

**THE PATTERN AND EARLY
OUTCOME OF PAEDIATRIC
CRANIAL-CEREBRAL
INJURIES MANAGED AT
KENYATTA NATIONAL
HOSPITAL.**

**A DISSERTATION SUBMITTED IN PART
FULFILLMENT FOR THE MASTER OF MEDICINE
IN SURGERY DEGREE, UNIVERSITY OF NAIROBI.**

BY:

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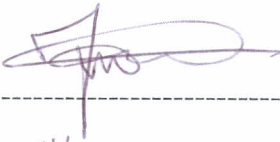
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DECLARATION

This dissertation is my original work and has not been submitted for a degree in any other university.

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DEDICATION

To all great persons who have influenced my life, especially my wife Lucy, my grandfather Karanja Ibuchio, my daughter Joy and my departed colleague, Dr. Wadie, murdered through a fatal head injury.

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LIST OF ABBREVIATIONS

AAP	American Academy of Paediatrics
A/E	Accident and Emergency
APLS	Advanced Paediatric Life Support
CT	Computed Tomograph
ER	Emergency room
ED	Emergency department
FH	Fall from a Height
GCS	Glasgow Coma Scale
GOS	Glasgow Outcome Scale
ICI	Intracranial injury
ICP	Intracranial Pressure
ICU	Intensive care unit
KNH	Kenyatta National Hospital
LOC	Loss of consciousness
MRI	Magnetic resonance imaging
MSE	Mental State Exam
MVA	Motor vehicle Accident
NAI	Non- accidental injury
ORIF	Open reduction and internal fixation
RTA	Road Traffic Accident
TBI	Traumatic brain injury
USA	United States of America

SUMMARY

This is a prospective study of children below 13 years with head injuries, seen at the Kenyatta National Hospital over a period of five months from October 2004 to February 2005.

A total of 101 children were managed 64 males and 36 females (Male to female ratio was 1.7:1)

Their mean age was 4.9 years (range 3months-12years).

The commonest cause of head injury was fall from a height (65.3%) followed by road traffic accident (26.7%) and assaults (7.9%). Most of the falls were from balconies (57.6%)

The mean time interval between trauma and admission into hospital was 7 hours.

Most of the patients were admitted with mild head injuries (83.2%) while 8.9% had severe injuries.

Skull radiographs were done in 95% of the cases and were positive for skull fractures in half of them.

Computerized tomography (CT) scan of the head was done in only 24% of the patients. The clinical indicators for a CT were good predictors of intracranial injury (ICI). 6 patients with ICI had no skull fracture.

21 patients had cranial surgery 10 of who had a surgical toilet. 5 patients had extra cranial surgery.

Factors that were associated with poor outcome in the first 24 hours of admission were admission Glasgow coma score, papillary signs, focal neurological signs and CT signs of brain injury.

The average duration of hospital stay was 7.2 days.

There was a 1% overall mortality and a 13 % poor functional outcome at discharge.

INTRODUCTION

Head injury is a common clinical problem in the paediatric population worldwide. It may occur as the only injury or as one entity in polytrauma. Head injury causes significant morbidity in the immediate period. Subsequent deterioration, from intracranial complications, may result in death or recovery with severe neurological or/and neuropsychological deficits. Cognitive dysfunction following head injuries may manifest as a delayed complication many years later. These long-term sequelae and consequences are often more devastating in children than in adults. The financial costs involved in the care of a child with Traumatic brain injury (TBI) are a heavy burden when extended over the child's lifetime.

Prompt and accurate diagnosis of the pathology depends on a careful analysis of the presenting history, the physical findings and imaging. An assessment of severity of the injuries determines the management process and may help predict the eventual outcome. Various protocols have been designed to aid in clinical decision-making.

Whereas most patients will present with apparently minor head injuries with expected good clinical outcomes, failure to identify the few at risk of severe/ permanent brain injury, can be of serious medical and legal consequences. In a resource deficient environment, triaging of patients depends largely on clinical assessment. The utility of plain radiographs is controversial while CT scans and MRI, despite having better predictive results, are still not easily accessible. The clinician must therefore appropriately assess, manage, and follow up the patient.

Children differ from adults in their behavioral and anthropological predispositions to head trauma and different populations exhibit varying patterns of injuries. The many differences in epidemiology, mechanism, pathophysiology and outcome of head injury in childhood, makes reasonable the separation of "paediatric neurotraumatology" as an entity.

An understanding of the causes, risk factors, management considerations and outcome prognostication in a local setting will help advice on prevention, triage, appropriate consultation and effective resource allocation in the management of paediatric head injuries.

LITERATURE REVIEW

DEFINITION

The definition of head injury varies with authors. In this context, Head Injury includes physical insults to that part of the head covering, enclosing and including the brain. Such may follow blunt forces exerted to the cranium, shearing forces to the brain, as well as penetrating injuries.

INJURIES IN CHILDREN

The epidemiology, mechanisms, pathophysiology and outcomes of head injury in children differ from those in the adult population (1). Children exhibit both anthropometrical and biomechanical differences from adults.

- a) Children have a bigger head-to-torso ratio and hence have a higher center of gravity. This magnifies the angular biomechanical forces, which cause acceleration and deceleration in a trauma victim (2).
- b) The presence of open sutures and fontanels.
- c) Thin, soft and hence more resilient bones that absorb more impact.

Numerous mechanisms of injury are unique to the child, including walker injuries, sport injuries, falls, and child abuse, the "shaken baby" syndrome as well as those injuries common to all age groups.

Children's resting cerebral blood flow is higher. The cerebrovascular response in head injury allows a physiological response that provides for quicker edema formation but also faster functional and anatomical recovery. (2)

In response to the same focal impact, young children experience less amount of neuronal damage than the older children or adults.

Special management challenges in children arise from the small systemic blood volume, temperature instability, and difficulty in imaging or intubating small children.

Outcome after surgery has also been shown to be better in children than in adults. This is possibly due to the greater plasticity of the brain in childhood. A significant high number of children recover without neurological residual deficit.

SIGNIFICANCE OF HEAD INJURIES

The significance of head trauma lays mainly on the risk of brain injury. Brain injury is the most common cause of paediatric traumatic death. It may also result in physical and functional alterations that affect the neurological, psychological and cognitive functions of the child.

Injuries in young people are likely to have enduring physical, emotional, and financial consequences.

Childhood trauma is for the most part preventable and the impact of prevention strategies can be measured in terms of lives saved, disabilities prevented and hospitalizations avoided. These result in great monetary savings. (3)

Mortality

The case specific mortality of head injuries exceeds that of any other form of traumatic injuries. Head injury accounts for up to half of all deaths from trauma (4). Shokunbi observed that while head trauma accounted for only 2% of trauma cases admitted, the mortality rate was 10 times that of all other trauma patients. (5)

Physical/morphological consequences

Post trauma MRI several months after the injury have shown cerebral morphological and volumetric changes. Changes seen include an increase in total prefrontal CSF volume, a decrease in gray mater volume, hemosiderin deposits, encephalomalacia, and cerebellar atrophy. The lesions are commonly located in frontal lobes, the basal ganglia, and the cerebellum. (6)

Physiological consequences

The risk of epilepsy is increased after even mild head injuries than in controls. (7)

Cognitive consequences

Children who suffer head injuries are more likely than children from the general population to have limitations in physical health, and cognitive function causing poor school performance and altered social behavior. Such children demand special schools, rehabilitation and social services. (8)

Severe head injuries are more likely to cause these functional limitations than less severe injuries.

Neoplastic changes

A weak association has been described between childhood head trauma and the development of brain tumors. (9) The risk of a brain tumor among children with a previous head injury that results in medical attention is slightly elevated when compared with children with no reported head injury.

Poly-trauma patients

The presence of a cranial-cerebral injury in a multiply injured patient increases the mortality significantly. Rupperecht H. et al demonstrated that the severity and the prognosis of polytrauma depended on the extent of the brain injury. (10)

Family impact

More than a third of families report a negative impact of TBI on the family dynamics (finances, breakups, loss of job) and/or sibling behavior (fear and withdrawal from the injured child). (11) Primary carers are at greatest risk of poor psychosocial outcome, and a number of secondary and tertiary carers also display high levels of psychological distress (anger, fatigue, depression and anxiety. (12) The economic burden of TBI in the acute-care setting is substantial. (13)

EPIDEMIOLOGY

Incidence

Few studies have described the population-based incidence of head injuries. Most have reported incidence among patients attending or admitted to hospitals.

A 10-year surveillance study linked to census counts in the USA between 1983-1992, found the incidence of neurological injuries resulting in hospitalization or death was **155** incidents per 100,000 population per year. (14) Other studies in the developed world report similar incidences of **150-200 per 100000** population per year.

Higher incidences are estimated in the developing countries.

Children account for **20-30%** of all head injury patients admitted to hospitals.(15)

Age

The mean age varies diversely (18-77) months and admission rates vary depending on the local protocols and availability of inpatient and imaging facilities.

Sex

Males are about **twice** more commonly affected than females. (16)

Severity

The majority of the injuries are **minor** (70-90%) while severe injuries range from (4-20%) of the cases. Case specific mortality is low except for the severe forms of head injuries. It ranges between **2-6%**. (17)

Local studies:

A prospective 6-month study on head injuries at KNH by Mwang'ombe in 1979 found 10.3 % of all the patients admitted were between ages 0-10 years. An extra 11.4% were aged between 11-20 years. (18)

Lubanga, in a 5-year retrospective study of 486 patients at KNH, found an increasing number of admissions from 77 in 1981 to 117 in 1985. The mean age was 4.65 years, (range 2months to 12 .5 years). M: F ratio was 1.12:1. (19)

Risk factors

Age

Younger children have increased risk due to their small size and inability to protect themselves whereas increased risk in older children results from increased exposure to hazards (RTAs) and increased risk taking behaviour. (3)

Forces

The degree of cranial-cerebral injury may relate to the magnitude of forces implicated. However, other factor alters the physical application and the physiological response. e.g. contraction of the neck muscles, tangent of the forces and nature of the surface.

Majority of them are falls from a height. (16)

In Canada Falls from heights account for 47% of injuries in children aged 0-9 years. (27)

In China, falls from a height account for majority of the falls in young children, but falls from bicycles or during play are more common in school going children. (28)

Bulut observed falls were the most common mechanism for injury children in Turkey, comprising 38% of admissions. 47% of falls were from balconies. (29)

The severity of sustained injuries varies with the age of the patient and the height of the fall relative to the patient's height. Children sustaining falls ≤ 3 ft [0.9 m], with no history of neurologic symptoms, have a very low risk of intra-cranial complications. (30) This is however held in controversy. (31)

2. MVAs (motor vehicle accidents) / RTAs (Road Traffic Accidents)

These account for 10-20 % of the injuries. Most of these are pedestrian injuries

They account for most of the severe head injuries and for most of the fatalities. (16)

3. Assaults:

These are less common than in adults

4. Birth Injuries:

These may follow vacuum assisted deliveries or forceps trauma. They present as cephalohematomas or skull fractures. Dural defects may form growing skull fractures.

Special circumstances e.g. war; refugee camps and natural disasters present special patterns of injuries.

Aetiologic patterns

Many Studies in the US describe aetiology of hospitalized head injuries as: Falls (53%), MVAs (17%), and Abuse (14%). (16)

Among children admitted to hospitals, falls are most common in children younger than 4 years, pedestrian motor vehicle accidents are most common in late childhood, and assaults are most common in early adolescence. (14)

Similar findings have been observed in Hong Kong. (32)

Fall from a height was the major cause of head injury leading to admission in infants and children in preschool age groups, whereas traffic-related or bicycle-related accidents were more likely to be the cause of head injury for those aged 11-15 years.

The two most frequent causes of paediatric head injury in Nigeria were falls at home (40%) and pedestrian-vehicular accidents (38%). (5)

Lubanga's local study in children found that falls from a height accounted for 50%, RTA for 41.5% and Assaults for 8.5% of the admissions.

Falls were more common in younger children while RTAs accounted for most Head Injuries in older children. (19)

The study did not evaluate the injury severity or CT scan evaluation.

Mwan'gombe and Kiboi, in an extensive 5-year retrospective study on outcomes following severe head injuries, identified children 0-13 years accounted for 10% of the patients with severe injuries. This group had best outcome GCS at discharge. (33)

Pathophysiology

The pathophysiology associated with head injury can be classified into primary or secondary brain injury:

Primary brain injury –

This occurs at the time of injury as mechanical forces are exerted onto the brain. Linear contact forces are exerted by the interior surface of the skull or foreign bodies causing direct contact injury and contusion. Inertial forces result from acceleration, deceleration and angular rotational movements of the brain relative to the skull. This is the target of primary community based preventive strategies.

Secondary brain injury –

This refers to a cascade of physiologic and biochemical reactions that occur after primary brain injury. Mechanisms include hypoxia, raised intracranial pressure and decreased blood flow. These result in increased release of excitatory transmitters, formation of free radicals, increased intracellular proteolysis and inflammation. This increases apoptosis and neurodegradation. (34)

Secondary cerebral stresses of systemic origin such as hypotension, hypoxaemia, hypercarbia, and anaemia in severely head injured children have been shown to have significant impact on mortality and morbidity in the short- and long-term. (35)

The focus of current management and most investigational therapies is aimed at preventing or minimizing secondary brain injury.

Mechanisms

Injurious forces may be exerted to the brain substance through the following mechanisms.

1. Dynamic loading. This forms the majority of the injuries.

2. Static loading

Static loading occurs when forces are applied slowly to the head, as when the head is ran over by a slow moving motor vehicle or when the child pulls on a heavy object, which then falls with the child and lands on the head.

3. Penetrating injuries/ stabs

These result from instruments penetrating the skull including bullets, screws, pencils, nails etc. Buaer observed no regional preference despite differences in bone thickness, and that stab wounds of the brain are almost invariably associated with multiple stab wounds to the trunk.³⁶

Spectrum of injuries

Anatomical classification

1. Scalp Lacerations

Scalp lacerations are very common in children and may overlie a significant brain injury. Exploration of the wound with a gloved finger should be done to feel for an underlying fracture. If there is no fracture, the laceration is cleaned and stitched. If a fracture is present, further assessment and thorough surgical toilet is required. Tetanus status should be checked. A scalp haematoma could overlie a fracture.

2. Fracture skull

These could be simple (closed) or compound (open) depending on the integrity of the overlying scalp

Linear Skull Fractures

Linear skull fractures are the most common skull fractures identified on plain skull radiographs. The presence of a fracture reflects significant impact and therefore increased potential for underlying brain injury. Fractures that cross the path of the middle meningeal artery or dural sinuses are at greater risk for intracranial bleed. Simple linear fractures require no surgical intervention.

b. Depressed Skull Fractures

Depressed skull fractures account for 10- 20% of fractures in children. The inner table of the skull is displaced downwards. Surgical elevation is necessary when the depression is greater than the thickness of the skull. A depressed fracture may be hidden under a scalp haematoma.

c. Base of Skull Fractures

Base of skull fractures are difficult to diagnose radiologically. The diagnosis of a base of skull fracture should be suspected based on clinical findings such as associated cerebrospinal fluid otorrhoea and rhinorrhoea, haemotympanum, Battle's sign (mastoid ecchymosis), and racoon eyes (periorbital ecchymosis).

3. Concussion

A concussion is a traumatically induced temporary alteration in mental status, associated with *confusion, loss of consciousness and post-traumatic amnesia*. Symptoms may present for several hours after the injury but most patients become normal within a few hours.

4. Post-Traumatic Seizures

Seizures may occur in the immediate, early or late periods after injury.

Immediate seizures: occur *within seconds* of the injury and represent traumatic *depolarization*. These patients do not require extensive workup if they are normal on presentation. They require no medication and have no long-term sequelae.

Early seizures: occur *within 1 week* of injury and are the result of focal injury to the brain. 25% of children presenting with early seizure have recurrences. These children should be evaluated with imaging and electroencephalogram (EEG) and may need anticonvulsant therapy. They need to be reviewed by a paediatric neurologist.

Late seizures: occur after *more than 1 week* of the injury and are attributed to scarring of brain tissue. Most of these patients require anticonvulsant therapy to prevent recurrences. Review by the paediatric neurologist is also mandatory.

5. Intracranial Haematomas

a. Epidural/ Extradural Haematoma

This is a collection of blood between the skull and the dura mater. An overlying fracture is present in 75% of cases. Classically, the child has initial loss of consciousness followed by a *lucid interval* and then subsequent deterioration. An epidural haematoma requires immediate surgical evacuation.

b. Subdural Haematoma

A subdural haematoma is a collection of blood between the dura mater and the brain parenchyma resulting from direct trauma or child abuse. A large subdural haematoma requires surgical evacuation while small ones can be observed.

c. Intracerebral Haematoma

These result from vascular injuries or intracerebral accumulation following contusional injuries

Head Injury and Child Abuse

Most abused children are infants and children less than 3 to 6 years. Intracranial lesions are more common from such abusive head injuries.

Non-accidental head injuries can result from shaking (Shaken baby syndrome), direct impact or from a combination of the two. It is characterised by subarachnoid haemorrhage or subdural bleeds with retinal haemorrhages. Severity of injury is higher in abused children. (12, 16)

Head injury associated with physical abuse carries a significantly worse clinical outcome than accidental trauma.

MANAGEMENT OF PAEDIATRIC HEAD INJURY

Clinical guidelines for management of head injuries are designed for specific institutions based on the incidence of injuries and the facilities available.

The main principals are outlined by AAP (38, 39)

Management priorities

1 Resuscitation

The first step in the management of children with head injuries is the assessment of the airway, breathing and circulation. (A B C)

Prompt treatment of shock and hypoxia are mandatory to prevent secondary brain injury.

Following APLS guidelines assessment involves:

- Primary Survey
- Resuscitation
- Secondary Survey
- Definitive Management and/or Transfer

One should also consider that the cervical spine might have been injured.

2 History Taking

A brief history of the event including:

- ✓ Time of injury,
- ✓ Mechanism of injury e.g. height of fall, the surface of contact, speed of the vehicle,
- ✓ Symptoms and their progression since the injury, including: LOC, vomiting, headache, seizures, confusion, amnesia, irritability, lethargy, or agitation.
- ✓ Details of any significant medical history eg.epilepsy, previous ventriculo- peritoneal shunt insertion or a bleeding diathesis
- ✓ History of alcohol or other drug use

Many children will vomit 2- 3 times or have transient loss of consciousness (≤ 1 minute) or a brief seizure after even a minor head injury. However, repeated seizures or protracted vomiting associated with other symptoms or signs indicate a more severe head injury.

3 Physical Findings

- Vital signs. (Pulse, respiratory rate, blood pressure, Temperature)
- Head examination: looking for scalp haematoma, depressed fracture, haemotympanum, or CSF leaking from the nose or ear.

The neurological examination should include the following:

- Eye examination,
- Mental status examination,

A quick and simple **mental status examination** uses the AVPU method, which describes the level of consciousness as follows:

- **A** - Alert
- **V** - responds to Vocal stimuli
- **P** - responds only to Painful stimuli
- **U** - Unresponsive

- Cranial nerve examination, and
- Checking the extremities for movements.

The neurological examination helps to determine the presence of focal neurological signs

- Complete physical examination for other injuries is carried out.

4) Severity assessment and triage

Glasgow Coma Scale (GCS)

The conscious state of the patient, based on the Glasgow Coma Scale (GCS), is an important indicator of severity of the injury, helps predict intracranial deterioration and influences treatment decisions and outcomes.

GCS is a qualitative measure of consciousness level based on the sum of scores in 3 areas of assessment: eye opening, motor response and verbal response.

The verbal response in the GCS has been modified for children less than 2 years of age, who have limited verbal skills.

The Modified Glasgow Coma Scale

Eye- opening response

>1 year	< 1 year
4 Spontaneous	4 Spontaneous
3 To speech/verbal command	3 To shout
2 To pain	2 To pain
1 None	1 none

Best limb motor response

> 1 year	< 1 year
6 Obeys commands	6 Normal movements
5 Localizes to pain	5 localizes to noxious stimuli
4 Withdraws	4 Flexion withdrawal
3 Abnormal flexion	3 Flexion/ Decorticate posturing
2 Extensor response	2 Extension/ decerebrate posturing
1 None	1 No response to noxious stimuli

Verbal response

>5 years	2-5 years	<2 years
5 Oriented	5 Appropriate words/ phrases	5 appropriate smiles, Coo or cry
4 Confused conversation	4 Inappropriate words	4 Consolable cry, screams
3 Inappropriate words	3 Cries/ screams	3 Inconsolable/ irritable
2 Incomprehensible sounds	2 Grunts	2 Grunts/agitated
1 None	1 None	1 None

Children less than 2 years of age should receive full verbal score for crying after stimulation. If a person is intubated, Verbal response is indicated as T.

Classification of severity of head injury

A common way of grading the severity of head injury is based on the GCS is:

Minor Head Injury - GCS 13- 15

Moderate Head Injury - GCS 9- 12

Severe Head Injury - GCS 4- 8

This has been shown to have a good predictive value of morbidity and mortality, and guides the triaging and management of patients.

The Glasgow Coma Scale has the advantage of being an examination with a quantitative analysis, which minimizes inter-observer variation.

5. FURTHER MANAGEMENT

Minor head injury

Minor head injury, with brief or no loss of consciousness, is seen in most of the children. However, the GCS classification of minor head injury (GCS 13- 15) has been shown to be inadequate as there is a heterogeneous pathophysiology among patients with GCS scores in the 13-15 range. (39, 40)

The management of mild head injuries has remained controversial. Reports of neurologically intact (GCS 15) children with intracranial injuries have caused many to recommend cautious management, while the infrequency of serious intracranial injuries after minor head trauma have prompted others to be less conservative. (40, 41)

Duus BR. et al (42) found intracranial complications (ICC) in 9 out of 1876 patient classed as minor head injuries. The risk of developing an ICC was predicted significantly by the presence of agitation, amnesia >5 minutes, vomiting, impaired consciousness and positive neurological signs.

Iverson GL (43) and others observed abnormal CT findings in 16-21% of patients with GCS 13-15. There was relationship between the presence of intracranial abnormalities with lower GCS scores, frequency of LOC and skull fractures.

Batchelor and McGuinness (40) identified five predictive symptoms with varying odds ratio for an abnormal head tomogram. These were: dizziness, blurred vision, severe headache, nausea and vomiting

Borcuk P. (44) Found abnormal CT scan in 8.2% of patients with GCS 13 and above after blunt head trauma. These were predicted significantly with the presence of cranial soft-tissue injury, a focal neurologic deficit and signs of basilar skull fracture.

The neurological examination (including mental status and the GCS) has been shown to be the best predictor of subsequent deterioration and/or intracranial haemorrhage requiring surgical intervention in patients

Consequently, the degree of risk of deterioration from intracranial injuries can be estimated on the basis of the child's history and the findings at physical and neurological examination. Thus patients can be classified into low risk, medium risk and high-risk minor head injuries as characterized by:

Low risk

- ❖ Asymptomatic
- ❖ Mild or no headache
- ❖ Vomiting (< 3 episodes)
- ❖ Glasgow Coma Scale score of 15
- ❖ Transient loss of consciousness (seconds)
- ❖ Scalp injury - bruise or laceration

Medium risk

- ❖ Loss of consciousness (> 1 minute)
- ❖ Progressive lethargy, progressive headache
- ❖ Vomiting protracted (> 3 times) or associated with other symptoms
- ❖ Post- traumatic amnesia, Post- traumatic seizure
- ❖ Multiple trauma
- ❖ Serious facial injury
- ❖ Signs of basal skull fracture
- ❖ Possible penetrating injury or depressed skull fracture
- ❖ Possible child abuse
- ❖ Neonate or young child (< 2 years)
- ❖ Glasgow Coma Scale score of 13- 14

High risk

- ❖ Glasgow Coma Scale score of 13, or decrease of ≤ 2 points, not clearly caused by seizures, drugs, decreased cerebral perfusion or metabolic factors
- ❖ Focal neurologic signs
- ❖ Penetrating skull injury
- ❖ Palpable depressed skull fracture
- ❖ Compound skull fracture

1. Management of minor Head Injuries

The goal is to identify those at risk of late deterioration particularly from intracranial bleeding. This is achieved through good clinical assessment and selective CT scanning.

1) APLS directed assessment and early management

Low risk mild injuries

A CT scan may be avoided if patients have a normal neurological evaluation and show no signs of basal or depressed fractures. (45)

Some authors however advocate mandatory use of early CT in all cases of minor HI to help avoid unnecessary hospitalization. These argue that CT scan is the only reliable assessment and would reduce avoidable mortality and morbidity by identifying the patients who are at higher risk than is at first evident. (46)

A normal CT scan is the most accurate way of excluding intracranial injury and reducing the likelihood of late deterioration

2) Imaging

The following subgroup requires **early CT scanning (<2hrs)**

- i. Penetrating skull injury
- ii. Depressed skull fracture (open and closed)
- iii. Focal neurological deficit
- iv. Post-traumatic seizure (after 1st hour post injury)
- v. Decreasing level of consciousness (> 2 GCS points)

3) All other mild head injuries with a history of a true injury to the head require neurological observation for **4 hours**:

These including **half hourly** neurological observations recording:

- * GCS
- * Pupil size and reactivity
- * Power in limbs
- * Vital signs (BP, pulse, respiration.)

At 4 hours, clinical assessment and categorization into the risk groups based on GCS and clinical features is repeated.

If CT scan is normal or shows only uncomplicated fracture, and children have responsible carers, then discharge can be considered. (47)

Admission may be required if no appropriate carer, late at night or persistent disabling symptoms e.g. vomiting.

High/Moderate Risk mild injuries

These are at a greater risk of intracranial pathology and require a **semi-urgent** CT scan (<4hrs)

- a. GCS <15 after 4 hrs observation
- b. Progressive headache or persistent vomiting >4 hrs
- c. Intoxication with drugs/alcohol where conscious state does not improve in 2hrs
- d. Children < 2 years with any persistent symptoms including scalp haematoma
- e. Unconscious > 5 mins & persistent symptoms after 4 hrs observation
- f. Persistent confusion or PTA (i.e. inability to hold new memories) after 4 hrs observations
- g. Significant subgaleal haematoma (may signify an underlying skull fracture) and warrants a non-urgent CT scan
- h. Patients on anticoagulants & residual symptoms at 4 hrs

The following require CT scanning on a **non-urgent** basis (<12hrs) if clinically stable

- Clinical evidence of a base of skull fracture
- Skull fracture (on Skull x-ray when already performed)
- Ongoing post concussional symptoms
- Reasonable suspicion of NAI. All children with suspicion of NAI require admission for assessment

NB: CT scanning in children <10 years may require general anaesthesia.

Indicators for Admission of mild injuries

- GCS <15
- CT abnormality except simple uncomplicated fracture
- Delayed seizure
- Disabling symptoms
- Inadequate supervision / poor access to medical care/NAI

Children may also be admitted at the discretion of the doctor in regard of other local and social factors. Brown observed that easy access to hospital beds was more influential than clinical findings in determining admission.(16)

Management of Mild Head Injury on Wards

- I. **1hrly** Neurological observations
- II. Clear fluids orally for 6 hours, IV fluids if persistent vomiting
- III. Simple analgesia e.g. Paracetamol
- IV. Reassess and consider CT scan if patient develops neurological symptoms, GCS decline or persistent vomiting >4hrs after admission
- V. Consider **discharge >12 hrs** if asymptomatic

Discharge Requirements:

- Orientated time and place (GCS 15)
- No focal neurological signs
- Mild / moderate headache only
- No complicated skull fracture (if x-ray already performed)
- A responsible person available to continue observation of patient (best with access to phone and transport)
- Satisfied that the mechanism was accidental
- OR
- Normal CT scan (if done) without skull fracture or with uncomplicated fracture only

Discharge instructions (48)

Carers are advised to return the patient to hospital if they observe:

- Increasing headache
- Persistent vomiting
- Restlessness or drowsiness
- Seizures

Information regarding post concussion syndrome and where to seek assistance is also important.

2: Management of Moderate Head Injury (GCS 9-12)

“APLS” directed assessment and early management

Neurological observations:

If not improved in 2 hours: CT scan

Discuss with ICU as likely to require intubation

If improved (GCS to 13-15) continue as for “Minor HI”

Admit under Neurosurgery management if: GCS 9-12 or CT abnormality

All must be seen and assessed by the Neurosurgical Team

3: Management of Severe Head Injury (GCS 3-8)

- ✓ Full resuscitation (“ABC”) and assessment as for APLS guidelines:
- ✓ Aim for: PaO₂ > 80 mmHg, PaCO₂ 35 - 40 mmHg, BP systolic > 100 mmHg (Or age appropriate equivalents)
- ✓ If no improvement after full resuscitation ALL require endotracheal intubation for airway protection and facilitation of ventilation
- ✓ CT scan (immediately after resuscitation and stabilization)
- ✓ If evidence of raised ICP or risk of intracranial herniation: ie.
 - Deteriorating GCS > 2 points
 - Dilating pupil
 - Developing focal signs
 - Extensor posturing
 - Cushing’s reflex (hypertension, bradycardia)

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Diuretics: Mannitol (0.25g/kg) +/- Frusemide to be used in transit to CT scanner

- ✓ Neurosurgical consultation is required in all such patients
- ✓ Further management dependent on CT findings:
- ✓ ? Operating Theatre (for elevation, hematoma drainage etc)
- ✓ ? ICU (for ventilation, ICP monitoring)

NEUROIMAGING

1. Skull X- ray

Before the advent of CT, this was the only imaging study available for evaluation of children with head injuries. Skull X-rays were systematically performed on children after head injuries.

Current literature suggests that skull X- rays are not useful and should not routinely be obtained in patients with head injuries. This is much so where CT scanning facility is readily available. (49)

Skull radiographs only show fractures and do not afford visibility of either brain or blood to demonstrate an intracranial injury. The presence of a skull fracture without neurological abnormalities is of little management significance. Similarly, the discovery of a skull fracture as an isolated finding rarely warrants intervention.

Patients with intracranial injuries most commonly show neurological deficits and/or unconsciousness, indicative of intracranial injury with a high degree of probability than the presence of a skull fracture. The use of X-ray to decide whether or not CT is necessary is therefore not warranted. (50)

Management decisions are based primarily on a careful neurological examination and when intracranial injuries are a concern, a CT scan should be obtained. (51)

It would be a mistake to be reassured about the severity of a head trauma because skull X-rays are normal. Routine skull X-rays after head trauma are not justified either for financial or radioprotection reasons.

The suggested indications for skull radiography are:

- ❖ Possible penetration/possible-depressed fracture / compound fracture
- ❖ Previous craniotomy with indwelling shunt
- ❖ Child with a boggy scalp haematoma
- ❖ Suspected child abuse

These criteria permit economy with skull X-rays and indicate when to use other diagnostic means (CT).

2. Computerized Tomography (CT) of the Head

CT is currently the first line imaging technique for traumatic head injury where available.

The value of CT is the demonstration of scalp, bone, extra-axial hematomas and parenchymal injury. Dislocation of the midline structures or cortical relief shows the mass effect of intracranial hemorrhage. In many cases localized edema can be identified.

It is rapid and easily done in the presence of the multiple monitors that many trauma patients have in place. It can be used to demonstrate the bony anatomy of the spine and is good for evaluation of abdominal and chest trauma in polytrauma. (52)

CT Head has virtually supplanted skull x- rays for acute assessment.

Some authors recommend a mandatory cranial CT scan in patients with even the mild head injuries arguing that it stands more predictive of intracranial injury than any clinical findings. (46). Many others however emphasize the need to document clinical indicators of ICI and limit its use to children with ongoing specific symptoms and/or focal neurological signs, which have been shown to be sensitive predictors of ICI. (45)

CT is still expensive and not readily accessible to many patients. It sometimes requires sedation of the patient, and always requires skilled interpretation. Using it in assessing all head injuries would both tax limited scanning facilities and result in unnecessary exposure to radiation. The management significance of some subtle radiological changes is also controversial. (53)

Clinical assessment should therefore guide the selection of patients to undergo CT scanning.

General guidelines for CT scanning:

A. Absolute indications:

- GCS < 9 after resuscitation
- GCS 9 - 12 persisting after 2 hours
- Neurological deterioration: Deterioration GCS > 2, focal signs
- Focal neurological signs, Penetrating injury or depressed skull fracture

B. Relative indications (dependent on availability):

- GCS 13 - 14 after 4 hours
- Persistent severe headache, vomiting
- Post-traumatic amnesia
- Seizures
- Signs basal skull fracture (non-urgent)
- Radiological skull fracture
- Higher risk patient: age < 2yr, coagulation defects
- Assessment difficult e.g. alcohol intoxication
- Suspected non-accidental injury

In children with skull fractures altered conscious level is the main indication for urgent CT scanning.

Patients with mild head injuries, cleared on CT scan, are unlikely to develop further significant deterioration and can be safely discharged home from the emergency department.

Frontal, temporal and parietal regions in that order account for the most focal sites of injuries on computed tomogram. (28)

3. Magnetic Resonance Imaging (MRI) of the Head

MRI is more sensitive for all posttraumatic lesions other than skull fracture and subarachnoid hemorrhage, and can demonstrate subtle sub acute contusions and parenchyma brainstem and spinal cord injury. It helps visualize diffuse axonal injury and contusions better. The extent

and location of both hemorrhagic and nonhemorrhagic injuries are better-visualized and thereby providing prognostic information. Its utility is interfered by certain monitors and ventilators outside the MRI magnetic field.

MRI will be used increasingly to study early head injury because of its ability to measure cerebral blood flow, cerebral blood volume and the location and extent of cerebral edema. If the CT does not demonstrate pathology adequate to account for the clinical state, MRI is warranted.

Follow up is best done with MRI, as it is more sensitive to parenchymal change than is CT. (52) Owing to the fact that acute lesions may be missed, it is advisable to perform MRI in the first 2 weeks following trauma. (54)

In some developed countries, MRI has become the first line imaging modality in medium and high-risk patients while in young infants first undergo Ultrasound Study first. HR-CT is reserved for lesions of the visceral cranium. X rays are out. (55)

Early proton magnetic resonance spectroscopy has also been used to demonstrate functional changes in normal-appearing brain. (56)

MRI is however still not readily available nor affordable in many places especially for emergency services and should be used mainly for follow- up studies as a supplementary examination

4. TRANS-CRANIAL ULTRASOUND SCAN AND DOPPLER

Transcranial Doppler ultrasonography (TCD) is a non-invasive technique for the assessment of cerebral blood flow. By measuring the blood velocity and the resistance index, cerebral perfusion pressure can be calculated. These can be used to estimate intracranial pressure. (57) A significant correlation is found between changes in blood flow parameters and neurological status. (58)

5. ELECTROENCEPHALOGRAM (EEG)

EEG can be used for detecting posttraumatic pathologic unspecific alterations with a high accuracy, but is not useful in specifying the findings for an exact diagnosis. (59)

6. SPECT (single photon emission computed Tomography)

This has been used in assessing cerebral perfusion after trauma. SPECT evaluation may be a useful additional tool in the objective assessment of posttraumatic amnesia.(60)

7. BIOLOGICAL MARKERS

Neuron specific enolase (NSE) and **protein S-100B** are considered to be specific neurobiochemical indicators of damage to glial (S-100B) or neuronal (NSE) brain tissue.

Their serum assays have been shown to closely associate with intracranial pathologic changes as demonstrated in computerized tomography (CT). Assays and duration of release relate to the severity of TBI based on the GCS. Serum concentrations of NSE and S-100B significantly correlated with the volume of contusions, even when not evident on CT. (61)

These markers are therefore useful in assessing severity and prognosticating the outcomes.

FOLLOWUP

Although most HI children make good physical recovery, cognitive and behavioural problems concomitant with deterioration in school performance, are more common compared with those with lesser or no head injury. (62)

This highlights the need for rehabilitation services to enable a gradual return into regular school. (8)

COMPLICATIONS OF HEAD INJURIES

Meningitis

This occurs in 1% of patients with basal skull fractures. Use of antibiotics to prevent its occurrence depends on local clinical guidelines.

Post traumatic complains

Many patients experience posttraumatic complaints, (PTC). These include headache dizziness, and drowsiness. The presence of these following a mild TBI is strongly associated with the severity of the injury as related to increased serum biochemical markers (neurone specific enolase and S-100B) concentrations. (63)

Cognitive dysfunction

The brain injury sustained by a child occurs concurrently with development. Despite returning to school, children may present with severe learning difficulties years after the injury has been forgotten or discounted. The simple act of returning to school is not an acceptable index for recovery. Nelson has demonstrated retrieval deficits as an important component of memory difficulties post-severe closed head injury. This retards the ability to learn new information, particularly the rate of learning with significant academic and career implications. (62)

The final assessment of outcome after childhood traumatic brain-injury should be done only after several years.

Functional limitations in physical health, behavioral problems, and educational difficulties program have been observed in all levels of head injury severity, although children with severe head injuries were more likely to demonstrate these functional limitations than were children with less severe injuries.

This underscores the importance of evaluating all children hospitalized with head injuries for functional limitations and providing rehabilitation and social services when needed.

Others

Other complications of severe head injuries: include Posttraumatic hydrocephalus, hygromas, chronic subdural hematomas, intracranial abscess and arterial venous fistulae.

OUTCOMES

Severely injured patient have worse outcomes.

Mwang'ombe and Kiboi studied the outcome of severe injuries treated in the same institution.

(33) They recorded age specific mortality of 35.7% in patients below 13 years.

Sousa observed 25% functional outcome and 75% poor outcome (death and severe disability) in severely injured patients (64).

Mortality is lower in milder injuries. Overall mortality rates of 1-3 % have been reported. (19, 29)

Functional and cognitive recovery is variable and may be delayed or impaired. Most cases of mild head injury in young children do not produce any adverse effects, but long-term problems in psychosocial function occur in more severe cases, especially when this event occurs during the preschool years. (65)

The view that all mild head injuries in children are benign events requires revision and more objective measures are required to identify cases at risk.

This emphasizes the need for close follow up and rehabilitation of the patients and their families.

OUTCOME ASSESMENT

The **Glasgow outcome scale (GOS)** is employed in outcome assessment. (66)

Score	Meaning
5	Good recovery-resumption of normal life despite minor deficits
4	Moderate disability (disabled but independent)
3	Severe disability (conscious but disabled)-dependent
2	Persistent vegetative state-unresponsive and speechless
1	Death

PROGNOSTIC FACTORS

- 1) GCS: Initial GCS and that at 24 hours are of prognostic significance. (33)
- 2) CT scan findings:
Compression of the basal cisterns on the initial CT scans is associated with poor outcomes. (64,66)
- 3) Injury severity

Severely injured patient have worse outcomes. (64) Minor injuries GCS 13 and above have best outcomes.
- 4) Hypoxia on admission is associated with a poor outcome.
- 5) Hypotension is profoundly detrimental and associated with increased mortality. (33)
- 6) Electrolyte derangements occurring during admission strongly correlate with the outcome.
- 7) Age

Younger children have better morphological and functional outcomes after severe head injuries. (66,33)

This difference is thought to be related to the greater plasticity and to the better rehabilitation effect in younger brain.
- 8) Duration of posttraumatic amnesia

The duration of coma and of post-traumatic amnesia correlate strongly with the occurrence of neurological, behavioural and intellectual residual sequelae. (25)
- 9) Premorbid psychosocial state. (67)
- 10) Poly trauma. This may worsen the hypotension.
- 11) Adequacy of initial management

PREVENTION OF HEAD INJURIES.

Various strategies have been employed going hand in hand with general trauma prevention.

However, nothing can replace close supervision that an adult caregiver can provide, in childhood injury prevention.

Infants and toddlers

These should not be left unattended, on an adult bed or baby cot without proper barriers. Baby walkers can topple over and cause head injuries. Violent shaking of babies is discouraged since it can cause severe and fatal internal head bleeding. Appropriate restraints should be fitted on seats used by the babies.

School aged children

Playgrounds need to be carefully designed and maintained. Close supervision of children during play is crucial.

Properly fitted protective helmet should be used for activities like cycling and sliding. Efforts to increase helmet use should be undertaken through social and legislative initiatives. Children should be taught sport, road and home safety rules

JUSTIFICATION OF THE STUDY

The most recent local study on a similar topic was conducted in 1992. This was a retrospective study assessing the presentation and management of paediatric head injuries.

Much has changed since then in the social, cultural and economic setup of the local and global population. Population growth, urbanization and traffic congestion have markedly increased. Sporting activities of a wider variety are now more accessible to children both at home and at school e.g. Cycling, rugby and cricket.

Clinical practice has similarly changed. The uses of Glasgow Coma Scale, its modification for paediatric patients, the practice of advanced paediatric life support (APLS) as well as availability of the CT scan are key advances the previous study did not have access to.

This prospective study hopes, in view of these factors, to redefine the patterns, current management and outcome of craniocerebral injuries in our setup.

This data could form a foundation for advocating prevention strategies and guiding clinical practice and resource allocation.

STUDY OBJECTIVES

BROAD OBJECTIVES

- 1.To describe the epidemiological pattern of paediatric head injuries as seen in KNH.
2. To describe the early outcomes of various cranial cerebral injuries as managed at KNH.

SPECIFIC OBJECTIVES

- 1.To determine the incidence, aetiologic and predisposing factors associated with head injuries in children of various age groups and of varying severity.
- 2.To evaluate the clinical management of head injuries of varying severity including the role of neuroimaging studies.
- 3.To determine the outcomes and the prognostic factors of early outcome of head injuries in children.

MATERIALS AND METHODS

STUDY DESIGN

This is a prospective study conducted over four and a half months from 12th October 2004 when the study was approved to 28th February 2005 when the determined sample size was achieved. Selected cases were studied prospectively from their admission to discharge.

STUDY SETTING

The study was conducted at KNH casualty, Paediatric surgical ward and neurointensive care units. KNH is a tertiary care hospital serving a wide population living in and around Nairobi and receives referrals from other hospitals in Kenya. It is the sole national public hospital with specialist neurosurgical and paediatric surgical units.

Acute Surgical patients presenting to ER are triaged by nurses and medical officers and managed by surgical registrars (SHOs) under supervision and with consultation with the respective specialties.

STUDY POPULATION

Patients of less than 13 years of age, presenting to KNH, with head injuries.

ELIGIBILITY CRITERIA

Inclusions:

All persons below 13 years, seen at ED and/or admitted to the wards with a diagnosis of head injury, during the study period.

Exclusions:

- 1) Any persons with previous neurological impairment that would confound observations e.g. epilepsy, mental retardation, hydrocephalus, brain tumour.
- 2) Injuries resulting from surgical procedures.

SAMPLE SIZE

The hospital records reviewed indicated that between September 2003 and January 2004, a total of 516 patients were admitted to the paediatric surgical ward. Of these, 53 were admitted with a diagnosis of head injury, accounting for about 10% of the admissions.

Using the following formula $n = \frac{Z^2 (1-P) P}{\delta^2}$

The sample size is calculated

Where n =desired sample,

Z= standard error from the mean of 95th percentile

P=Prevalence of head injury from previous study/estimates

δ= absolute precision (5%)

$$n = \frac{1.645^2 (0.10) (0.90)}{0.05^2} = \frac{2.7 (0.10) (0.90)}{0.0025}$$

Therefore desired sample number n was 97

DATA MANAGEMENT AND ANALYSIS

Data collection

The researcher enrolled all eligible patients by reviewing daily the ED registration log and following up the patients admitted to the wards. Clinical and injury details were collected and entered on a pre-tested questionnaire (Appendix). Patients and their case records were reviewed progressively to determine clinical progress and outcome. No patient declined participation.

Data collected was summarized on a coded data sheet. This included demographic details, historical features, physical findings, radiographic findings, progress by GCS, surgery, duration of admission and functional state at discharge.

Data analysis

Information from the data sheet was entered into data editor of the Statistical Package of Social Sciences (SPSS) for windows, version 11.5, U.S.A. 2002.

Comparison of data was performed by cross tabulation. The Pearson chi-square was used for parametric data and the Mun Whitney and Kaplan-meir method for nonparametric variables. A p value less than 0.05 was considered significant.

ETHICAL CONSIDERATIONS

The approval of the Kenyatta National Hospital Ethics and Research committee was sought and approval granted for the study from 12th October 2004. (Appendix).

Informed consent from the parents/guardian was sought before patients were enrolled in the study.

The study consisted mainly of interviewing of parents/guardians and observation of the patients and their records. There was no adverse interference or alteration of clinical decisions regarding the patients under the primary surgeon. Any suggestions by the researcher were discussed with the attending doctor.

Details regarding the patients' identity were held confidential.

STUDY LIMITATIONS

Patients who died at the scene of injury or on the way to hospital were not included in the sample whereas they represent a vital part of the group.

The duration of hospitalization may have been affected by financial and transport difficulties and not the clinical factors.

The study was limited to KNH hence the results may not represent what happens in the whole country.

RESULTS

One hundred and one children with head injuries were admitted to the paediatric surgical unit over a five-month period between October 2004 and February 2005.

1. Demographic characteristics.

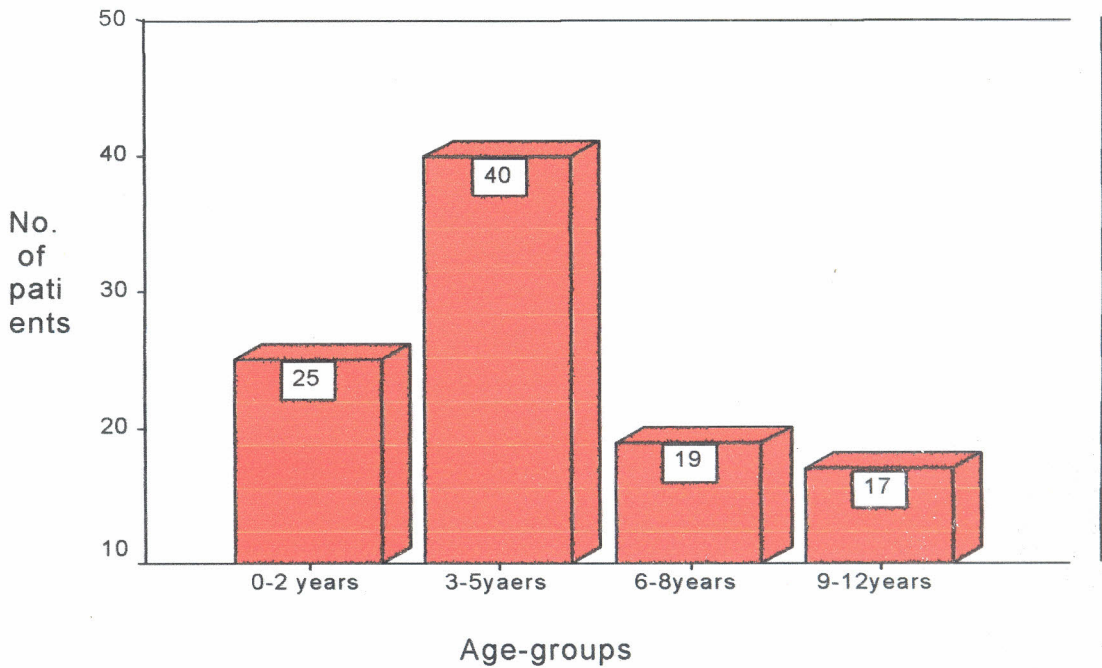
There were 64 males (63.4%) and 37 females (36.6%). Male to female ratio, 1.7:1. The youngest patient was 3 months and the oldest was 12 years old (mean age 4.9 years). Majority of the patients were between 3 and 5 years (40%). 64% were below 6 years. (Table 1, Figure 1.)

Table 1: Age Distribution of the Patients

Age group	Frequency	Percent
0-2 years	25	24.8%
3-5 years	40	39.6%
6-8 years	19	18.8%
9-12 years	17	16.8%
Total	101	100.0%

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Figure 1: AGE DISTRIBUTION



2. Injury pattern.

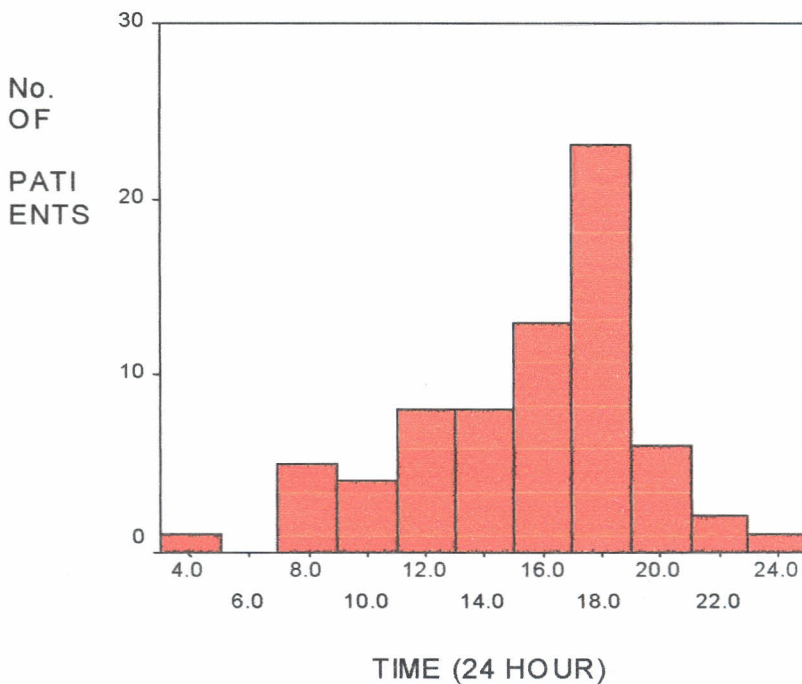
The average number of patients seen per month was 20.2 the highest being 24 and the lowest being 16. There was no statistically significant variation in the monthly distribution.(Table 2)

Table 2: Frequency of Injuries by Months

Months	Number of Patients	Percent
Oct '04	19	18.8
Nov'04	16	15.8
Dec' 04	24	23.8
Jan '05	22	21.8
Feb '05	20	19.8
Total	101	100.0

Most of the patients were injured between 8am and 7 pm (Figure 2) and there were hardly any injuries between midnight and 6 am.

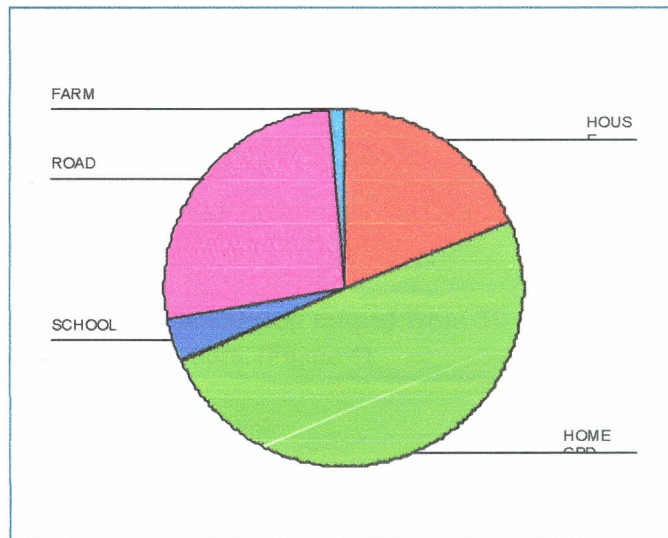
Figure 2: Time of Injury Vs No. Of Cases



15% of the cases were referred from hospitals outside Nairobi. Nairobi's Kayole and Pipeline estates had the highest numbers of cases (12 and 7 respectively) among the patients that came from within Nairobi

69% of the injuries occurred at home (indoor 19% and outdoor 50%) Road traffic accident associated injuries accounted for 27%, injuries in school 4% and farm injuries 1%.(Figure 3)

Figure 3: Place of Injury



66 of the cases seen resulted from falls from a height. Road traffic accidents accounted for 27% and assaults accounted for 8%. (Table 3). There were no sport injuries or cases of non-accidental injuries.

Table 3: Causes and Age Distribution of Head Injuries in Children.

AGE GROUP (Years)	CAUSE OF INJURY AND NUMBER OF PATIENTS			
	FALL	RTA	ASSAULT	Total
0-2	23	0	2	25
3-5	32	8	0	40
6-8	7	9	3	19
9-12	4	10	3	17
TOTAL	66	27	8	101
	65.3%	26.7%	7.9%	

Falls were more common in the younger age group while road traffic accidents (RTA) were commoner in older children

The causes of falls ranged from fall from balconies of high-rise buildings to domestic falls

(chair, tree, stairs, bicycle, mother's back etc).

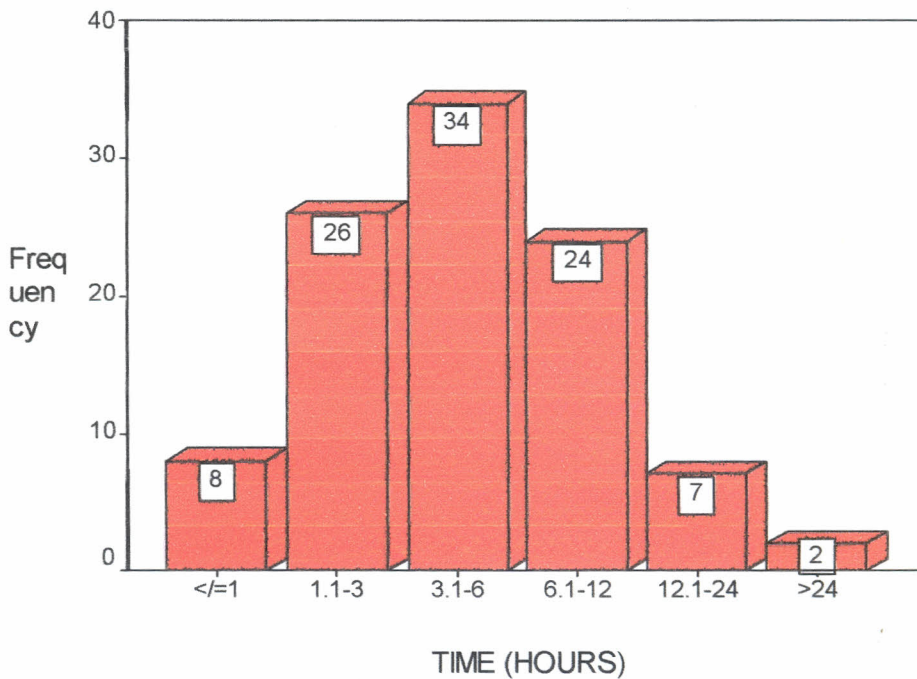
Twenty-seven patients were admitted with injuries due to road traffic accidents. Most of them were pedestrians (85%) who mostly (52%) had been knocked down by public service vehicles –matatus. (Table 3)

8 assault cases were recorded.

The weapons involved included stones (3), metal bars (2), being pushed onto a hard surface (2) and 'fork jembe' injury (1)

The time interval between trauma and admission ranged from 30 minutes to 60 hours with a mean of 6.9 hours and a peak of 3 to 6 hours. (Figure 4)

Figure 4: TIME TO HOSPITAL



3. Clinical presentation

The main presenting symptoms and signs are as shown below.

Table 4: Main Symptoms

Symptom	Frequency	Percentage
LOSS OF CONSCIOUSNESS	72	71.3%
EMESIS	44	43.6%
IRRITABILITY	37	36.6%
DROWSINESS	28	27.7%
HEADACHE	23	22.8%
SEIZURES	23	22.8%
DIZZINESS	12	11.9%
DYSPHYIA	2	1.9%
AMNESIA	1	0.9%

Loss of consciousness (LOC) varied in duration from one minute to four hours.

Seizures varied from one to ten episodes while vomiting ranged from one to six episodes. No patient reported visual changes.

Speech changes included aphasia and slurred speech reported in two patients.

Table 5: Main Signs

Sign	Frequency	Percentage
SCALP INJURIES	76	75.2%
FOCAL SIGNS	16	15.8%
PUPILLARY SIGNS	8	7.9%
SIGNS OF VAULT FRACTURE	14	13.9%
SIGNS OF BASE FRACTURE	14	13.9%
EXTRACRANIAL INJURY	25	24.8%

92 patients (91.1%) suffered blunt trauma and 9 had penetrating injuries (8.9%).

76 exhibited scalp features of trauma while 25 had a normal scalp.(Table 6)

Table 6: Scalp Injuries

Injury	Frequency	Percentage
Laceration	25	32.9%
Haematoma	22	28.9%
Tenderness	13	17.1%
Bogginess	8	10.5%
Abrasion	8	10.5%
Total	76	100%

Signs of base fracture observed were otorrhea / rhinorhea in 13 and raccoon eyes in 3 patients.

Common associated extra cranial injuries observed were in the extremities (16), neck (7), abdomen (5), chest (1) and spine (1)

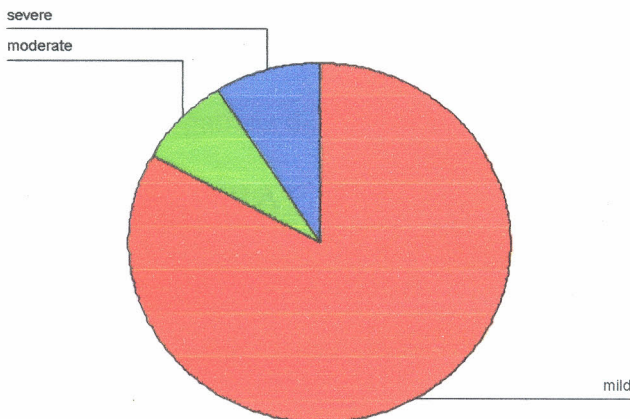
4. INJURY SEVERITY GRADES

Glasgow Coma Scores ranged from 4 to 15.

Mild head injuries accounted for the majority (84) of the patients (**83.2%**).

There were 8 moderate (**7.9%**) and 9 severe injuries (**8.9%**).

Figure 5: Injury grades



Severity of trauma was higher in the RTA group compared with the falls group.

Severe injury was similarly associated with presence of seizures and of pupillary abnormalities. (Table 7)

Table 7: Injury Grade Vs Causes, Seizures and Papillary Signs

	INJURY GRADE				
		MILD N=84	MODERA TE N=8	SEVERE N=9	<u>TOTA L</u>
CAUSES	FALLS	57 67.9%	5 62.5%	4 44.4%	66
	RTA	19 22.6%	3 37.5%	5 55.5%	27
	ASSAULT	8 9.5%	0	0	8
CLINICAL FINDINGS	SEIZURES PRESENT	16 19%	2 25%	5 55.5%	23
	ABNORMAL PUPILS	3 3.6%	1 12.5%	4 44.4%	8

Loss of consciousness, speech changes (aphasia and dysphasia) and focal signs were also associated with severe injury but headache and vomiting were most common in the mild and moderate injuries.

The grade of injury did not vary with the height of the fall.

5. INVESTIGATIONS

The main investigations done were plain skull radiography and CT scanning

5.1. SKULL XRAY

95% of the patients underwent plain skull radiography at the emergency department.

45% of all skull radiographs revealed a fracture.

98% were *vault* fractures, while 2% involved the skull *base*.

74 % of the vault fractures were *linear* and 26% were *depressed*.

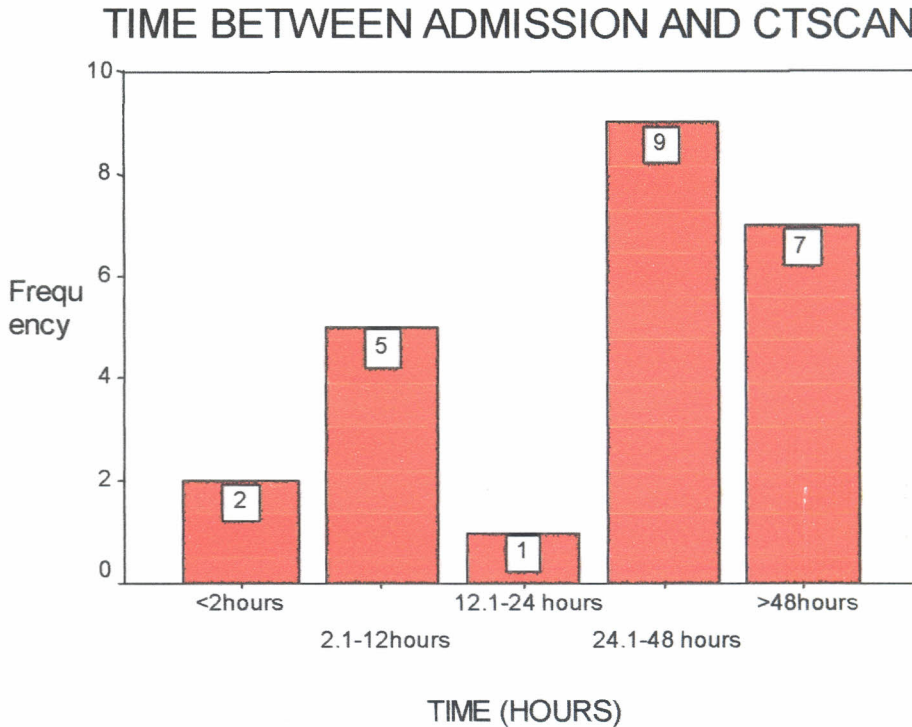
5.2. CT SCAN

24 patients underwent a cranial CT scan (23.8%) of which 6 were normal (25%).

All of these had a preceding skull x-ray with half of them revealing a vault skull fracture.

The time interval between admission and CT scan ranged from 30 minutes to 720 hours with a mean of 18.4 hours

Figure 6: Bar graph showing time from admission to CT scan



Emergency CT (within 2 hours) was done in only 8% of the patients.

Early CT scanning (<12 hours) was done in 29% of the patients.

66.7% of the scans were delayed beyond 24 hours.

Indications for CT scanning were severity grade of injury , pupillary changes, presence of focal neurological deficits, presence of skull fracture, loss of consciousness, amnesia and penetrating injuries.

Eighty-four patients were managed for mild head injury out of which 15 underwent CT scanning.

Two patients had skull fractures confirmed on CT scans that had been missed on plain radiographs.

10 patients had intra-cranial injuries (**ICI**) (oedema, haematoma and/or contusion) confirmed on CT. 6 of these had no associated skull fracture. (Table 8)

Table 8: Features on CT Imaging

CT FINDING	FREQUENCY	PERCENT
NORMAL	6	25%
FRACTURE	8	33%
FRACTURE+ OEDEMA	2	8.3%
FRACTURE+ HAEMATOMA	1	4.2%
FRACTURE+ OEDEMA+HAEMATOMA	1	4.2%
HAEMATOMA ONLY	2	8.3%
OEDEMA ONLY	2	8.3%
OEDEMA+CONTUSION	1	4.2%
OEDEMA+CONTUSION+HAEMATOMA	1	4.2%
TOTAL	24	100%

Five patients had intracranial haematoma confirmed on CT imaging (2 Extradural, 2 intracerebral and 1 subdural)

Features of ICI on CT (Oedema, contusion and haematoma) were common in patients with: pupillary abnormalities, focal signs, severe grade of injury, amnesia, prolonged duration of LOC and drowsiness.

6. MANAGEMENT

6.1. Admissions

Three patients were reviewed in casualty and discharged home, under the care of parents. They had mild head injuries. Two were injuries from falls and one an assault case.

Three patients with severe head injuries were admitted into ICU, one after a fall and two after RTA.

Ninety four percent of patients were admitted to the paediatric surgical ward.

Eighty five percent of ward admissions were mild head injuries; eight percent moderate and six percent were severe head injuries.

6.2. SURGERY

26 patients underwent surgery. (25.7%)

21 of these were cranial operations while 5 were extra -cranial (19.2%). (Table 9)

Table 9: Surgical Procedures Done

OPERATION	Frequency	Percent
Stitching	3	11.5
Surgical toilet	10	38.5
Elevation	3	11.5
Clot Drainage	5	19.2
Limb fracture	2	7.7
Splenectomy	2	7.7
Laparotomy	1	3.8
Total	26	100.0

The time interval between admission and surgery varied between one hour and 480 hours (Table10).

Table 10: Categories of Time before Surgery

TIME (HOURS)	Frequency	Percent
<1 hour	4	15.4
1-12 hours	3	11.5
13- 24 hours	7	26.9
25-48 hours	4	15.4
49- 72 hours	3	11.5
> 72 hours	5	19.2
Total	26	100.0

All primary stitching was done within the first hour of admission but only a third of fracture elevations were performed in the first hour.

Only 20% surgical toilet procedures were done in the first 12 hours.

60% of cranial haematoma drainage were performed after 72 hours of admission

Majority (28.5%) of major surgical operations were performed between 13 and 24 hours of admission. (Table 11)

Table 11: Interval between Admission and Cranial Surgery

SURGERY	TIME IN HOURS						TOTAL
	<1 HOUR	1-12 HOURS	13-24 HOURS	25-48 HOURS	49-72 HOURS	>72 HOURS	
WATCHING	3 100%	0	0	0	0	0	3 100%
MAJOR SURGICAL	0	2 20%	4 40%	1 10%	2 20%	1 10%	10 100%
EVASION	1 33.3%	0	1 33.3%	0	1 33.3%	0	3 100%
AMPUTATION	0	0	1 20%	1 20%	0	3 60%	5 100%
TOTAL	4	2	6 28.5%	2	3	4	21 100%

7. OUTCOME

7.1. Neurological status 8 hours after admission is shown in table 12.

Table 12: Neurological Status 8 Hours after Admission.

Neurological status	Frequency	Percent
Deteriorated	1	1.0
Stabilized at normal	68	67.3
Remained abnormal	6	5.9
Improved to normal	15	14.9
Improved to near-normal	11	10.9
Total	101	100

7.2. Factors associated with outcome 8 hours after admission.

Patients were classified as stable and unstable 8 hours after admission based on the Glasgow coma scale.

A GCS score of 15 was identified as stable and a score below 15 as unstable.

Eighty-three patients were observed to be stable and eighteen to be unstable.

Factors, which were associated with non-improvement, 8 hours after admission, were: a poor admission GCS, abnormal pupillary responses, presence of focal neurological signs and CT evidence of traumatic brain injury.

Other factors that were closely linked to non-improvement at 8 hours were: history of loss of consciousness, presence of seizures, drowsiness, amnesia and speech changes.

The age of the patient, cause of head injury, presence of skull fracture and surgery were not associated with the outcome following management 8 hours after admission.

Table 13: Factors Associated With Outcome 8 Hours after Admission

ADMISSION CLINICAL FINDING		PATIENTS STABLE AT 8 HOURS n=83	PATIENTS UNSTABLE AT 8 HOURS n=18	% UNSTABLE
Injury grade (GCS)	Mild	79	5	6.0%
	Moderate	2	6	75.0%
	Severe	2	7	77.8%
Pupils abnormal		3	5	62.5%
Focal signs		8	8	50%
ICI on CT		1	9	90%

7.3. Factors associated with outcome 24 hours after admission:

By 24 hours of admission, there were fourteen unstable (13.9%) and eighty-seven (86.1 %) stable patients

One of the 83 patients stable at 8 hours deteriorated and 5 of the 18 unstable patients improved 24 hours after admission.

Factors that were associated with non-improvement 24 hours after admission were history of loss of consciousness and its duration, seizures, irritability, drowsiness, vomiting, amnesia, initial injury grade, presence of focal signs, abnormal pupillary reaction to light, CT scan evidence of intracranial injury, surgery and unstable outcome at 8 hours.

Table 14: Factors Associated With Outcome 24 Hours After Admission.

ADMISSION CLINICAL FINDING		PATIENTS STABLE AT 24 HOURS n=87	PATIENTS UNSTABLE AT 24 HOURS n=14	% UNSTABLE
Injury grade	Mild	80	4	4.8%
	Moderate	5	3	37.5%
	Severe	2	7	77.8%
Abnormal pupils		4	4	50%
Focal signs		10	6	37.5%
ICI on CT		2	8	80%
Unstable Outcome at 8 hours		5	13	92.9%
Surgery		20	6	23%

Outcome at 24 hours was not influenced by age of the patient (table 15).

Table15

OUTCOME AT 24 HOURS AND AGE GROUP

			AGE GROUP.				Total
			0-2 years	3-5yaers	6-8years	9-12years	
outcome 24	stable	Count	22	34	16	15	87
		% within age .	88.0%	85.0%	84.2%	88.2%	86.1%
	unstable	Count	3	6	3	2	14
		% within age .	12.0%	15.0%	15.8%	11.8%	13.9%
Total	Count	25	40	19	17	101	
	% within age .	100.0%	100.0%	100.0%	100.0%	100%	

8. NUMBER OF DAYS IN HOSPITAL

3 patients were discharged home after review in casualty on the day of presentation

The duration of stay for those admitted ranged from 1 day to 74 days with a mean of 7.2 days (Figure7)

Figure7: Graph of number of patients vs number of days in Hospital

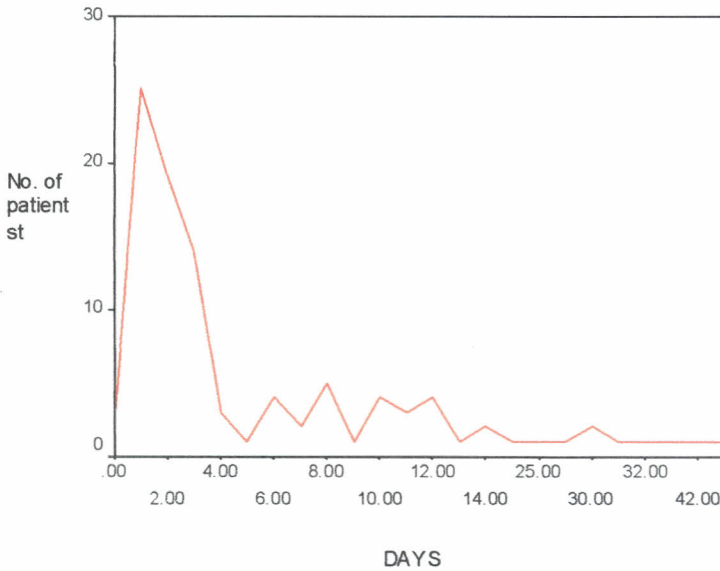


Table 16: Number Of Hours/Days In Hospital.

	Frequency	Percent	Cumulative Percent
Time 0	3	3.0	3%
24 hours	24	23.8	27%
48 hours	19	18.8	46%
72 hours	14	13.9	60%
Up to 7 days	11	10.9	70.%
Over 7 days	20	19.8	90%
Over 14 days	10	9.9	100.%
Total	101	100.	

Although 86% of the patients (87) admitted were stable after 24 hours in hospital, only 27% were considered well enough for discharge.

The number of patients well enough to go home increased rapidly to 46 by 48 hours and 60 by 72 hours. 40% of the patients stayed in hospital for more than 72 hours (3 days)

Factors that were associated with prolonged hospital stay were high injury grade, headache,

amnesia, abnormal pupillary reaction, focal signs, fracture skull, presence of intracranial injury on CT scan, time interval between admission and surgery, surgery and age above 6 years.

9. OUTCOME AT DISCHARGE

Outcomes were assessed using the Glasgow Outcome Score (table 17)

Majority of the patients (86%) had good recovery.

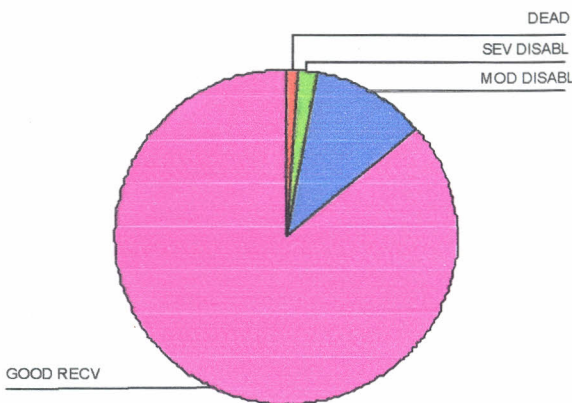
Only one patient out of 101 patients admitted died (1% overall mortality)

Thirteen percent of the children had an abnormal functional state at discharge. 11 had moderate disability and 2 had severe disability.

Table 17: Outcome at Discharge Using Glasgow Outcome Score

OUTCOME	FREQUENCY	PERCENT
DEAD	1	1
SEVERE DISABILITY	2	2
MODEATE DISABILITY	11	10.9
GOOD RECOVERY	87	86.1
TOTAL	101	100

Figure 8: Pie chart of outcome using GOS



Good outcome was more common in children of age 6 years and below as only 10% had a poor outcome compared to 23 % of children above 6 years.

Worse outcome was more common in pedestrians RTA victims, depressed skull fractures, and evidence of ICI.

Factors that were associated with a poor outcome at discharge were similar to those observed after 8 hours and 24 hours of admission namely: cause of head injury, pupillary reaction, presence of focal neurological deficits, severity of head injury on admission and unstable outcome at 8,24 and 72 hours. (Table 18)

Table 18: Factors Associated With Outcome At Discharge.

ADMISSION CLINICAL FINDINGS		ABNORMAL OUTCOME	%
Causes	RTA	8/27	29.6%
	Assault	2/6	25%
	Fall	4/62	6.1%
Abnormal Pupils		4/8	50%
Focal signs		6/16	37.5%
Injury Grade	Mild	4/84	4.8%
	Moderate	3/8	37.5%
	Severe	7/9	77.8%
Unstable outcome At 8 hours		11/18	61.1%
Unstable outcome At 24 hours		10/14	71.4%
Admission>72Hours		12/41	29.3%

DISCUSSION

The hospital-based incidence of 20.2 patients per month translates to about 242 admissions per year. Lubanga, in a 5-year retrospective study of 486 patients at KNH, reported an increasing number of admissions from 77 in 1981 to 117 in 1985. The mean age was 4.65 years and M: F ratio was 1.12:1. (19) This trend may be a reflection of population growth in Nairobi.

With a mean duration of admission of 7.2 days, head injuries alone occupy about 12% of the 40-bed paediatric surgical ward. This contributes significantly to the care burden, considering the staffing, radiological and accommodation demands.

The male to female ratio of 1.7:1 compares with ratios of 2:1 reported by Shonkunbi in Nigeria and Durkin in USA. (5,16).

This study found a mean age of 4.9 years. The 3-5 years age group has the highest risk and should be targeted in prevention strategies.

Higher incidence among males has been related to boys being involved in more forceful and risky recreational activities than the girls. Lalloo and Demellweek have reported that higher scores of premorbid behavioural problems and hyperactivity are associated with a higher incidence of injuries in boys. (20,23)

The role of premorbid behaviour patterns was however not explored in this study.

Children residing in the low and medium socio-economic status estates, especially the upcoming high-rise estates have an increased risk of falls. RTA and assaults were more widespread. Poor social economic factors, coupled with poor environmental organization have similarly been shown to predispose to head injuries in Scotland and USA. (21,22,23)

While KNH, being the only public hospital with a specialized neurosurgical unit, could be receiving most injuries in the region, it is likely that the economically endowed parents sought medical attention from the private health institutions. Comparing these results with those from other institutions in Nairobi would be useful.

Injuries are uncommon during the night as most children are asleep but increase with increasing activity level peaking between 5 and 7 pm when most children are least supervised. Chen and colleagues reported a similar pattern in Taiwan with most injuries similarly occurring outdoors especially in the home compound. (28) In many residential estates, the only compounds available for play are the house balconies. This increases the risk of falls and contact injuries.

Few injuries occur in schools probably due to constant supervision by teachers and reduced play due to intensive academic programmes.

Falls accounted for a higher proportion of injuries (65%) than in the previous local study (50%). (19) In Turkey, Bullut and others studied the pattern of injuries in a total of 1039 admitted children. Falls comprised 38% these admissions, and 47% of falls were from balconies. Similar findings are reported in Canada (47%) and USA (53%). (27,29,6)

This could be a reflection of variation in environmental factors. Poorly designed housing estates with unsafe balconies could be a greater risk factor in this study setting.

Younger children are at greater risk due to their immature supporting and grasping movements coupled with increased movement and play.

Road accidents, the second common cause of head injuries, were more frequent in older children, and the injuries were more severe than those from falls. Comparable findings were reported by Durkin in USA and Shonkunbi in Nigeria (14,5). Passenger injuries were mild as probably less force was involved.

While younger children are mostly involved as passengers, the older ones risk pedestrian injuries due to poor road decisions. In Taiwan, RTAs lead at 74% (28). Most of these involve cyclists, which is not a common mode of transport in Nairobi.

The speedy public commuter van is responsible for most pedestrian RTAs. Enforcement of speed governors is likely to alter this pattern in future.

Assaults contribute a smaller fraction (8%) as Durkin observed in USA (12%). (14) Obvious non-accidental injury (NAI) is uncommon locally but contributes a more significant number of injuries in the developed countries. (25) Brown and Malone reported NAI contributed 14% of the childhood head trauma in Alaska. (16)

Most assaults involved the older children who adopt and experience violent habits like adults.

The lack of contact sport injuries reflects a change in the sporting activities children engage in. In the USA, Chen and others observed that sports injuries contributed 17 % of head injuries and involve baseball, basketball, biking, football, skating, and soccer. (24)

Farming and industrial related injuries are uncommon among children.

In the 1970s and 1980s, Mwang'ombe observed most head injured patients arrived to KNH within the first hour of trauma. (18) The mean delay of 6.9 hours in this study, with only 8 patients presenting within an hour since injury depicts a deterioration in ambulance services and increased traffic congestion in the city. Children and parents may sometimes fail to realize the significance of head injury until dramatic features like loss of consciousness, convulsions and vomiting appear.

Mild injuries account for most (83.2%) of the injuries presenting to the hospital. A 5-year study of 2478 patients in five countries (Argentina, Brazil, France, Hong-Kong and Spain), by Murgio and others reported Minor HI accounting for **56.4%**, moderate HI for 38.9%, and severe HI for 4.7% of the injuries. (17) In the US, minor head injuries account for **76%** of neurological injuries. (14)

This suggests that most injuries in young children are of low energy. Similarly, the resilience of the child's head to physical forces due to softer bones, open sutures and higher brain elasticity help reduces the degree of injuries.

Severe injuries form a small proportion (8.9%) of the patients. Kiboi and Mwang'ombe found children 0-13 years accounted for only 10% of severe head injuries seen at KNH. (33) However this could be confounded by deaths before patients arrived to hospital, noting the long pre-hospital duration. The opportunities to intervene in the golden hour were missed in

most patients. Examining the mortuary and postmortem records could help determine the pre-hospitalization mortality.

Association of head injury with injuries of extremities, neck, abdomen, chest and spine emphasizes the need for a full and detailed clinical assessment of the children.

The role of the height of a fall in determining the severity of the injury remains controversial due to many other factors altering the application of the forces. (30, 31)

The presences of loss of consciousness, seizures, abnormal pupillary reaction, speech and focal signs have been documented as predictors of intracranial complications. (42,43,44) However, patients who were able to complain of headache were likely to be more alert and hence less severely injured unlike reported by Batchelor and McGuinness (40).

Clinical stratification of mild head injuries, based on the risk for ICI, has been advocated by many authors in determining the criteria for investigation and admission. (39,41)

However, this sub-classification was not utilized in the local management protocol.

Primary physicians in casualty ordered almost mandatory X-ray for almost all head- injured patients. This is however held in controversy as evidenced by 5 patients who were managed without an X ray. Evidence of skull fracture observed in 44.8% of the radiographs compares with 32.8% incidence reported by Lubanga, 90% of which involved the vault and 10% involved the skull base. (19)

A fracture was however shown not to determine severity or outcome of the injuries, but to delay discharge from hospital. 6 patients had ICI without skull fracture. This depicts the limited value of skull x-ray in predicting traumatic intra-cranial damage as reported by Read and others. (51,55). Clinical neurological abnormalities are more reliable predictors of intracranial injury. (50) Resources used in routine x-rays could perhaps cater for the selected patients requiring CT scan.

The clinical significance of a missed linear fracture is questionable. A fracture overlying middle meningeal vessels may predict extradural haematoma formation but these would be associated with other signs. Vogelbaum and others have shown that patients with uncomplicated skull fractures can be considered for discharge home. (68)

Patients clinically suspected to have a depressed vault fracture could be referred straight for CT scan without a preliminary plain radiograph, to determine the extent of depression and the associated intra-cranial injuries, vital in deciding the surgical intervention. An X-ray would be taken in cases where depression was in doubt.

The unavailability of Computed tomography (CT) may be the reason why plain skull radiographs are routinely taken. The information obtained is however limited.

Some centers have adapted a mandatory early CT for all patients with head injuries as the only sure way of excluding traumatic brain injury (46). Adhering to such a policy in a resource-constrained setting, where even the most indicated CT scans were difficult to obtain, could both tax limited scanning facilities and result in unnecessary exposure to radiation.

Ng and colleagues reported intracranial injury on CT in less than 7% of children with mild head trauma and even lower in children with no clinical risk characteristics (45). A selective approach is more rational to reduce unforeseen morbidity and minimize costly inpatient care

Children with skull fractures and a normal conscious level could be managed initially by neuro-observations. CT scan should be obtained for the children with a diminished/diminishing level of consciousness, prolonged loss of consciousness, focal signs, pupillary signs, high injury grade, amnesia and drowsiness.

Clinical parameters in this study were notably sensitive for intracranial injury. This underscores the value of clinical acumen before utilizing CT to determine the nature and extent of injuries.

The availability of CT in this study was limited hence many indicated patients missed the test. All the 25 patients scanned were referred to other institutions; accounting for the long intervals before a CT was performed. International recommendations regarding CT scanning need be viewed in the light of local accessibility and affordability of the service.

25 % of the scans had no evident abnormal findings. This could be due to subtle and functional brain changes (concussion) that could not be visualized on CT. MRI and EEG could be used to document the early functional brain changes that may not be seen on CT. EEG has been used by Pointinger and others in evaluating mild head injuries. (59) MRI and Ultrasound scans were not performed. The role of angiographic studies has been overtaken by the use of CT and MRI.

The general surgical ward carries the greatest care burden of head injuries. 83% of admitted children had mild injuries. Most patients were admitted for neuro-observation to detect any clinical deterioration and allow early intervention. This was necessitated by unavailability of CT and MRI. Where these are available, authors disapprove the need for mandatory hospital admission of paediatric patients with minor head injury (MHI) and negative computed tomographic (CT) scans for head injury. (47)

Only 3 patients were discharged home under parental observation. This is a possible option but requires careful patient selection. Distance from the hospital, transport access and the availability of responsible care are important to ensure instructed monitoring and timely consultation should deterioration occur. (47)

If the caregiver is incompetent, unavailable, intoxicated, or otherwise incapacitated, provisions for admission must be made to ensure adequate observation of the child. Improved telephone accessibility and higher education levels of parents may allow consideration of home monitoring of mildly injured low risk patients. Nighttime presentations may require overnight observations in the ward. Easy access to hospital beds has been observed to encourage admission for most head injuries. (16)

In this study, one patient had a medium risk injury that required closer observation but was discharged home.

While Simon and others have recommended 4 hours observation of mild injuries in a casualty observation room (46), this option was not available and most patients went to the ward for observations.

A prudent duration of observation, at least 24 hours, is recommended by American Academy of Paediatrics (AAP). (39)

Majority of patients were admitted for neuro-observations, which included regular evaluation of vital signs, GCS, pupils, focal signs, and seizures. Analgesics and antibiotics were administered where indicated and regular nursing support continued. Early identification and intervention in deteriorating patients is beneficial.

The marked delay before surgical decontamination and closure of open wounds increases the risk of cranial infections. Delay was even longer before drainage of intracranial haematoma mainly due to delay in getting CT scanning.

Further delays in surgery could have resulted from slow patient transfer to the ward and to theater.

Since none of the mild injuries at low clinical risk of intracranial injury deteriorated in the 8 hours or 24 hours of admission, it would be possible to discharge such patients direct from casualty.

Other mild injuries could be discharged if stable at 12 hours from injury as recommended by AAP. (39) Mild injuries deserve observation before considering CT scanning as deterioration occurred in only a small proportion.

Patients who deteriorated in the first 8 hours had severe and moderately severe injury, pupillary changes and focal signs. CT scanning had evidence of ICI.

Unlike findings by Reiber, in this study the heights of falls, emesis or irritability were not predictors of worse outcome. (30,31,42) Spencer and others observed no complication in patients of 13 years of age and below with closed injuries and a negative head CT scan. (47)

Deterioration in the first 24 hours was observed in mild injuries with medium and high risk factors, and in moderate injuries. At least a 24-hour observation in patients with these injuries is advised. (39)

Worse outcome in pedestrian RTA victims perhaps indicates the higher forces exerted in the head by a speeding vehicle unlike the more controlled and targeted forces in assaults.

Unlike in the reports of Iverson and others (43), the presence of a skull fracture on CT or skull radiography, whether linear or depressed, did not determine the outcome at 24 hours in this study.

Presence of headache is usually associated with better outcome, as patients able to complain of headache are likely to be more alert.

A prolonged hospital admission was noted in patients whose clinical parameters indicated severe injury. Delays in performing the CT scan and surgery lead to prolonged hospital stay.

There was prolonged admission of patients who had stabilized in this study. Seventeen percent of mild head injuries that were stable at 8 hours were hospitalized beyond 72 hours. This could be an expression of the financial difficulties in settling hospital bills at discharge. Avoidance of unnecessary admissions could therefore reduce this burden.

The overall mortality in this study was only 1 %. This finding compares with a mortality rate of 1.6% reported by Shokunbi (5), but differs from findings by Brown in a study in New York, where a 7% mortality rate was reported. (14)

These low mortality rates are a reflection of the good outcome generally observed in head injuries in children (66.33).

Unfavorable outcome (neuro-deficits) was seen in 13% of the patients. Similar findings have been reported in Nigeria by Shokunbi , where there was an unfavorable outcome in 17% of the patients (5). Identifying patients with poor functional outcome is important to allow intensive rehabilitation and maximize physical and functional recovery.

A further study to evaluate the role and utilization of rehabilitation services, adjustment to school, the family/social impact of head injuries and the long term outcomes of these children needs to be considered.

CONCLUSIONS

This study has shown that hospital admissions secondary to paediatric cranial-cerebral trauma represent an increasingly significant health problem. While all children are at risk of injury, increased risk has been observed in boys, children aged 3-5 years and children residing in high-rise residential estates. The younger children are at an increased risk of falls especially from balconies while the older ones sustain more injuries from traffic accidents and assaults. Efforts to prevent neurological trauma in children who live in the city should focus on preventing falls especially from balconies and improving traffic safety. The parents must play a great role in the prevention strategies since majority of the injuries occur within the home compound. Majority of the injuries admitted are mild but with variable risk indicators for intracranial complications.

Optimal management of head injuries at KNH is hindered by delayed presentation of the patient, lack of CT scan facilities and delayed surgical intervention. It is crucial to clinically assess risk factors in each patient in order to guide in selective use of the limited and expensive CT scan facilities. Routine skull radiography is still practiced despite evidence of its limited clinical utility.

The in-hospital mortality following head trauma is low but a significant proportion of patients are discharged with functional limitations. These may have significant long-term consequences and require close follow-up and rehabilitation services.

Factors associated with unfavorable outcome are older age, RTA, initial injury severity, evidence of intracranial injury, and outcome at 8 and 24 hours.

Recommendations

- 1) Prevention of head injuries is the best intervention. Community awareness and policy enforcement needs to address the housing designs, balcony grills and traffic regulations.
- 2) Efforts to improve patient transport would enhance early presentation and intervention to prevent secondary brain insults.
- 3) Efforts to increase availability of CT scanning would enhance early diagnosis of injuries requiring surgical intervention.
- 4) The utilization of clinical grading systems and risk stratification of the injuries would reduce the number of admissions and reduce the burden of in-patient care.

Further studies are however needed to assess:

- I. Premorbid behavioural characteristics if injured children. (Hyperactivity, conduct disorders, mental retardation)
- II. Use of EEG in assessment of acute closed head injuries.
- III. Long-term outcome and rehabilitation of patients after head injury. (Functional, social and cognitive recovery).
- IV. Financial care burden following head trauma.

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Other injuries: Neck Chest abdominal Extremities Spine

Clinical Severity/risk: Mild a) low risk b) Medium risk C) High risk
 Moderate
 Severe

NEUROIMAGING

SXR: yes/no

Report:

Skull fracture: (present /absent) Nature: (Vault, base), (linear/Depressed)

CTSCAN:

(Yes/no) Time since ER

Findings: (Fracture, Edema, Haematoma, Contusion, Basal cistern obliteration, Normal)

MANAGEMENT

Disposition: (1home, 2 general ward, 3 ICU)

Ward progress: GCS Ward:

GCS 8 Hrs

GCS 24 hrs

Surgery: (Yes/ No)..

Procedure:

Time since injury:

Duration of admission:

Discharge GCS:

Discharge physical performance: (Glasgow Outcome Scale 1-5) 1:Dead, 2 vegetative, 3 severe disability, 4 moderate disability 5 good recovery.

Consent Form

A: English

CONSENT FOR PARTICIPATION IN STUDY

I am Dr. Mwangi from the department of surgery, the University of Nairobi. I am carrying out a study aimed at improving the management of children with injuries to the head. I have got the permission of the hospital Ethics and research committee. I kindly request your participation and that of your child in this study.

Upon your consent, I will ask you some personal questions regarding your child and the injury he/she has sustained. I will also examine the child as well as review his investigations and treatment.

All the information I collect will be held confidential and your identity will not be revealed. Only a code number, and not your name will identify you. Your consent or lack of it will not jeopardize the treatment you receive whatsoever. You will be free to withdraw this consent at any time should you feel unhappy with the study.

My consent:

Signed: _____ of _____

Investigator: _____ date: _____

B: Kiswahili

KIBALI CHA KUSHIRIKISHWA NA UTAFITI

Mimi ni Daktari Mwangi kutoka shule ya upasuaji, chuo kikuu cha Nairobi. Ninafanya utafiti utakaonufaisha matibabu ya watoto walioumia vichwani. Nimepata ruhusa ya chama cha utafiti cha Hospitali na sasa naomba kibali chako ili nikuhusishe wewe na mtoto wako kwenye utafiti huu.

Ukikubali, nitakuuliza maswali kusuhi mtoto na yale majeraha aliyoyapata. Pia nitampima mtoto na niangarie vipimo, picha na matibabu anayoyapata.

Habali zote utakazonipa ama nitakazozipata kusuhi mtoto huyu, nitazihifadhi kwa siri. Jina lake halitachapishwa popote ila tu ile nambari nitakayompa. Kukubali ama kukataa kushiriki kwa utafiti huu hakutadhuru matibabu anayoipata kamwe.

Usipolidhika na utafiti huu, unaweza kukiodoa kibali hiki wakati wowote.

Kibali changu mimi,

Sahihi: _____ wa _____

Mtafiti:

Sahihi: _____ Tarehe: _____



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Ref: **KNH-ERC/01/2410**

Date: **12th October 2004**

Dr. Joshua W. Mwangi
Dept. of Surgery
Kenyatta National Hospital

Dear Dr. Mwangi,

RE: "THE PATTERN AND EARLY OUTCOME OF PAEDIATRIC CRANIAL CEREBRAL INJURIES AS MANAGED AT KENYATTA NATIONAL HOSPITAL" (P91/7/2004)

This is to inform you that the Kenyatta National Hospital Ethics and Research Committee has reviewed and approved the revised version of your above cited research proposal for the period 12th October 2004 – 11th October 2005. You will be required to request for a renewal of the approval if you intend to continue with the study beyond the deadline given.

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,

PROF. A N GUANTAI
SECRETARY, KNH-ERC

*noted to pay 1500/- if not an employee of KNH
26/10/04*

Cc Prof. K Bhatt, Chairperson, KNH-ERC
The Deputy Director (C/S), KNH
The Dean, Faculty of Medicine, UON
The Chairman, Dept. of Surgery, KNH
✓ CMRO

Supervisors: Prof. Nimrod J. Mwangome
Dept. of Neurosurgery
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