]9][10].

Several prognostic indicators of severe brain injury have been reported. Some of these include: age, Glasgow coma scale (GCS) score, abnormal CT scan findings, pupillary size and light reactivity. Other factors such as severity of injury, spine injuries, hypotension, hypoxia, and electrolyte imbalance and poly trauma also influence outcome. [7][11-18]

Several studies have been done to find out how some of the above factors influence outcome across different age groups. Leursen et al showed that age has a significant prognostic value in determining outcome.[19] Smoller et al found that the predictability of outcome by GCS score as derived from adults population cannot be applied to the pediatric population as outcome of pediatric cases with similar neurological function is considerably better than that of adults with the same GCS level.[20]However a study by Johnson et al showed that age is not an important prognostic factor compared to the cause of the injury.[21] A study by Facco et al showed light reflex as having the best prognostic value in adults whereas in children it was oculocephalic reflex.[22] Wagstyl et al showed that pupillary reflex alone was inaccurate in predicting

outcome .[23] Sandeep et al showed that pupillary reactivity ,GCS and respiration are significant predictors.[24] Gemma et al stated that initial abnormal findings on the CT scan was related to outcome in children whereas Shibu et al stated that an early CT scan did not have a significant prognostic value.[25][26] Diffuse brain injury is common in children and its presence point to poor prognosis whereas in adults, acute subdural hematoma has been associated with poor outcome.[27-29] Local studies by Mwangi J showed GCS score, pupillary changes, CT scan findings ,sex, age, cause of injury and severity of the injury influence outcome in children whereas Kiboi J showed the systolic blood pressure, age, pupillary reaction and GCS score and not sex or CT scan findings predicted outcome in adults.[5][6]

Based on this background of scarcity of prospective studies involving this topic as well as varied findings in previously done studies that I undertake to do this research. The aim of this study is to describe some of the factors that influence early outcome of STBI in children and in adults at KNH and to evaluate whether these factors have different values in children and in adults. The main variables being studied are Age, GCS score, reactivity of the pupils and abnormal CT scan findings whereas the outcome measure will be based on Glasgow outcome scale (GOS).

LITERATURE REVIEW

Children are known to have a lower mortality and better quality of recovery than adults after brain injury. Despite severe injury and prolonged coma after head injury, majority of children generally do well. [6][19][20] The type of intracranial lesion is also an age dependent factor. The occurrence of subdural hematoma is higher in adults compared to diffuse brain edema which is more common in children. [19][27-29] The symptoms, pathophysiology and outcome of head injury in pediatric age group is also different from that seen in the adult population. This is because of the thin elastic skull in children which is capable of greater deformity before fracturing, a larger head in proportion to body surface area hence a larger proportion of total blood volume in the head. The brain of a child has a water content of about 88% compared to that of the adult which is 77%. This makes the pediatric brain softer hence more susceptible to acceleration-deceleration injury. The water content is also inversely proportional to myelination process and this makes the pediatric brain more susceptible to shear injuries with rapid and intense physiologic reactions but of a shorter duration. Infants have open sutures and fontanelles while the subarachnoid spaces and brain extracellular spaces are larger. This allows for quicker edema formation but at the same time allows for tolerance to increased intracranial pressures. In general children have quicker functional and anatomic recovery compared to adults. Due to the previously discussed pathology, unique features may be seen in children such as diffuse brain swelling and low incidence of parenchyma lesions. A combination of primary injuries depending on the degree and mechanism of injury can occur after a traumatic brain injury for example, contusion, intracranial hemorrhage, subdural hemorrhage, extradural hemorrhage, subarachnoid hemorrhage, intraventricular hemorrhage, diffuse axonal injuries among others. The most common lesion in children is diffuse generalized brain oedema with compression of lateral and third ventricles and perimesencephalic cisterns. [7][18][30-36] Some studies have shown that surgically treatable lesions are uncommon in pediatric age group with classic surgical lesions present in less than 10% in some series .[37-39] Non focal subarachnoid or subdural hemorrhage seen in the posterior portion of the interhemispheric fissure and occasionally over the tentorium is a common finding in the battered child. Small focal hemorrhages within brain parenchyma

represent shearing injury to axons and associated blood vessels. This finding is associated with a poorer prognosis. [40][41]

Various studies have been done to determine some of the factors that predict the outcome of STBI. A study done by Leurssen et al compared patients under 14 years to those above 14 years for mechanism of injury, admission GCS score, pupillary reactivity, blood pressure and presence of subdural or epidural hematoma with posttraumatic mortality. This study showed that mortality increased from 28.8% in pediatric patients with severe head injury to 47.7% in adults, 1.4% in children compared to 6.8% in adults in moderate head injury and 0% in children with mild head injury compared to 0.9% in adults. However all patients who were severely hypotensive and those with subdural hematoma had almost similar mortality rates. Among children, those less than 2 years had the highest mortality with 12 years being the age with minimum mortality. [19]

Smoller et al who studied factors affecting short term outcomes of head trauma patients found that the motor component of GCS was the most important predictor of short term outcome. They also noted that increasing age, pupillary unreactivity and lower GCS score increased mortality. They further found out that the predictability of outcome by GCS score derived from adult patients cannot be applied to the pediatric age group. This is because pediatric cases with similar GCS score were found to have better outcome than adult population. [20]

A study done by Johnson et al compared outcome between severely head injured children and adults where outcome was defined by mortality. The overall mortality was 36.5% for children (patients under 18 years) and 47.6 % for adults. However for patients involved in RTA, mortality for children 3 to 11 years was 35%, 12 to18 years 31.4% and adults 32.5%.Hence from this study, children involved in RTA are just as well likely to die from severe head injury as adult patients.[21] This is supported by another study done in Washington University School of Medicine to understand the relationship between age and clinical outcome in patients over 15 years old which showed that older patients had overall higher mortality but vegetative survival did not show a trend related to age. GCS score did not significantly differ with age; however injury mechanism was related to age. The findings of this study failed to eliminate the age of the patient as an independent predictor of outcome. According to this study the effect of age on

outcome following head trauma is dependent upon an alteration in the pathophysiological response of the aging of the central nervous system to severe trauma and not an increased incidence of other clinical parameters. [42]

An Italian study compared children between ages of 3 and 14 years to adults in the range of 15 to 60 years by assessing presence or absence of pupillary response, GCS Score, oculocephalic reflex, presence of associated injuries and abnormal posturing on admission. Outcome was measured using GOS. The outcome was poor in 51% of children compared to 61% of adults. Oculocephalic and light reflexes, posturing, need for ventilatory support and GCS score significantly related to outcome in children whereas oculocephalic and light reflexes and posturing significantly related to outcome in adults. Simultaneous evaluation of oculocephalic reflex and need of ventilatory support was the best prognostic guide in children while the light reflex was the best prognostic indicator for adults. [22] A retrospective study which studied early prediction of outcome following head injury in children less than 15 years by Wagstyl et al also showed GCS score was sensitive as a predictor of outcome by 88% in the first 24 hours with a GCS of 5 and above having a 93% chance of good recovery. Abnormal plantar and pupillary reflex were shown to predicted poor outcome with a sensitivity of up to 99% in combination but on their own, the predictive value was inaccurate. [23]Another study "Early prediction of outcome following head injury in children: an assessment of the value of GCS score and abnormal planter and pupillary light reflex" by Grewal et al in Birmingham Accident Hospital studied 95 children under the age of 15 for 72 hours. GCS score trend or reflexes used alone showed significant correlation to outcome which was categorized as death or survival with neurological deficits. There was a statistical significant correlation when the above variables were used in combination. However the clinical value of combined GCS score and reflexes was just slightly greater than when GCS score was used alone. [43]

A prospective study done by Sandeep et al looked into early prediction of outcome in very severe head injury (GCS of 5 and below) in children using serial GCS after admission for 24 hours showed 76.5% of the patients died while 23.5% survived. Children with an improvement of GCS by two points in twenty four hours, those with spontaneous respiration and brisk pupillary reaction had better survival chances. The combination of the above increased survival rate from

6.1% to 57.1%. Age or gender were not found to be significant prognostic factors.[24] This study contrasts with the one done by Mwangi J in relation to age and gender, as predictors of outcome but compares to the one by Kiboi J who did not find gender as an important prognostic factor.[6][7]

A retrospective study to determine predictors of outcome in pediatric intensive care unit King Fahad Hofuf Hospital by Kamal et al studied one hundred and six children aged under twelve years with severe head injury admitted between January 2004 and December 2005.The dependent factors were pathological types of brain injury, age, sex, GCS and CT scan brain done within three hours of admission, other body trauma, initial hypotension, liver enzymes and serum albumin .The independent factors were death, survival with or without neurological deficits .The average time of observation was seventy six hours. The conclusion from this study was that GCS score, brain CT scan findings, combined pathology, hypotension, high liver enzymes and low serum albumin predicted outcome after TBI. Intracranial edema was the most common finding on deaths and survivors with neurological deficits followed by intracranial contusion and subdural hematoma. Combined brain pathologies also had a higher mortality and morbidity rates. The most important risk factors for deaths and neurological deficits were combined brain pathologies and GCS less or equal to 8.The risk increased when other risk factors were added. GCS of 12 and above predicted survival with no neurological deficits. [44]

Another retrospective study done in Children's Medical Centre ,Washington DC where predictors of outcome were studied in severely injured children under 17 years during the first 72 hours of hospitalization between 1991 and 1995 where dependent variables were age, GCS score, CT scan evidence of brain injury, physiological variables, gender, and neurorescuscitative medication and outcome was survival with secondary end points as stay in PICU, loss of consciousness, death, and day when GCS was 14 or above. The results were that GCS score determined outcome, other predictor were severity of injury and systolic blood pressure. CT scan findings and age were not found to be significant predictors of outcome in this study. [45] A Nigerian study done retrospectively between 1989 and 1999 where causes, outcome and outcome predictors were studied in children under the age of 16 years found that age and coma scale predicted outcome. [46]

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A study by Young et al "Early predictors of outcome in head injured patient" showed 95% of patients with a GCS score of 7 and above on admission showed favorable outcome one year later, 80% of patients whose GCS score improved to above 7 had favorable outcomes too while only 12% whose GCS persisted between 5 and 7 for one week showed favorable outcome .A midline shift of less than 4.1mm on initial CT Scan was associated with a better prognosis than a bigger shift. There was no significant difference between GCS score trend only versus GCS score and CT scan finding of a midline shift, however a combination of GCS score and midline shift at 72 hours gave a more accurate indicator of outcome.[47]An eight year retrospective study done in Barcelona studied CT scan findings as a prognostic factor where 156 patients aged below 18 years between January1995 and December 2003 showed that initial GCS score was related to CT scan findings and that CT scan findings were useful in predicting outcome.[25] However another retrospective study done in India which studied the short term outcomes of 74 children with diffuse brain injury showed an early or single CT scan did not have any prognostic value in the said brain injury, however GCS score and oculocephalic reflex were important prognostic factors with a sensitivity and specificity of 79% and 65 % respectively of correctly predicting unfavorable outcome. This study however only studied one type of lesion of brain pathology.[26] Another study done in Estonia to study the correlation of CT scan finding with clinical state, early and late in children and adolescent with head injury, showed shearing injury, intracerebral and subdural hematoma combined with brain damage and parenchymal injury were poor prognostic factors.[48] In a study done by Quattrochi et al poor outcome was seen in midline shifts(50%) as compared to no shift,(14%) the worst being a midline shift without intracranial hemorrhage. This is supported by a study that was done by Lobato et al. [49] [50]

Locally, a study done by Kiboi J in 1999 of severely brain injured patients at KNH, age, GCS score, systolic blood pressure and pupillary reaction were found to predict outcome. GCS Score was the most significant predictor of outcome followed by pupillary reaction. Highest mortality was seen in patients with large non reacting pupil and the motor component of GCS was the most significant predictor of outcome in the GCS scale. Patients below the age of 13 years had better outcome that those above 13 years. This compares with that of Mamelak et al. [6] [51]

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A follow up study done by Mwangi J in 2002, looked into the pattern and early outcome of pediatric craniocerebral injury in children whereby outcome measures were GCS score at 8 and 24 hours and GOS on discharge. Initial GCS and that at 24 hours strongly correlated to outcome: better outcomes were seen in GCS score of above 13,whereas injury grade, lower GCS score, pupillary signs, focal neurological signs, compression of basal cisterns on the initial CT Scan, evidence of intracebral bleed ,pedestrian RTA victims and surgery were associated with poorer outcome at 24 hours.[5]

In general however patients with isolated head trauma do well than those with multiple injuries. Infants with brain lesions generally fare worse than older children .The intact survivors do well but often have minor physical and neural and behavioral deficits which require skilled evaluation and therapy. It is clear that prevention of injury is the surest way of reducing the problems associated with head trauma. In the event that this fails, then careful care provides at the earliest contact of each patient is the best chance for good recovery. [6][52][53]

Based on all the studies mentioned above, there is not yet good data to predict accurately early clinical outcome of an individual head injured patient using CT scan findings, Age, Pupillary reactions and size and GCS score across different age groups because of scarcity of such studies. The ones that are published have conflicting findings and most of them have varied definition of pediatric and adult age groups as well as the time that outcome were measured. This study will describe some of the factors which might predict early outcome namely Age, Pupillary reaction to light, GCS score and abnormal CT scan findings on admission whereas the outcome will be based on GOS done after 72 hours. Data which will be collected using questionnaires and patient data sheets. This will be presented in tables, prose, graphs, pie charts and will be analyzed using descriptive statistics to display the characteristics of the patient sample, correlation statistics and Chi square tests to generate association between independent and dependent variables. Discussion will be done in prose and conclusion and recommendations drawn from the discussion .The study will be conducted according to the ethical regulations of KNH.

JUSTIFICATION OF THE STUDY

Severe Traumatic Brain Injury is among the leading causes of morbidity and mortality following head injury. It accounts for 10% of all head injuries that are seen at KNH. It is associated with morbidity of 13.9% and mortality of 1% in the pediatric age group whereas in adult age group the mortality goes up to 56.2%. [5][6] A lot of hospital resources in form of bed occupancy in the wards and ICU go into the management of patients with STBI. The effects of STBI presents a major social ,economic, emotional and health problems in relation to long hospital stay, permanent neurological disability, long term need for rehabilitation facilities, complications associated with long hospital stay straining the available resources, loss of earning power and death. It also leads to anxiety of the patients' relatives regarding possible outcomes. There is therefore need for early identification of patients who will either have long term disability or those who will subsequently die for appropriate counseling of close relatives. For the clinicians it will help identifying patients at risk for a more focused approach to management as well set up a platform for further studies.

OBJECTIVES

MAIN OBJECTIVE

To study the factors that influence early outcome of severe traumatic brain injury
And compare these factors and outcome in different age groups at the Kenyatta
National Hospital.

SPECIFIC OBJECTIVES

1. To correlate Age, pupillary size and reaction to light, abnormal CT scan findings and Glasgow Coma Scale score to Glasgow Outcome scale in the pediatric patients with severe traumatic brain injury at the Kenyatta National Hospital.

2. To correlate Age, pupillary size and reaction to light, abnormal CT scan findings and Glasgow Coma Scale score to Glasgow Outcome Scale in the adult patients with severe traumatic brain injury at the Kenyatta National Hospital.

3. To compare how Age, Pupillary size and reaction to light, abnormal CT scan findings and Glasgow coma scale Score affect outcome based on Glasgow Outcome Scale in the different age groups with severe traumatic brain injury at the Kenyatta National Hospital .

HYPOTHESIS

Age, Pupillary reactivity to light, Abnormal CT Scan findings and Glasgow Coma Scale score have the same influence on outcome in the different age groups with severe traumatic brain injury.

MATERIALS AND METHODOLOGY

STUDY DESIGN:

Prospective descriptive study for a period of eight weeks.

SUBJECTS

Patients between 3 and 65years admitted with severe head injury based on GCS of 8 and below who were be followed up for a period of 72 hours and outcome measured by GOS after 72 hours.

VARIABLES DEFINATION

The **independent variables** are:

1. AGE

The range was between 3 and 65 years.
At the Kenyatta National Hospital the pediatric age group is children who are 12 years and below whereas adult patients are considered those who are 13 years and above.
Based on the previous studies done on this topic locally and some of the studies abroad, the pediatric age group was divided into three, that is, 3-5, 6-8 and 9-12 years, and the adult age group into 13-23,24-34,35-45,46-56,57 & above years.[5,6]
Children less than 3 years were not included in this study because GCS is not suitable for their evaluation owing to their different degree of higher integrative function. [22]

2. ABNORMAL CT SCAN FINDINGS

These included diffuse brain oedema; intracranial bleeding which include subdural hematoma, extradural hematoma, intraventricular bleed and contusion.

3. PUPILLARY REACTION TO LIGHT

Pupillary reaction to light was recorded as brisk which is expected normal reaction, sluggish reaction or no reaction. This compares to the studies quoted in the literature review.

4. GCS SCORE

The patients in this study had a GCS Score between 3 and 8 on admission to the hospital. This is because severe brain injury is defined by GCS Score of 8 and below. The lowest GCS score is 3.This was categorized into two, 3-5 and 6-8. [5,6,21,24,44]

Outcome measures

The main outcome was measured by the Glasgow outcome scale (GOS) after 72 hours from admission. This is a five-point GOS score which is categorized as follows:

1. DEATH

2. PERSISTENT VEGETATIVE STATE (unresponsive and speechless)

3. SEVERE DISABILITY (conscious but disabled)

4. MODERATE DISABILITY (disabled but independent)

- Dysphasia
- hemiparesis
- ataxia
- memory deficits,
- personality changes
- Intellectual deficits.

5. GOOD RECOVERY

This is resumption to normal life even though there may be minor neuropsychological deficits.

Based on previous studies, the outcome was categorized into 2, that is, poor outcome which included vegetative state and death and good outcome included severe disability, moderate disability and good recovery. This is because it has been shown that most patients with severe disability ultimately improve to moderate or good recovery at 6 months follow- up. [5, 6, 22, 42, 44, 53]

STUDY AREA

The study was conducted at the Kenyatta National Hospital which is the largest teaching and referral hospital in Kenya in the following departments:

- Pediatric Surgical unit

- Neurosurgical Unit

- Intensive Care Unit

SAMPLE SIZE

The sample size was calculated based on the two local studies by Kiboi J and Mwangi J and the World Health Organization study in which it was reported that the prevalence of severe traumatic brain injury was 10%.[3,5,6]

Hence:-

$$N=z^2pq/d^2$$

Where:

N =the desired sample size (when population is greater than 10000)

z = standard normal deviation usually set at 1.96 for 95% confidence level

q=1.0-p

p =prevalence (of severe head injury 10%)

d=degree of accuracy desired set at 0.05

Using the above formula:

$$N=z^2pq/d^2$$
$$N=(1.96)^2(0.1)(0.9)/(0.05)^2$$

=138

Preliminary study done between January and June 2009 showed a total number of severely head injured patients admitted at the hospital was110.

Considering the entire population is less than 10000,the final sample estimate (n_f)will be calculated using the following formula:

$n_f=n/1+n/N$

Where,

n_f=the desired sample size when population is less than 10000

n = the desired sample size when population is greater than 10000

N=the estimate of the population size

Hence ;

$n_f = 138/1 + 138/110$

The minimum study sample was 62, however it included 67 patients with STBI.

SAMPLING METHOD

Convenient sampling was used. All patients admitted at the Kenyatta national Hospital with severe head injury who fulfilled the laid out criteria of the study were recruited until the number of the sample size was arrived at.

INCLUSSION CRITERIA

- Patients between ages of 3-65 years old

- Patients with STBI which is defined by a GCS score of 8 and below

- Patients whose guardians gave informed consent to participate in the study

EXCLUSSION CRITERIA

- Patients who presented with traumatic head injury more than 72 hours

- Patients who did not have CT scan and cervical x-ray films

- *Patients whose guardians refused to consent to the study*

- Patients who were more than 66 years and less than 3 years

- Patients who died before arrival to the hospital

- Referral from other hospital who had a form of intervention like intravenous fluid therapy or and oxygen administration.

- Patients who had previous neurological problems

- Patients who had cervical spine and spinal cord injuries

- Patients who had been sedated

- Patients who were intoxicated

DATA COLLECTION INSTRUMENTS AND TECHNIQUE

QUESTIONNAIRE

A semi structured questionnaire was administered by the principal researcher and the assistant in a face to face interview and recorded before the clinical examination.
This included;

- the Study number (using numerical format for example 01)

- Hospital number

- Age in years which will be grouped as 3-5, 6- 8,9-12, 13-23,24-34,35-45,46-56,57 & above

- Gender

- History of the injury which will include; cause of injury, time of injury, presenting complaints and treatment given before admission at KNH

- Past medical history which will seek to find out if there have been previous neurological illnesses

- History of alcohol ingestion before injury or drug abuse

CLINICAL EXAMINATION

This was filled out in the patient data sheet. It included:

- Temperature in degree centigrade, pulse rate per minute, blood pressure in mmHg and respiratory rate per minute at admission.

- The severity of head injury using the Glasgow coma scale score on admission. The pediatric patients will be scored using the pediatric GCS (see appendix v and vi)

- Pupillary reaction to light at admission was assessed. Reaction to light will be recorded as brisk which is considered normal, sluggish reaction to light or dilated and no reaction to light for both pupils.

- Outcome scored using the Glasgow outcome scale which is a scale of 1 to 5.This was done after 72 hours from admission. The scale is as follows:

1. DEATH
2. PERSISTENT VEGETATIVE STATE
3. SEVERE DISABILITY
4. MODERATE DISABILITY(
5. GOOD RECOVERY
(see appendix VII for more details)

RADIOLOGICAL EXAMINATION

Pathological types of brain injury on CT scan were assessed. These included:

- Brain oedema
- Brain contusion
- Intracranial hemorrhages which will include subdural hematoma, extradural hematoma, intracerebral hemorrhage, subarachnoid hemorrhage, intraventricular hemorrhage

DATA MANAGEMENT AND ANALYSIS

Questionnaires were kept in a lockable cabinets.

Consent forms were   kept in a separate file from questionnaires in a lockable cabinet

Only the researcher and data manager had access to the information collected

The information was kept in a password protected computer

A statistical analysis was performed using Statistical Package of Social Sciences (SPSS), Inc., for windows version 12 (2003), Chicago, Illinois, U.S.A, on a personal computer to derive descriptive statistics and frequency distributions.

Data was analyzed using descriptive statistics to display the characteristics of the patient sample.

Chi square tests was used to generate bivariate association between independent and dependent variables

Correlation regression was used to show association between independent and dependent factors.

VALIDITY AND RELIABILITY

The principal investigator and the assistant who was a neurosurgery senior house officer were calibrated to calculate inter –examiner reliability of the variables in the study. A repeated examination was done on every 10th subject. Cohen's kappa was used to calculate intra – examiner reliability.80% Kappa score was acceptable.

CONTROL OF BIASES AND ERRORS

Errors in data collection were minimized by standardization of the examination to control intra-examiner errors. This was done using a pilot survey on a few subjects to check for consistency of the examiners. This helped reduce intraexaminer variability. Only the patients who met the inclusion criteria were enrolled in the study. All data collection tools were pre-tested. All instruments used were calibrated.

Only with CT scan done from the radiology department at the Kenyatta National Hospital were used in the study for consistency.

The Glasgow outcome score was done only by the principle investigator 72 hours after admission for consistency.

ETHICAL CONSIDERATIONS

Permission to carry out the study was obtained from the Kenyatta National Hospital Ethical and Research Committee

Data was used for the purpose of the study only

Informed consent was given by the next of kin only. There was an English and Kiswahili version of the next of kin consent.

The information obtained was kept confidential.

LIMITATION OF THE STUDY

- Financial constraints
- Some relatives were unwilling to sign the consent form
- The study was limited to Kenyatta National Hospital so the results may not be entirely representative for the entire Kenyan population.

RESULTS

Sixty seven patients with severe head injury were reviewed during the study period at the Kenyatta National Hospital. Twenty two of them were pediatric while forty five were adult (Figure 1) (Table 1).

TABLE 1.DISTRIBUTION OF PATIENTS BY AGE

Age	Frequency	Percent
3-5	8	11.9
6-8	7	10.4
9-12	7	10.4
13-23	14	20.9
24-34	15	22.4
35-45	8	11.9
46-56	6	9
57 and above	2	3
Total	67	100

Majority of the patients were between 24-34 years (22.4%)followed by the 13-23 age group which had 20.9% of the total number of patients. This was followed by the 35-45 and 3-5 years age groups which had 11.9% each ,the 6-8 years and 9-12 years age group was had 10.4% each, the 46-56 years age group had 9% of the total number of patients and finally the 57years and above age group which had 3% of the total number. Among the pediatric age group the 3-5 years group were the majority(11.9%)(Table 1).

FIGURE 1.DISTRIBUTION OF PATIENT INTO PAEDIATRIC AND ADULT AGE GROUP
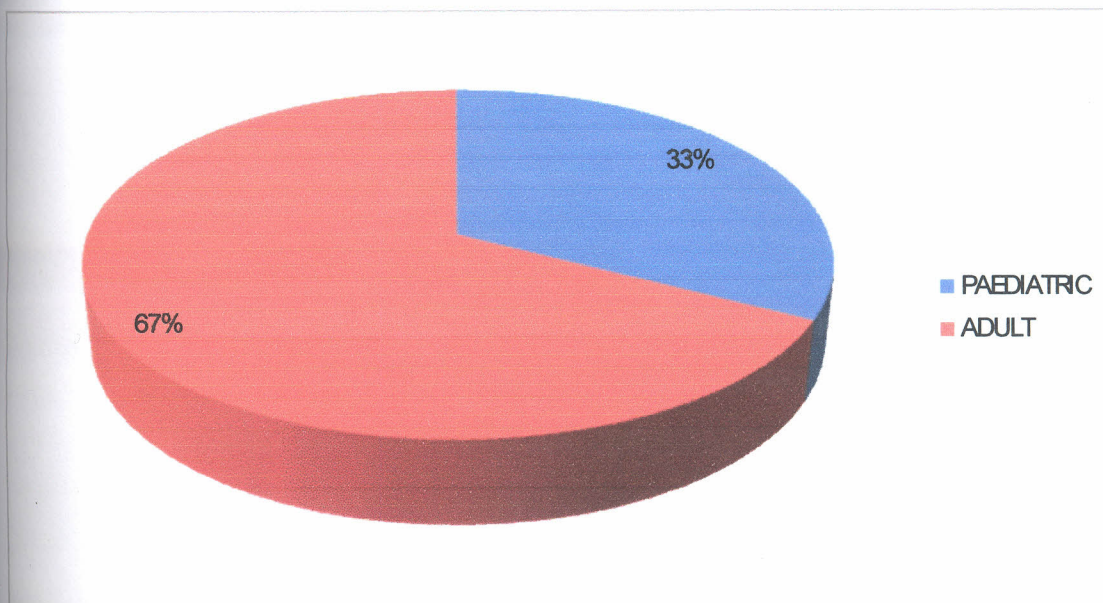
GCS SCORE

Majority of patients in this study had a GCS of 3(34.3%)on admission, followed by GCS score of 7(28.4%),GCS Score of 5 (17.9%)GCS Score of 5 and 7 each 7.5% while GCS score of 8 had the least patients(4.5%).(Table 5).

TABLE 2.DISTRIBUTION OF GCS SCORE

GCS SCORE	FREQUENCY	PERCENT
3	23	34.3
4	5	7.5
5	12	17.9
6	5	7.5
7	19	28.4
8	3	4.5

FIGURE 2.DISTRIBUTION OF GCS SCORE INTO CLUSTERS OF 3-5 AND 6-8
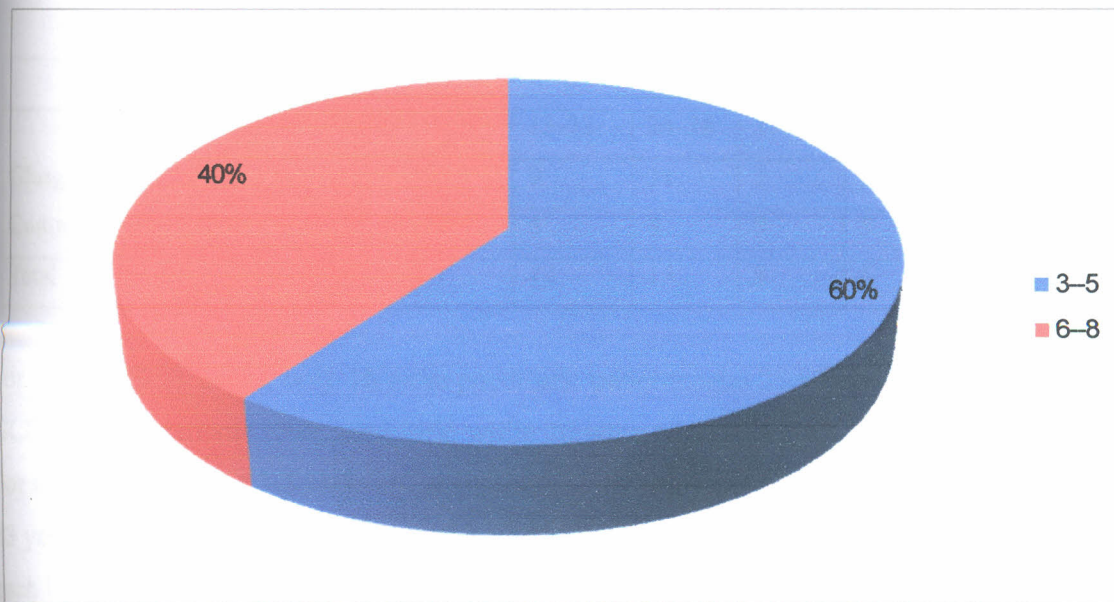
Forty patients (59.7%) had a GCS score of 3-5 whereas 27 patients had a GCS Score of 6-8(40.3%) (Figure 2).

TABLE 3.DISTRIBUTION OF GCS SCORE ACROSS AGE GROUPS

		3-5	6-8	9-12	13-23	24-34	35-45	46-56	57 & above	Total
									Age of Patient	
Glasgow	6-8	5	5	6	9	11	3	1	1	41
Comma Scale	3-5	3	2	1	5	4	5	5	1	26
Total		8	7	7	14	15	8	6	2	67

For the 6-8 GCS score, only 16 were paedriatic patients who 25 were adult patients. For the 3-5 GCS Score, 6 patients were paedriatic while 20 were adult patients.

For the GCS Score of 3-5,majority of patients were between 24-34 years(16.4%),followed by 13-23 years age group at 13.4%.The 9-12 years age group had 9%,the 3-5 and 6-8 years age group each had 7.5%,the 35-45 year age group had 4.5% whereas the 46-56 and above 57 years age groups had 1.5% each.

For the GCS score of 6-8, the 13-23,35-45 and 46-56 year age groups each had 7.5%,the 24-34 year age group 6%,the 3-5 year age group4.5%,the 6-8 year age group at 3%,the 9-12 and 57 & above age groups each had 1.5%.

TABLE 4.DISTRIBUTION OF GCS INTO PEDIATRIC AND ADULT AGE GROUPS.

Type of Patient				
		paedriatic	Adult	Total
	6-8	16	25	41
	3-5	6	20	26
GLASGOW COMA SCALE	Total	22	45	67

Twenty six (38.8%) of the patients had GCS score of 3-5 whereas forty one(61.2%) had GCS Score of 6-8.Six of the pediatric patients(9%) had a GCS score of between three and five compared to the adult age group which had twenty (29.8%) of the adult patients within the same

GCS score range. Sixteen of the pediatric patients (23.9%) had a score of between 6 and 8 compared to twenty five patients of the adult age group (37.3%)(TABLE 4).

CT SCAN FINDINGS

All patients reviewed in this study underwent a cranial CT scan. Majority of patients had brain oedema(55.2%),followed by intracerebral hemorrhages at 34.3% and finally contusion accounted for 10.5%(Figure 3).

FIGURE 3.PIE CHART TO SHOW THE DISTRIBUTION OF CT SCAN FINDINGS OF ALL PATIENTS

CTScan
- Intracelebral Haemorrhage
- Oedema
- Contussion

10.45%

34.33%

55.22%
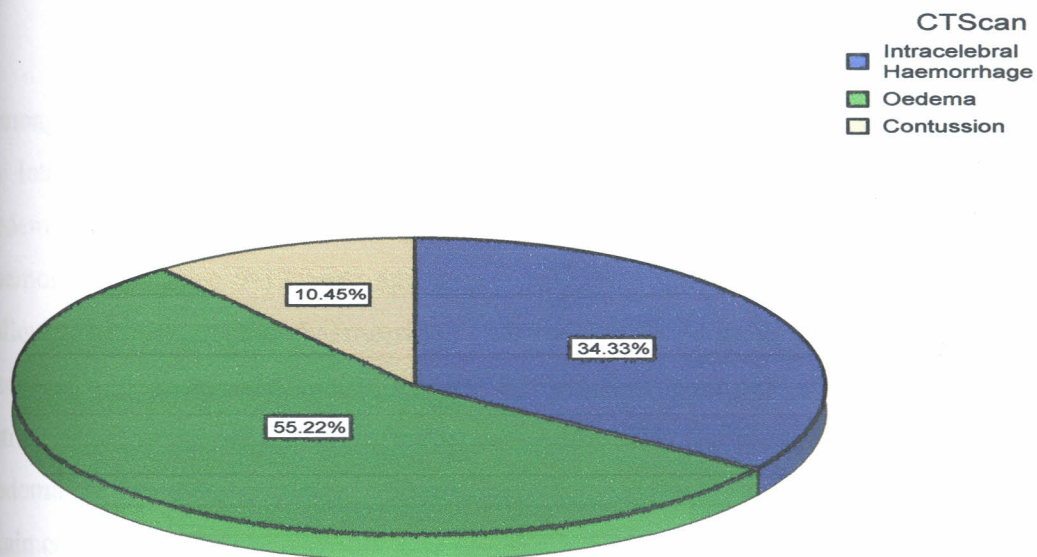
TABLE 5. DISTRIBUTION OF CT SCAN FINDINGS ACROSS DIFFERENT AGE GROUPS

		Age of Patient								
		3-5	6-8	9-12	13-23	24-34	35-45	46-56	57 & above	Total
CT Scan	Intracerebral Haemorrhage	2	1	3	7	3	3	4	0	23
	Oedema	5	4	4	6	10	5	1	2	37
	Contusion	1	2	0	1	2	0	1	0	7
Total		8	7	7	14	15	8	6	2	67

Among the 3-5 year age group, brain oedema was the most common CT scan finding followed by intracerebral hemorrhages and finally brain contusion. In the 6-8 years age group brain oedema was the most common pathology, followed by contusion and finally intracerebral haemorrhages, three 9-12 year age group had brain oedema as the most common pathology followed by intracerebral haemorrhages. There was no contusion in this age group. The 13-23 year old age group had brain oedema as the most common CT scan feature followed by intracerebral haemorrhage and finally contusion. The 35-45 year age group also had brain oedema as the most common feature, followed by intracerebral haemorrhages. There was no brain contusion in this age group. The 46-56 year old age group had the most common feature as intracerebral haemorrhage followed by equal number of brain oedema and contusion. The 57 & above age group had brain oedema as its only CT scan feature (TABLE5).

FIGURE 4.PIE CHART TO SHOW DISTRIBUTION OF CT SCAN FEATURES IN PEDIATRIC AGE GROUP
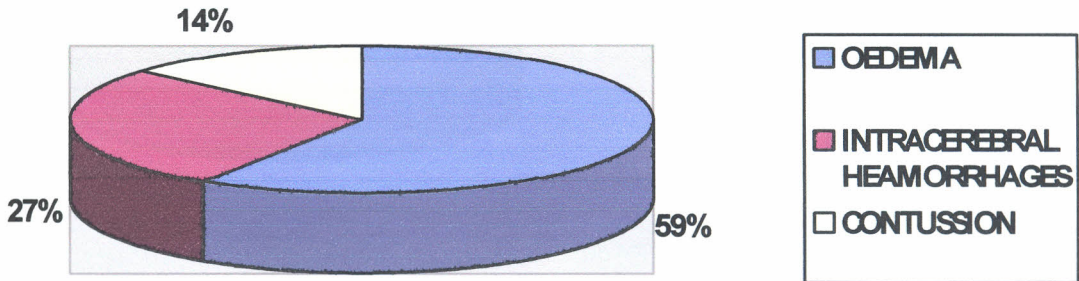
Thirteen (59%) of the pediatric patients had brain oedema, six(27%) had intracerebral haemorrhages, three (14%) had contusion. The most common lesion in the pediatric age group was brain oedema (Figure 4)

FIGURE 5.PIE CHART SHOWING DISTRIBUTION OF CT SCAN FINDINGS IN ADULT AGE GROUP
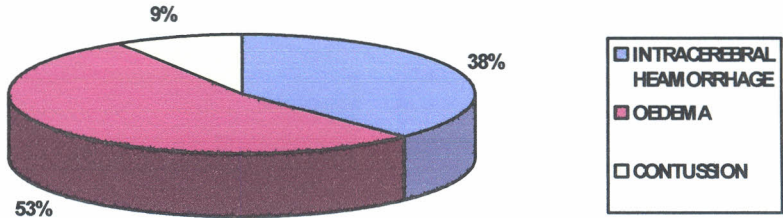
Seventeen patients (38%)of the adult patients had intracerebral pathology, twenty four patients(53%)had oedema and four(9%) had contusion. The most common lesion in the adult age group was intracerebral pathology (Figure 5).

PUPILLARY REACTION

Twelve patients (17.9%) had normal pupillary reaction to light while fifty five patients (82.1%) had abnormal pupillary reaction to light (Figure 6).

FIGURE 6.PUPILLARY REACTION TO LIGHT

18%

82%

□ abnormal pupillary reaction

□ normal pupillary reaction
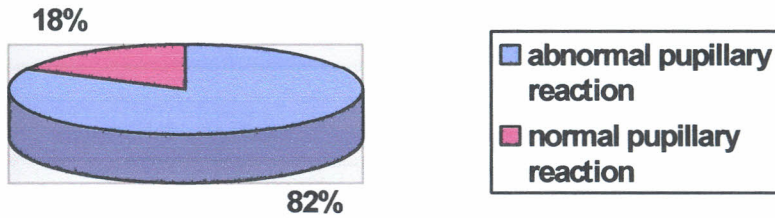
TABLE 6.DISTRIBUTION OF PUPILLARY REACTION TO LIGHT ACROSS AGE

		Age of Patient								
		3-5	6-8	9-12	13-23	24-34	35-45	46-56	57 and above	Total
Pupillary reaction to light	Brisk	0	1	1	5	3	2	0	0	12
	Sluggish	3	2	0	5	5	1	0	0	16
	Unresponsive dilated pupils	5	4	6	4	7	5	6	2	39
Total		8	7	7	14	15	8	6	2	67

Very many patients(58.21%) had dilate pupilary reaction to light. 23.88% had sluggish pupillary reaction to light while 17.91% had brisk pupillary reaction to light.Majotiry of the unresponsive pupilsa were in 24-34 age group.100% of patients in age groups 46 and above had unresponsive pupils.(Table 6).

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TABLE 7.DISTRIBUTION OF PUPILLARY REACTION IN PAEDIATRIC AND ADULT AGE GROUPS

Type of Patient				
		paedriatic	Adult	Total
	Brisk	2	10	12
	Sluggish	5	11	16
Pupillary reaction to light	Dilated and unresponsive	15	24	39
Total		22	45	67

Majority of the patients had dilated and unresponsive pupils (58.2%).23.9% had sluggish reaction to light whereas 17.9% had normal reaction to light. Majority of both the pediatric and adult patients had dilated and responsive pupils (22.4% and 35.8% respectively) followed by sluggish reaction to light at 7.5% and 16.4% respectively. Normal reaction to light was seen in 3% and 14.9% respectively (Table 7).

TESTING SIGNIFICANCE OF ASSOCIATION BETWEEN THE OUTCOME AND THE VARIABLES

The response variable is the consequence of a severe head injury which was measured in terms of the Glasgow comma scale. This has two levels either poor or good. It was hypothesized that this outcome is determined by four variables namely the age of the patient, the Glasgow comma scale , the Ct scan findings and the pupillary reaction to light. To measure the significance of the association between the Glasgow outcome scale and each variable a chi-square test was run. All the p-values will be compared to a level of significance of 0.0025.

TABLE 8.AGE VERSUS OUTCOME

		Age of Patient								
		3-5	6-8	9-12	13-23	24-34	35-45	46-56	57 and above	Total
Glasgow	Poor	7	4	4	10	13	8	6	2	54
Outcome scale	Good	1	3	3	4	2	0	0	0	13
Total		8	7	7	14	15	8	6	2	67

Fifty four (80.6%) patients had poor outcome compared to thirteen(19.4%) who had good outcome. Majority of the patients with poor outcome were in the age group 24-34,followed by 13-23.The worst outcome was seen in age groups 35-45,46-56,57 and above followed by 3-5 year age group. The best outcome was seen in 6-8 &9-12 year age groups.

TABLE 9.CHI SQUARE TEST FOR AGE

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.12623966	7	0.1815
Likelihood Ratio	12.24831867	7	0.09268
N of Valid Cases	67		

0.1815>0.0025, hence the age of the patient is not significant in determining the outcome of a severe head injury.

TABLE 10.OUTCOME OF PAEDIATRIC VERSUS ADULT AGE GROUPS

	Type of Patient			
		paedriatic	Adult	Total
Glasgow Outcome scale	Poor	15	39	54
	Good	7	6	13
Total		22	45	67

In general,22.4% of pediatric age group had poor outcome compared to 58.2% of the adult age group.10.4% of pediatric age group had good outcome compared to 9% of adults.

TABLE 11.CHI SQUARE TEST FOR OUTCOME BETWEEN PEDIATRIC AND ADULT AGE GROUPS

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.228528879	1	0.0724
Likelihood Ratio	3.067528797	1	0.07987
N of Valid Cases	67		

Consequently, whether the patient is a paedriatic or an adult does not influence the outcome.

TABLE 12.GLASGOW OUTCOME SCALE VERSUS GLASGOW COMA SCALE

		Glasgow Comma Scale		
		6-8	3-5	Total
	Poor	28	26	54
Glasgow Outcome scale	Good	13	0	13
Total		41	26	67

Outcome was poor in all the patients (100%) who had GCS score of 3-5.41.8% of patients with GCS score of 3-5.68.3% of patients with GCS score of 6-8 had poor outcome compared to 31.7% who had good outcome(Table 10.).

TABLE 13.CHI SQUARE TEST FOR GLASGOW OUTCOME SCALE VERSUS GLASGOW COMA SCALE

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.22854562	1	0.0014
Likelihood Ratio	14.70907707	1	0.000125
N of Valid Cases	67		

$0.0014 < 0.0025$, hence the Glasgow comma scale significantly determines the outcome of a severe head injury.

TABLE 14.OUTCOME VERSUS CT SCAN FINDINGS

		CT Scan Findings			
		Intracerebral Haemorrhage	Oedema	Contusion	Total
Glasgow Outcome scale	Poor	19	28	7	54
	Good	4	9	0	13
Total		23	37	7	67

Of patients who had intracerebral haemorrhages,82.6% had poor outcome, those with brain oedema,75.7% had poor outcome and those with contusion100% poor outcome.

Cerebral oedema had the highest incidence of poor outcome at 41.8% of the total patients followed by intracerebral haemorrhage at 28.4%.Contusion had 10.4%.

TABLE 15.CHI SQUARE TEST OF OUTCOME VERSUS CT SCAN FINDINGS

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.317739144	2	0.3138
Likelihood Ratio	3.621722266	2	0.1635
N of Valid Cases	67		

0.3138>0.0025, hence the CT Scan findings do not significantly determine the outcome from a severe head injury.

TABLE 16.OUTCOME COMPARED TO PUPILLARY REACTION TO LIGHT

		Pupillary Reaction to Light			
		Brisk	Sluggish	Dilated/Pin point	Total
Glasgow	Poor	5	14	35	54
Outcome scale	Good	7	2	4	13
Total		12	16	39	67

Of patients with normal pupillary reaction to light,41.7% had poor outcome, of those with sluggish reaction to light,87.5% had poor outcome while those with unresponsive pupils, 89.7% had poor outcome(Table 12).

TABLE 17.CHI SQUARE TEST FOR OUTCOME COMPARED TO PUPILLARY REACTION

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.20366718	2	0.0008
Likelihood Ratio	11.77947793	2	0.0028
N of Valid Cases	67		

0.0008<0.0025, hence the pupillary reaction to light significantly determines the outcome from a severe head injury.

A summary of the above findings is given in the table below.

TABLE 18. SUMMARY OF P VALUES FOR ALL VARIABLES

SUMMARY	
Variable	P-value
Age	0.1815
Glasgow Comma Scale	0.0014
CT Scan Findings	0.3138
Pupillary Reaction to Light	0.0008

Classification Table (a,b)					
			Predicted		
			Glasgow Outcome scale		Percentage Correct
	Observed		Poor	Good	
ep 0	Glasgow Outcome scale	Poor	54	0	100
		Good	13	0	0
	Overall Percentage				80.6

rom the above results, one can therefore go ahead to fit a logistic model to the variables. This an appropriate model since both the response variable (poor, good) and the explanatory ariables are grouped in different categories or levels.

rom the above table, we will be correct 80.6% of the time if we predict that the outcome from a evere head injury will be poor.

ABLE 20. TABLE TO CALCULATE ODDS

Variables in the Equation (Null model)							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-1.424034689	0.308936232	21.24729	1	4E-06	0.2407

The Intercept Only model, also called the null model reflects the net effect of all variables not in the model plus error. This model gives us In(odds)=-1.424. On exponentiating both sides of the model we have that the predicted odds is 0.2407. This implies that the odds of having a good outcome relative to a poor outcome in case of a severe head injury are 0.2407.

An inclusion of the significant independent variables, thus Glasgow coma scale and pupillary reaction to light gives the results in the table above:

TABLE 21.TABLE OF VARIABLES IN EQUATION

		B	S.E.	Wald	df	Sig.	Exp(B)
				Variables in the Equation (Full Model)			
Step 1(a)	GCS(1)	-20.02101589	7775.86307	6.63E-06	1	0.998	2E-09
	Pupreac			6.316731	2	0.042	
	Pupreac(1)	0.182321557	0.963212218	0.035829	1	0.85	1.2
	Pupreac(2)	2.063693185	1.001982162	4.241996	1	0.039	7.875
	Constant	-1.504077397	0.78173596	3.701862	1	0.054	0.2222

The Glasgow coma scale above has the severe level as the referencing point. As for the pupillary reaction to the light decisions on the two categories, sluggish and dilated are made with reference to the brisk category.

From the above table, the following can be deduced:

The odds of a poor outcome form a severe head injury is 0.000000002 more likely for a patient with a GOS of 3-5 scale compared to one with a GOS of 6-8.

The odds of a poor outcome from a severe head injury is 1.2 times more likely for a patient with a sluggish pupillary reaction to light compared to one with a brisk one.

The odds of a poor outcome from a severe head injury is 7.875 times more likely for a patient with a dilated pupillary reaction to light compared with one who has a brisk pupillary reaction to light.

The odds of a poor outcome from a severe head injury is 6.675(7.875-1.2) more likely for a patient with a dilated pupillary reaction to light as compared to one with a sluggish papillary reaction to light.

The model therefore can be written as:

$$\ln(ODDS) = -1.504 - 20.02GCS(1) + 0.18Pupreac(1)/2.06Pupreac(2)$$

The model can be used for prediction hence given as:

$$ODDS = \exp\{-1.504 - 20.02[GCS(1)] + 0.18[Pupreac(1)]/2.06[Pupreac(2)]\}$$

TABLE 22. A SUMMARY OF OUTCOME OF ALL VARIABLES

	Age	3-5	6-8	9-12	13-23	24-34	35-45	46-56	57and above
	Glasgow Outcome Scale	G/P Poor	G/P	G/P	G/P	G/P	G/P	G/P	G/P
GCS	6-8	1/4	3/2	3/3	4/5	2/9	0/3	0/1	0/1
	3-5	0/3	0/2	0/1	0/5	0/4	0/5	0/5	0/1
CT Scan	Intracerebral Haemorrhage	0/2	1/0	1/2	2/5	0/3	0/3	0/4	0/6
	Oedema	1/4	2/2	2/2	2/4	2/8	0/5	0/1	0/2
	Contusion	0/1	0/2	0/0	2/1	0/2	0/0	0/1	0/0
Pupillary reaction to Light	Brisk	0/0	0/1	1/0	4/1	2/1	0/2	0/0	0/0
	Sluggish	1/ 2	1/1	0/0	0/5	0/5	0/1	0/6	0/0
	Dilated	0/5	2/2	2/4	0/4	0/7	0/5	0/0	0/2

KEY

G/P- Good/Poor

DISCUSSION

Sixty seven patients with severe head injury were reviewed during months of October and November 2009. Outcome was measured after seventy two hours using Glasgow Outcome Scale. Of the subjects, 67% of the patients were adults and 33% were children.

Majority of the patients were young adults between the ages of 24-34 years (22.4%). The next most frequent group was the 13-23 age groups which had 20.9% of the total number of patients. This compares to a study done at the Kenyatta National Hospital where the majority of the patients were young adults 21.9% followed by the 14-25 year age group at 15.8% .[6] This was followed by the 35-45 and 3-5 years age groups which had 11.9% each ,the 6-8 years and 9-12 years age group was had 10.4% each, the 46-56 years age group had 9% of the total number of patients and finally the 57years and above age group which had 3% of the total number. The incidence was seen to decrease with increasing age from 46 years and above, an observation that was also noted by Kiboi's study.[6] Among the pediatric age group the 3-5 years group were the majority (11.9% and 36.4% of the pediatric age group), the 6-8 and 9-12 year age groups had almost similar incidence at 10.4%.This compares to a study done by Mwangi J where the highest incidence was in the 3-5 years at 39.6% and almost an equal incidence of the 6-8 and 9-12 year age group. [5].

More adults were seen with severe head injury compared to children. These observations can be explained by the fact that most adolescent and young adults are exposed to more risks related to occupational and recreational activities. In the pediatric age group, the 3-5 year age group had the highest number which may be explained by the fact that older children are more developmentally mature in terms of supporting and grasping movements compared to younger children. Older children also tend to spend most of their time in school where most activities are supervised. Younger children who are more active and explorative are usually left under the eye of the care givers who may also have other house related chores to attend to hence may not give them as much supervision as they require. Besides with increasing high rise buildings with poorly designed balconies more children are exposed to falls.

Overall poor outcome was seen in fifty four (80.6%) compared to thirteen subjects (19.4%) who had good outcome. Majority of the poor outcome was seen in adults compared to children for the same severity of head injury. This can be explained by the special attribute of the brain and skull of a pediatric patient. The immature brain is thought to tolerate anoxia and hypoxia better compared to an adult brain. [54] Majority of the patients with poor outcome were in the age group 24-34,followed by 13-23.The worst outcomes were seen in the older age groups with up to 100% poor outcome in patients over 46 years followed by the 3-5 year age group with 87.5%. The best outcome was seen in 6-8 &9-12 year age groups. This supports the fact that overall, increasing morbidity and mortality increases with age and at the same time extremities of age is associated with poor outcome. [6] The higher mortality seen in the 3-5 year age group can be explained by the corresponding higher incidence of unresponsive dilated pupils, intracerebral and cerebral oedema and a lower GCS score compared to the other pediatric age groups. The higher incidence of poor outcome seen in adult age groups of 46 years and above can be explained by the fact that they had higher incidences of pupillary unresponsiveness, a higher percentage of intracerebral hemorrhages and brain oedema for the age group and lower GCS Scores. The significance of age as a prognostic factor of outcome is s subject of controversy. A study by Leurssen et al reported age as a major independent factor that was influencing outcome. In their study, they showed that mortality increased from 28.8% in pediatric patients with severe head injury to 47.7% in adults. They also noted that among children, the younger age group had the highest mortality with 12 years being the age with minimum mortality which compares to this study. A study by Johnson et al and Smoller et al also showed overall children had better outcome compared to adults who also compares to this study.[19,20,22.] Odebode et al found age as a significant predictor of outcome.[46]

However when statistically tested (see appendix viii), age in this study was not found to significantly contribute to outcome per se in the adult and pediatric age groups with severe head injury as individual groups or as combined. This is supported by a study by Dennis et al which failed to eliminate age as an independent predictor of outcome as well as a study by Kamal et al. [42] [44] This difference could be due to the fact that Leurssen et al and Odebode et al studied the whole spectrum of head injury and not only severe head injury hence they would have significant differences in outcome. These studies were also retrospective. However, Leurssen et

al went on to state in their study that mortality rates were similar in hypotensive patients and those with subdural hematoma. Johnson et al also stated that patients involved in RTA had almost similar outcomes[19,22]Could it be stated that maybe the effect of age on outcome in head trauma depends on the difference in pathophysiological response to trauma of the central nervous system across different stages of human development and associated insults to the brain due to ageing process?

All patients in this study had their Glasgow Coma Scale (GCS) score recorded. Majority of patients in this study had a GCS of 3(34.3%)on admission, followed by GCS score of 7(28.4%),GCS Score of 5 (17.9%)GCS Score of 5 and 7 each 7.5% while GCS score of 8 had the least patients(4.5%). Twenty six (38.8%) of the patients had GCS score of 3-5 whereas forty one (61.2%) had GCS Score of 6-8. This correlates well to a study done by Kiboi where majority of the subjects had GCS score of 3 and also that the GCS Score range of 6-8 had a higher incidence compared to the 3-5 range. However the study showed a GCS score of 8 as second commonest while in my study ,GCS score of 8 had the least incidence[6] For the GCS Score of 3-5,majority of patients were between24-34 years(16.4%),followed by 13-23 years age group at 13.4%.The 9-12 years age group had 9%,the 3-5 and 6-8 years age group each had 7.5%,the 35-45 year age group had 4.5% whereas the 46-56 and above 57 years age groups had 1.5% each. For the GCS score of 6-8,the 13-23,35-45 and 46-56 year age groups each had 7.5%,the 24-34 year age group 6%,the 3-5 year age group4.5%,the 6-8 year age group at 3%,the 9-12 and 57 & above age groups each had 1.5%.

Six of the pediatric patients(9%) had a GCS score of between three and five compared to the adult age group which had twenty (29.8%) of the adult patients within the same GCS score range. Sixteen of the pediatric patients (23.9%) had a score of between 6 and 8 compared to twenty five patients of the adult age group (37.3%)).

More adults had low GCS score compared to children in both groups of GCS Score. This compares well to the study done by Kiboi which found that more adults had low GCS score rates compared to children[6] This may be attributed to the fact that adults may have extra

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cerebral confounding factors for example systemic diseases that may contribute to poorer outcomes compared to children. It could also be due to the unique physiological response of children to head injury owing to their unique cerebral physiologic mechanism compared to those of adults. However this contrasts to the findings in a study done by Dennis et al which did not find significant difference relation between age and GCS score. [42]

The GCS scoring showed that the high scores were associated with good outcomes compared to lower score.74.5% of patients with GCS Score of 3-5 had poor outcome. A study by Sandeep et al also had similar findings where 76.5% of patients who had a GCS Score of 5 and below had poor outcome. [24] A study by Wagstyl et al showed GCS Score was sensitive in predicting outcome in the first 24 hours and that a GCS of 5 and above was associated with better outcome compared lower values.[23] This still compares to the study done by Kiboi which found 66.8% of patients with GCS score of 5 and below to have poor outcome. [6]25.5% of patients with a score of 6-8 had poor outcome. Good outcome was seen in 87.5% of patients with a score range of 6-8 compared to those with a score range of 3-5 who had 12.5%. The elderly who had GCS score group of 3-5 had 100% mortality compared to other age groups.

Overall when statistically tested the GCS Score was found to have a significant impact in influencing outcome with a p value of 0.0014. Smoller et al also stated that lower GCS scores were associated with higher mortality. The study also stated that pediatric cases with similar GCS Score were found to have better outcome than adult population. This contrast the findings in this study where outcome for similar GCS Score across different age groups and between pediatric and adults failed to get a significant results (see appendix viii, Table 21).[6,20] However in general these findings compare to several studies which quote GCS score as an important predictor of outcome either on its own or in combination with other factors both in children and adult patients.. [5,6,22,44,46,47]

Radiological findings contribute enormously in the management of patients with head injury. In this study, the CT scan findings in all patients were considered. Majority of patients had brain oedema (55.2%), followed by intracerebral hemorrhages at 34.3% and finally contusion accounted for 10.5%. Thirteen (59%) of the pediatric patients had brain oedema, six (27%) had

intracerebral haemorrhages,three (14%) had contusion. These findings contrast with those of Kiboi whereby the majority of patients had intracerebral pathology followed by brain oedema [6]

The most common lesion in the pediatric age group was brain oedema. This compares with a study by Mwangi J where cerebral oedema was the commonest CT scan finding in pediatric age group [5] Seventeen patients(38%)of the adult patients had intracerebral pathology, twenty four patients(53%)had oedema and four(9%) had contusion. [5]

The most common lesion in the adult age group was intracerebral pathology. Contusion associated with depressed skull fracture was the least common lesion seen in both age groups .It was found that the type of brain lesion was to be age dependent. [6]

More children had cerebral oedema compared to adults who had more intracranial lesions. This is supported by several studies that state that children tend to have cerebral oedema after traumatic brain injury whereas adults tend to have intracerebral pathology This is because of the thin elastic skull in children, capable of greater deformity, a larger head in proportion to body surface area hence a larger proportion of total blood volume in the head with a higher water content compared to that of the adult which allows for quicker edema formation but at the same time allows for tolerance to increased intracranial pressures. [7,18,30-36,44].

Higher incidence of poor outcome was seen in patients with cerebral oedema, followed by intracerebral haemorrhage and finally contusion. Of patients who had intracerebral hemorrhages, 82.6% had poor outcome, those with brain oedema, 75.7% had poor outcome and those with contusion100% had poor outcome. In comparison with a study done at Kenyatta National Hospital, intracerebral pathology had poor outcome of approximately 72 %. A study by Kamal et al showed that in children, brain oedema was the commonest cause of poor outcome followed by contusions. [44]

However when statistically tested, the CT scan findings were not found to significantly influence outcome across different age groups or overall. These findings compare with those done in

Children Medical Centre in Washington whereby CT scan findings were not found to influence outcome as well as those of a study done in India[26,45] However a study done in Barcelona found that an initial CT scan findings to be a useful predictor of outcome.[25] Studies by Kamal et al and by Mwangi J, also showed that CT scan findings influenced outcome[5,44] The difference in these findings could be due to the fact that my study was based on short term outcome as opposed to the that done in done in Barcelona. Furthermore, in my study I did not assess individual intracerebral hemorrhages; they were all assessed as one group.

There is a strong correlation between pupillary reaction to light and outcome. 17.9% of the patients in this study had normal pupillary reaction compared to 82.1% had abnormal pupillary reaction to light.

Majority of the patients with abnormal pupillary reaction to light had dilated and unresponsive pupils (58.2%). This compares to a study done by Kiboi. [6]23.9% had sluggish reaction to light.

Majority of both the pediatric and adult patients had dilated and responsive pupils (22.4% and 35.8% respectively) followed by sluggish reaction to light at 7.5% and 16.4% respectively. Normal reaction to light was seen in 3% and 14.9% respectively.

Patients who had normal pupillary reactions had a better outcome compared to those who had abnormal pupillary reaction to light. Several studies have found this to be true. Of patients with normal pupillary reaction to light, 41.7% had poor outcome, of those with sluggish reaction to light, 87.5% had poor outcome while those with unresponsive pupils, 89.7% had poor outcome. This compares closely to a study by Kiboi which found that dilated unresponsive pupils had 89.8% mortality and 35% of patients with normal pupillary reaction to light had poor outcome[6]

Statistically tested, pupillary reactivity was not found to be significant across different age groups in patients with severe head injury (see appendix) which contrasts an Italian study in which light reflex was found to be the best prognostic indicator for adults compared to children. [2] Wagstyl et al found that pupillary reaction to light was inaccurate in predicting outcome but combined with abnormal plantar reflex the predictive value was positive[23]

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However overall, pupillary reaction to light was statistically significant with a p value of 0.0008.This also compares to several studies which state that abnormal pupillary reactions affect outcome of severe head injury. [5,6,24,43]The odds of a poor outcome from a severe head injury was 1.2 times more likely for a patient with a sluggish pupillary reaction to light compared to one with a brisk one. The odds of a poor outcome from a severe head injury was 7.875 times more likely for a patient with a dilated pupillary reaction to light compared with one who has a brisk pupillary reaction to light. The odds of a poor outcome from a severe head injury is 6.675(7.875-1.2) more likely for a patient with a dilated pupillary reaction to light as compared to one with a sluggish pupillary reaction to light.

In this study, age, pupillary reaction to light, abnormal CT scan findings and GCS score were found to affect outcome in patients with severe head injury. Poor outcome was seen less in the pediatric age group but this was not found to be statistically significant. However, the Glasgow Coma Scale score and pupillary reaction to light were the only two factors that were found to be statistically significant in influencing outcome. The outcome improved with increasing value of the Glasgow coma scale score and in patients with brisk reaction to light. These findings are consistent with several studies. A study by Kiboi J found that the two most important predictors of outcome were GCS score and pupillary reaction to light, Sandeep et al found that a combination of increasing GCS score and brisk pupillary reaction predicted outcome better than each of the single factors and Smoller et al also found that lower GCS and pupillary unreactivity and increasing age affected outcome. [5,6,20,23,24.43,45].Age and CT scan findings were not found to significantly affect outcome across different age groups in this study.

CONCLUSION

Sixty seven patients with severe head injury who fulfilled the criteria of the study were reviewed at the Kenyatta National Hospital during the study period and followed up for seventy two hours. These were patients with a Glasgow Coma Scale Score (GCS) of 3 to 8. Of the total number of patients in the study, 67% were adults and 33% were children.

Majority of patients in this study were between 24-34 years (22.4%) and the least number of patients was seen in the 57 years and above at 3%. The most frequent Glasgow Coma Scale Score (GCS) was of 3 (34.3%) while the least frequent score was 8 (4.5%). Brain oedema was the commonest CT scan finding (55.2%) while contusion was the least (10.5%). Most patients had abnormal pupillary reactions to light (82%) and the most frequent abnormal pupillary reaction was dilated unresponsive pupils at 89.7%.

Overall poor outcome, that is, the subjects either died or remained in persistent vegetative state was seen in fifty four subjects (80.6%) compared to thirteen (19.4%) who had good outcome. 22.4% of pediatric subjects had poor outcome compared to 58.2% of the adult. Poor outcome was also seen in extremities of age (87.5% in children between 3-5 years) as well as with increasing age with 100% poor outcome in patients who were 46 years and above. Lower GCS Scores, abnormal CT Scan findings and abnormal pupillary reaction to light were also associated with poor outcome.

From this study, the Glasgow Coma Scale score and pupillary reaction to light were found to significantly correlate to outcome with low GCS score value and abnormal pupillary reaction predicting poor outcome. Age and abnormal CT Scan features though affecting outcome, were not found to be statistically significant predictors of outcome.

Glasgow Coma Scale is a practical, convenient and economic test for patients. It is useful as a diagnostic, prognostic and a follow up tool for patients with head injury. It can be used by most medical staff due to its simplicity and explicability. Its proper use should be encouraged. Emphasis   should also be placed on proper pupillary examination as it has been shown to

strongly correlate to outcome in severe head injury. These two factors can assist greatly in predicting outcome in patients with severe head injury hence appropriate management. However other factors that are not in the scope of this study contributing to outcome and should not be overlooked in preference to the above two factors.

From the magnitude of poor outcome seen in this study, it is clear that prevention of injury is the best way of reducing the physical, psychological and economic burden associated with complications of head trauma. In the event that prevention fails, then proper management through identification of risk factors provides the patient with the best chance for good care hence outcome and it is also useful for relative counseling about the outcome of the patients.

RECOMMENDATIONS

Prevention of head injuries cannot be underestimated. The community should be continuously taught about road safety whether as pedestrian, passengers or drivers with heavy penalty for wrong doers be imposed. Community policing should be encouraged to curb incidences of assault, overall insecurity in the country should be addressed prevent criminal acts that can lead to eventual assault. Responsible drinking behavior should be advocated to prevent accidents. Personal safety measures should be emphasized. Building and construction safety measures should be enforced to curb injuries from falls.

To improve outcome, expansion of the Intensive Care Unit where patients with severe head injury can be initially be admitted until they are stable is mandatory.

The proper use of Glasgow Coma Scale and pupillary reaction to light should not be underestimated. It is a cheap way of predicting and monitoring outcome for continued medical care and relative counseling.

FUTURE STUDIES

Validation of the study model {ODDS=$e^{\wedge}$-1.504-20.02(x1) +0.18(x2)} with a larger sample size for both short and long term outcomes of severe head injury.

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APPENDICES

APPENDIX I: CONSENT FORM

NEXT OF KIN'S STUDY INFORMATION

STUDY NUMBER………. .   HOSPITAL NUMBER…………..

TITLE OF THE STUDY:

A PROSPECTIVE STUDY OF FACTORS THAT INFLUENCE EARLY OUTCOME OF SEVERE TRAUMATIC BRAIN INJURY ACROSS DIFFERENT AGE GROUPS AT THE KENYATTA NATIONAL HOSPITAL

INVESTIGATOR

Dr.Wafula Grace Taka

Senior House Officer from the department of surgery, University of Nairobi.

Introduction

I request you to voluntarily allow your child/spouse/sibling/relative to participate in my research study. The purpose of this consent form is to give you information you will need to help decide whether to participate in this study or not. You are free to ask any questions about the study or in this form that is not clear. When all your questions have been answered, you can then decide whether to participate in the study or not.

Purpose of the study

The purpose of this study is to find out whether Age, Pupillary size and reaction to light, Glasgow Coma Scale and abnormal CT scan findings influence the short term outcomes based on Glasgow Outcome Scale in Traumatic Brain Injury and if the findings differ across different age groups. This study is done as a partial fulfillment for the award of the degree of Masters of Medicine in General Surgery which I am undertaking at the University of Nairobi.

Similar studies have been done before elsewhere in the world and they are important because they give new information to the clinicians of what to emphasize on when reviewing a patient with severe brain injury as well as set a platform for future studies all aimed in giving evidence based care to our patients. The study will assist in identifying the age group at risk so that emphasis on prevention can be targeted to that age group and the whole population at large. It will also assist in patient and relative counseling as concerns possible outcomes of patients with severe brain injury.

Procedure

After you have accepted to participate in the study and signed this consent form, I may ask you a few questions to confirm or clarify where necessary information in your kin's file regarding this current admission. I will read the CT scan film of your and do a physical and neurological examination on your kin 72 hours after admission into the hospital. I will fill out a questionnaire on only the required information I will have gathered from the file, CT scan films and the physical and neurological examination.

Benefits of participating in the study

All questions regarding the condition of the patient will be fully explained

The information will assist add to already existing information about severe traumatic brain injury (STBI).

Risks of participating in the study

There are no risks anticipated for those who will participate in the study

The participation of your kin in this study is voluntary.

You are free to decline to consent on behalf of your kin and will not be victimized in any way or denied services for declining to be in the study.

Participation in the study does not entail financial benefits.

You can pull out of the study any time during the study period.

Confidentiality

All the information obtained will be held in the strictest confidence.

The questionnaires and consent forms shall be kept in lockable cabinets in the department of surgery and password enabled computers accessible only to me and the data manager.

Only a code number and not the name of your kin or your name will appear on the questionnaire.

Ethical consideration

This study has been reviewed and approved by the Ethical Review of Kenyatta National Hospital.

Do you have any questions?

Do you agree?

NEXT OF KIN CONSENT

Study No..

I (print full names in capital letters)...............................confirm that I have understood the relevant parts of the research explained to me to me by DR WAFULA GRACE TAKA who is carrying out a study at Kenyatta National Hospital to find out whether Age, Pupillary size and reaction to light, Glasgow Coma Scale and abnormal CT scan findings influence the short term outcomes based on Glasgow Outcome Scale in Traumatic Brain Injury and if the findings differ across different age groups. I hereby give consent to allow my child/spouse/sibling/relative participate in the study. By signing the consent, I also accept to do the following:

- Be interviewed concerning my child/spouse/sibling/relative illness by the principal investigator.
- Allow my child/spouse/sibling/relative be examined physically by the principal investigator and her assistant.

I understand that my participation in this study is voluntary and that I can withdraw my consent at any time. Failure to participate in this study or withdrawal of the consent will not affect the treatment of my child/spouse/sibling/relative in any way and all the information concerning my child/spouse/sibling/relative will be treated with utmost confidence and my name or that of my child/spouse/sibling/relative will not be included in the questionnaire, results or the discussion of this study.

FULL NAME OF THE PARENT/ child/spouse/sibling/relative
SPOUSE/SIBLING/GUARDIAN(IN CAPITAL LETTERS)

....
Signature/Thumb..
WITNESS' NAME

....
Signature/thumb Print.................................... ....
INVESTIGATOR

DR WAFULA GRACE TAKA
Signature...

FOMU YA KUKUBALI KUSHIRIKISHA MGONJWA KATIKA UTAFITI

Nambari ya Kushiriki.....................

Mimi(majina kamili kwa herufi kubwa)............nimeelewa maelezo yote ambayo nimepewa na DAKTARI WAFULA GRACE TAKA ambaye anafanya utafiti katika hospitali kuu ya Kenyatta unaochunguza matokeo baada ya masaa sabini na mbili ya wagonjwa walioumia vichwa. Nimekubali kushirikisha mtoto/mke/mume/ndugu yangu katika huu utafiti kama mgonjwa kwa hiari yangu na pia nimekubali kufanya yafuatayo:

- Kuhojiwa juu ya kuumia kichwa kwa mgonjwa wangu na DAKTARI WAFULA GRACE TAKA na kuandika yale nitasema kwa shuguli za huu utafiti.
- Kupimwa kwa mgonjwa wangu kimwili kwa minajili ya huu utafiti.

Ninaelewa ya kwamba hakuna malipo ya kushiriki na ninaweza kujiondoa wakati wowote.Habari yote nitakayo mpa mtafiti na ile atakayopata katika faili ya mgonjwa wangu haitatumika kwa njia yoyoye isipokua kwa minajili ya utafiti na habari yote itawekwa siri.Jina langu wala la mgonjwa halitaandikwa pahali popote katika makaratasi ya utafiti ila nambari ya utafiti tu. Pia ninaelewa kwamba kutokubali kushiriki au kujiondoa katika utafiti huu hakutaathiri matibabu ya mgonjwa wangu kwa njia yoyote ile.

JINA LA MSHIRIKI- MZAZI/MLINZI/

....

Sahihi/Kidole gumba............................

SHAHIDI

Sahihi/Kidole   gumba............................

MTAFITI

DAKTARI WAFULA GRACE TAKA

SAHIHI....................................

APPENDIX III: QUESTIONNAIRE

1. DATE...

2. STUDY NUMBER............

3. HOSPITAL NUMBER.........   WARD.............

4. TIME OF FIRST CONTACT WITH DOCTOR (USE 24 HOUR CLOCK)................

5. TIME OF INJURY (24 HOUR CLOCK)........................

FOR THE SUBSEQUENT QUESTIONS TICK WHERE APPLICABLE

6. AGE (years)   3-5   6 -8   9-12   13-23   24-34   35-45   46-56   57 & above

7. SEX   MALE...........   FEMALE......

8. CAUSE OF INJURY

         FALL FROM HEIGHT

         RTA –PASSENGER

                 SEAT BELT

                       WORN   NOT WORN

         - PEDESTRIAN

         -CYCLIST

-ASSAULT BY PERSON KNOWN TO PATIENT

BY PERSON UNKNOWN TO PATIENT

-RECREATIONAL INJURY   SPECIFY.....................

OTHERS..

9. PRESENTING COMPLAINTS

CONFUSION

HEADACHE

NAUSEA/VOMITING

CONVULSIONS

LOSS OF CONSCIOUSNESS

BLURRING OF VISION

WEAKNESS

DIZZINESS

10. ANY MEDICAL INTERVENTION BEFORE PRESENTING AT KNH

YES   NO

IF YES SPECIFY

....

11. HISTORY OF ALCOHOL INGESTION/DRUG ABUSE
YES   NO

12. PAST MEDICAL HISTORY (TICK WHERE APPLICABLE)

                                    YES   NO

CONVULSIVE ILLNESS...

CEREBRAL PALSY...

HISTORY OF CVA...

HISTORY OF SPINAL CORD INJURY.......................................

OTHERS...

APPENDIX IV: DATA COLLECTION FORM

STUDY NUMBER…………………………….

HOSPITAL NUMBER………………………..

WARD……………………………………….

1. GENERAL CONDITION
 (TICK WHERE APPLICABLE)

GOOD GENERAL CONDITION……………………………………….
SICK LOOKING……………………………………………………..
UNCONSCIOUS……………………………………………………..

2. VITAL SIGNS AT ADMISSION

BP (mmHg)…………………………………………..

TEMPERATURE (DEGREES CENTRIGRADE)…………………………..

RESPIRATORY RATE (BREATHS /MUNUTE) ……………………………

PULSE RATE (BEATS/MINUTE)…………………………………………..

3. NEUROLOGICAL EXAMINATION

GCS/PGCS ON ADMISSION

	MOTOR	VERBAL	EYE	TOTAL

4. PUPILLARY REACTION TO LIGHT

	BRISK	SLUGGISH	NO CHANGE
			PINPOINT DILATED
RIGHT			
LEFT			

5. CT SCAN FINDINGS (TICK WHERE APPLICABLE)

	PRESENT	ABSENT
A).MIDLINE SHIFT		
B).CEREBRAL OEDEMA		
C).CONTUSSION		
D).SUBDURAL HAEMATOMA		
E).EXTADURAL HAEMATOMA		
F).INTRACEREBRAL HAEMORRHAGE		
G).SUB ARACHNOID HAEMORRHAGE		
H).INTRAVENTRICULAR BLEED		

6. GLASGOW OUTCOME SCALE (AT 72 HOURS FROM ADMISSION)

(TICK WHERE APPROPRIATE)

1. DEATH..

2. PERSISTENT VEGETATIVE STATE...

3. SEVERE DISABILITY (conscious but disabled)..
   Also includes severe mental disability

4. MODERATE DISABILITY (disabled but independent)...................................
   - Dysphasia.................................
   - Hemiparesis.................................
   - Ataxia.......................................
   - Memory deficits.............................
   - Personality changes..........................
   - Intellectual deficits.........................

5. GOOD RECOVERY...

This is resumption to normal life even though there may be minor neuropsychological deficit

APPENDIX V: GLASGOW COMA SCALE: ADULT

The scale comprises three tests: eye, verbal and motor responses. The three values separately as well as their sum are considered. The lowest possible GCS (the sum) is 3 (deep coma or death), while the highest is 15 (fully awake person).

For adults the scores are as follows:

Eye Opening Response	Spontaneous--open with blinking at baseline	4 points
	Opens to verbal command, speech, or shout	3 points
	Opens to pain, not applied to face	2 points
	None	1 point
Verbal Response	Oriented	5 points
	Confused conversation, but able to answer questions	4 points
	Inappropriate responses, words discernible	3 points
	Incomprehensible speech	2 points
	None	1 point
Motor Response	Obeys commands for movement	6 points
	Purposeful movement to painful stimulus	5 points
	Withdraws from pain	4 points
	Abnormal (spastic) flexion, decorticate posture	3 points
	Extensor (rigid) response, decerebrate posture	2 points
	None	1 point

Best eye response (E)

There are 4 grades starting with the most severe:

1. No eye opening
2. Eye opening in response to <u>pain</u>. (Patient responds to pressure on the patient's <u>fingernail bed</u>; if this does not elicit a response, <u>supraorbital</u> and <u>sternal</u> pressure or rub may be used.)
3. Eye opening to speech. (Not to be confused with an awaking of a sleeping person; such patients receive a score of 4, not 3.)
4. Eyes opening spontaneously

Best verbal response (V)

There are 5 grades starting with the most severe:

1. No verbal response
2. Incomprehensible sounds. (Moaning but no words.)
3. Inappropriate words. (Random or exclamatory articulated speech, but no conversational exchange)
4. Confused. (The patient responds to questions coherently but there is some disorientation and confusion.)
5. Oriented. (Patient responds coherently and appropriately to questions such as the patient's name and age, where they are and why, the year, month, etc.)

Best motor response (M)

There are 6 grades starting with the most severe:

1. No motor response
2. Extension to pain (<u>abduction</u> of arm, internal rotation of shoulder, <u>pronation</u> of forearm, <u>extension</u> of wrist, *decerebrate response*)
3. Abnormal flexion to pain (<u>adduction</u> of arm, internal rotation of shoulder, <u>pronation</u> of forearm, <u>flexion</u> of wrist, *decorticate response*)
4. Flexion/Withdrawal to pain (<u>flexion</u> of elbow, <u>supination</u> of forearm, <u>flexion</u> of wrist when supra-orbital pressure applied ; pulls part of body away when nailbed pinched)
5. Localizes to pain. (Purposeful movements towards painful stimuli; e.g., hand crosses mid-line and gets above <u>clavicle</u> when supra-orbital pressure applied.)
6. Obeys commands. (The patient does simple things as asked.)

Interpretation

Individual elements as well as the sum of the score are important. Hence, the score is expressed in the form "GCS 9 = E2 V4 M3 at 07:35".

Generally, brain injury is classified as:

- Severe, with GCS ≤ 8
- Moderate, GCS 9 - 12
- Minor, GCS ≥ 13.

Intubation and severe facial/eye swelling or damage make it impossible to test the verbal and eye responses. In these circumstances, the score is given as 1 with a modifier attached for example 'E1c' where 'c' = closed, or 'V1t' where t = tube. A composite might be 'GCS 5tc'. This would mean, for example, eyes closed because of swelling = 1, intubated = 1, leaving a motor score of 3 for 'abnormal flexion'.

APPENDIX VI: PEDIATIRC GLASGOW COMA SCALE

The Pediatric Glasgow Coma Scale is the equivalent of the Glasgow Coma Scale used on children. The PGCS comprises three tests: eye, verbal and motor responses. The three values separately as well as their sum are considered. The lowest possible PGCS (the sum) is 3 (deep coma or death) whilst the highest is 15 (fully awake and aware person).

Best eye response: (E)

1. No eye opening
2. Eye opening to pain
3. Eye opening to speech
4. Eyes opening spontaneously

Best verbal response: (V) 0-5 years

1. No verbal response
2. grunts
3. cries to pain /persistent screams
4. irritable and continually cries /inappropriate words
5. normal activity/appropriate words and phrases

more than 5 years

1. None
2. Incomprehensible speech
3. Inappropriate responses, words discernible
4. Confused conversation, but able to answer questions
5. Oriented

Best motor responses: (M)

1. No motor response
2. Extension to pain (decerebrate response)
3. Abnormal flexion to pain for an infant (decorticate response)
4. Infant withdraws from pain
5. Infant withdraws from touch
6. Infant moves spontaneously or purposefully

For children under 5, the verbal response criteria are adjusted as follow

SCORE	2 to 5 YRS
5	Appropriate words or phrases
4	Inappropriate words
3	Persistent cries and/or screams
2	Grunts
1	No response

Any combined score of less than eight represents a significant risk of mortality.

APPENDIX VII: GLASGOW OUTCOME SCALE

1. DEATH

2. PERSISTENT VEGETATIVE STATE

3. SEVERE DISABILITY (conscious but disabled)

4. MODERATE DISABILITY (disabled but independent)

- Dysphasia
- hemiparesis
- ataxia
- memory deficits,
- personality changes
- Intellectual deficits.

5. GOOD RECOVERY

This is resumption to normal life even though there may be minor neuropsychological deficits.

APPENDIX VIII: CHI SQUARE CALCULATIONS

TABLE 23.OUTCOME OF GCS SCORE VERSUS DIFFERENT AGE GROUPS

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.08037836	7	0.1841
Likelihood Ratio	10.38149315	7	0.1680
N of Valid Cases	67		

There is no significant association between Glasgow comma scale and age.

TABLE 24.OUTCOME OF CT SCAN ACROSS AGE GROUPS

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.35131538	14	0.4991
Likelihood Ratio	15.4297389	14	0.3494
N of Valid Cases	67		

TABLE 25.OUTCOME OF GCS BETWEEN ADULTS AND CHILDREN

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.834764152	1	0.1756
Likelihood Ratio	1.886424452	1	0.1696
N of Valid Cases	67		

TABLE 26. OUTCOME OF CT SCAN FEATURES BETWEEN ADULT AND CHILDREN

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.882467787	2	0.6432
Likelihood Ratio	0.887580516	2	0.6416
N of Valid Cases	67		

TABLE 27. OUTCOME OF PUPILLARY REACTIONS ACROSS DIFFERENT AGE GROUPS

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.60923001	14	0.2252
Likelihood Ratio	23.27266515	14	0.05598
N of Valid Cases	67		

TABLE 28.OUTCOME OF PUPILLARY REACTION BETWEEN CHILDREN AND ADULT

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.000477532	2	0.3678
Likelihood Ratio	2.165367464	2	0.3387
N of Valid Cases	67		

All the variables above are not significantly related to the age of the patient.

TABLE 29.OUTCOME ACROSS DIFFERENT AGE GROUPS

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.12623966	7	0.1815
Likelihood Ratio	12.24831867	7	0.09268
N of Valid Cases	67		

TABLE 30.OUTCOME BETWEEN CHILDREN AND ADULT

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.228528879	1	0.0724
Likelihood Ratio	3.067528797	1	0.07987
N of Valid Cases	67		

TABLE 31.OUTCOME VERSUS GCS

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.22854562	1	0.0014
Likelihood Ratio	14.70907707	1	0.000125
Fisher's Exact Test			
N of Valid Cases	67		

Ref: KNH-ERC/ A/333   15th October 2009

Dr. Wafula Grace Taka
Dept. of Surgery
School of Medicine
University of Nairobi

Dear Dr. Taka

**RESEARCH PROPOSAL: "A PROSPECTIVE STUDY OF FACTORS THAT INFLUENCE EARLY
OUTCOME OF SEVERE TRAUMATIC BRAIN INJURY ACROSS DIFFERENT AGE GROUPS AT THE
K.N.H" (P219/7/2009)**

This is to inform you that the Kenyatta National Hospital/UON Ethics and Research Committee has
reviewed and **approved** your above revised research proposal for the period 15th October 2009
- 14th October 2010.

You will be required to request for a renewal of the approval if you intend to continue with the study
beyond the deadline given. Clearance for export of biological specimen must also be obtained from
KNH-ERC for each batch.

On behalf of the Committee, I wish you fruitful research and look forward to receiving a summary of
the research findings upon completion of the study.

This information will form part of database that will be consulted in future when processing related
research study so as to minimize chances of study duplication.

Yours sincerely

DR. L. MUCHIRI
AG SECRETARY, KNH/UON-ERC

c.c.   Prof. K.M. Bhatt, Chairperson, KNH/UON-ERC
          The Deputy Director CS, KNH
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