PAEDIATRIC TBI IN RESOURCE-CONSTRAINED SETTINGS

THYWILL GAMELI AZUMAH

SNR SPECIALIST, NEUROSURGERY

DEPT OF SURGERY, KBTH

SUMMARY OF TBI DATA OVER A 12 MONTH PERIOD

JANUARY 2023 TO JUNE 2024

SAMPLE SIZE: 52


NEUROSCIENCE UNIT


THIS MONUMENT WAS UNVEILED
BY
COLONEL I. K. ACHEAMPONG,

METHODOLOGY

STUDY AREA: KORLEBU TEACHING HOSPITAL

STUDY DESIGN: RETROSPECTIVE HOSPITAL BASED EVALUATION OF RECORDS

SAMPLE SIZE: COMPLETE CENSUS OF ALL CASES THAT FIT INCLUSION CRITERIA

STUDY PERIOD: JUNE 2023- JUNE 2024

INCLUSION CRITERIA: PATIENTS BELOW 18 YEARS MANAGED FOR HEAD INJURY

MALE

26(50%)

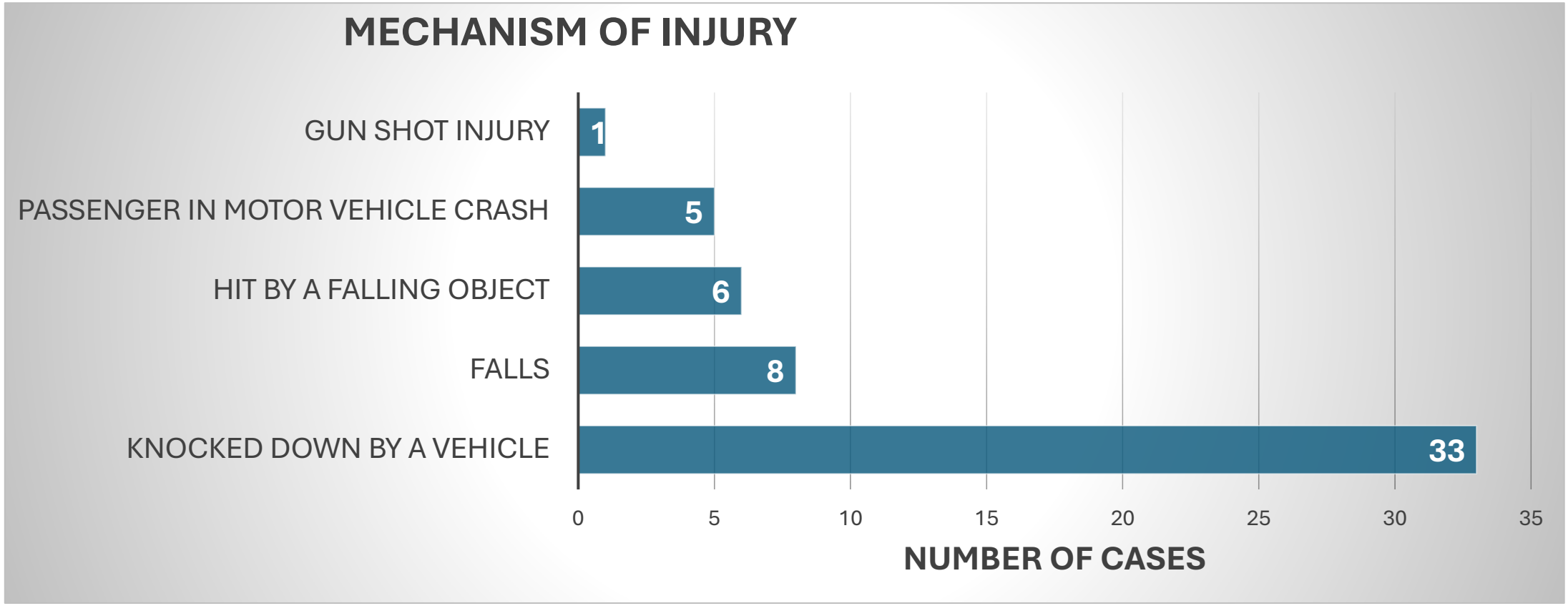
FEMALE

26(50%)

Average age: 7 YEARS

Range from 14 weeks – 14 years old

Mean: 14 years



- Most common presentation:
  - altered consciousness > seizures > vomiting >others
- Injury to arrival time at referral centre:
  - Within 6-12 hrs of injury

Falling objects ?

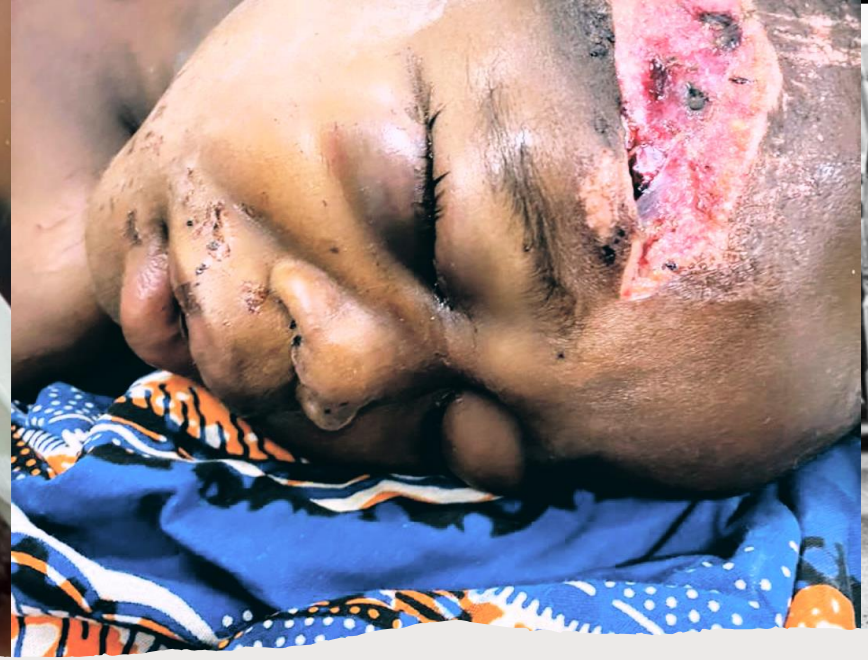
- Falling metal gate
- Dislodged ceiling fan
- Found buried under log of wood
- Collapsed wall - during a heavy rainfall
- Falling cabinet
- Falling coconut*

NO cases ??

Abuse ?

Sports

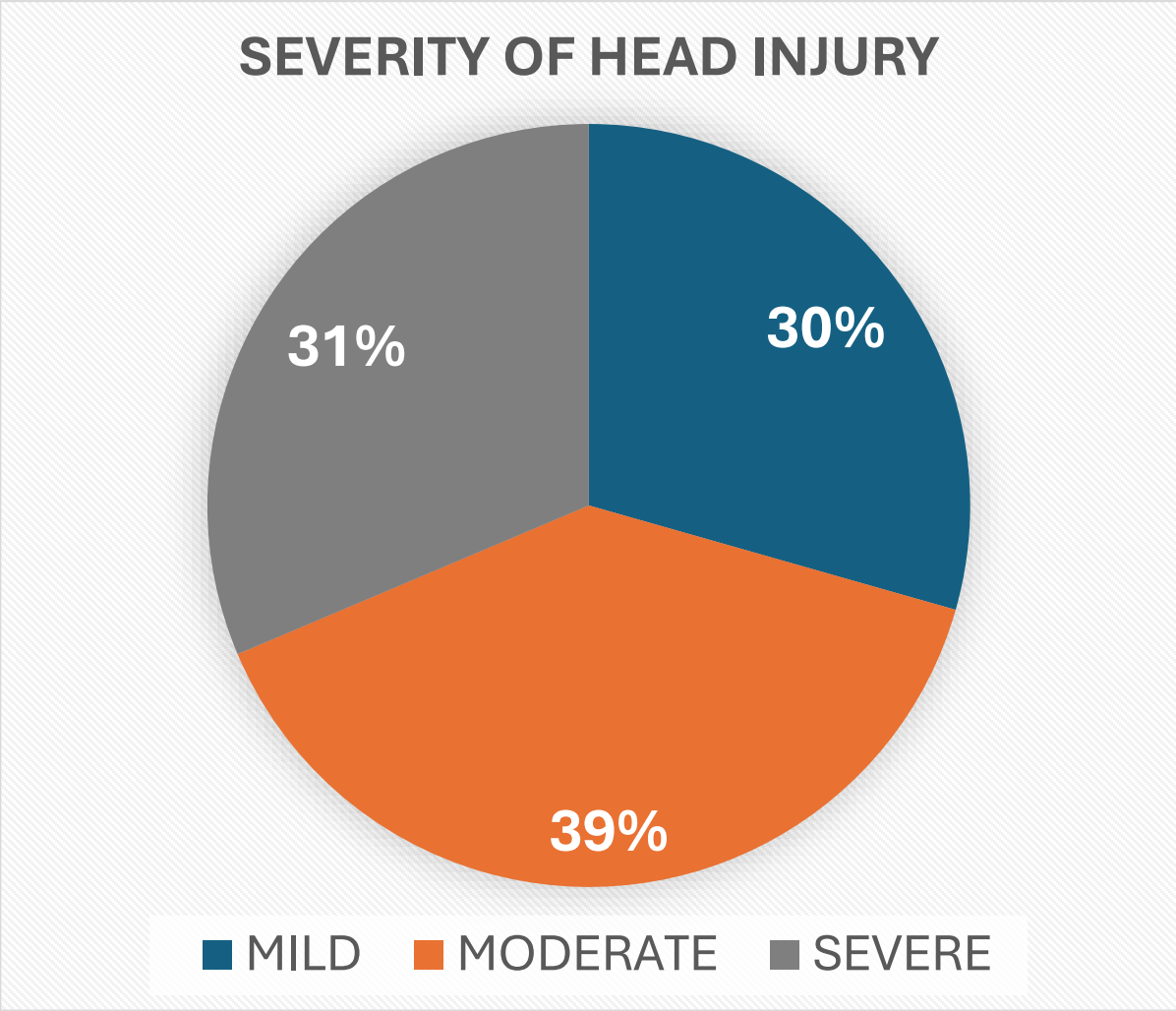
Bicycle



How safe are the roads ?

- 73% were road traffic related
- 63% of paediatric TBIs were pedestrian injuries
- Beyond the neurologic injury, many such injuries are physically disfiguring

Severity of head injury(GCS)

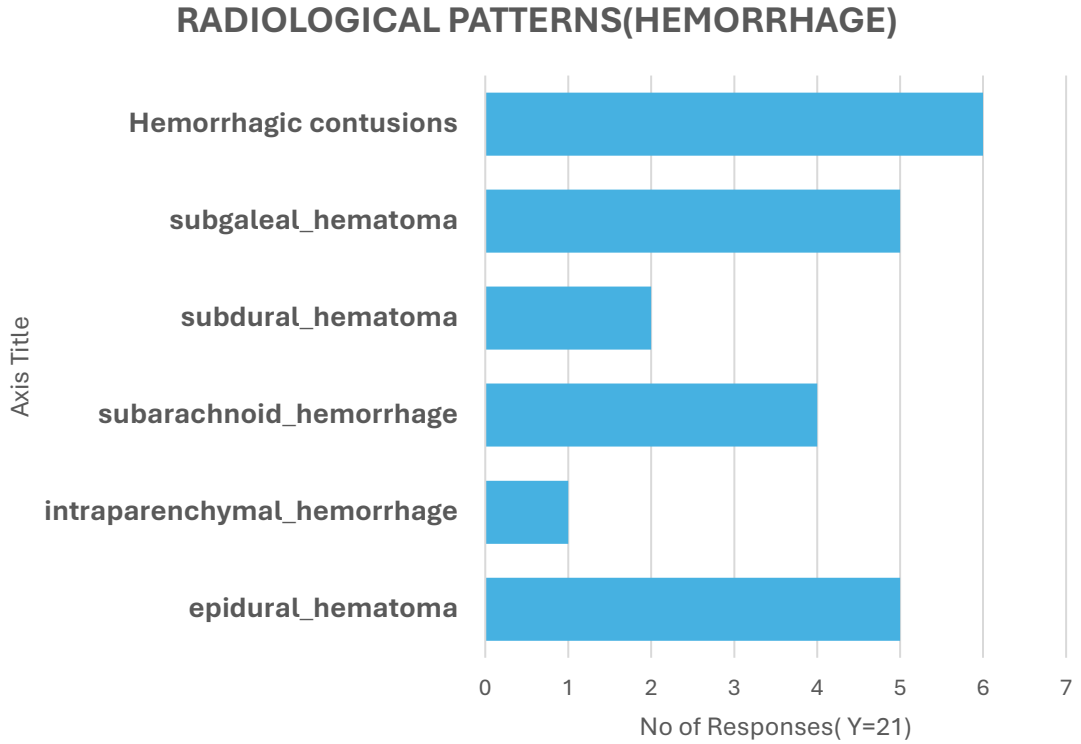


GLASGOW COMA SCORES

Mean GCS at Presentation (post resuscitation =10/15

N cases(out of 52)
Mild: 15
Moderate: 20
Severe: 17

RADIOLOGICAL FINDINGS



	PRESENCE OF HAEMORRHAGIC LESIONS
YES	23(44%)
NO	29(56%)

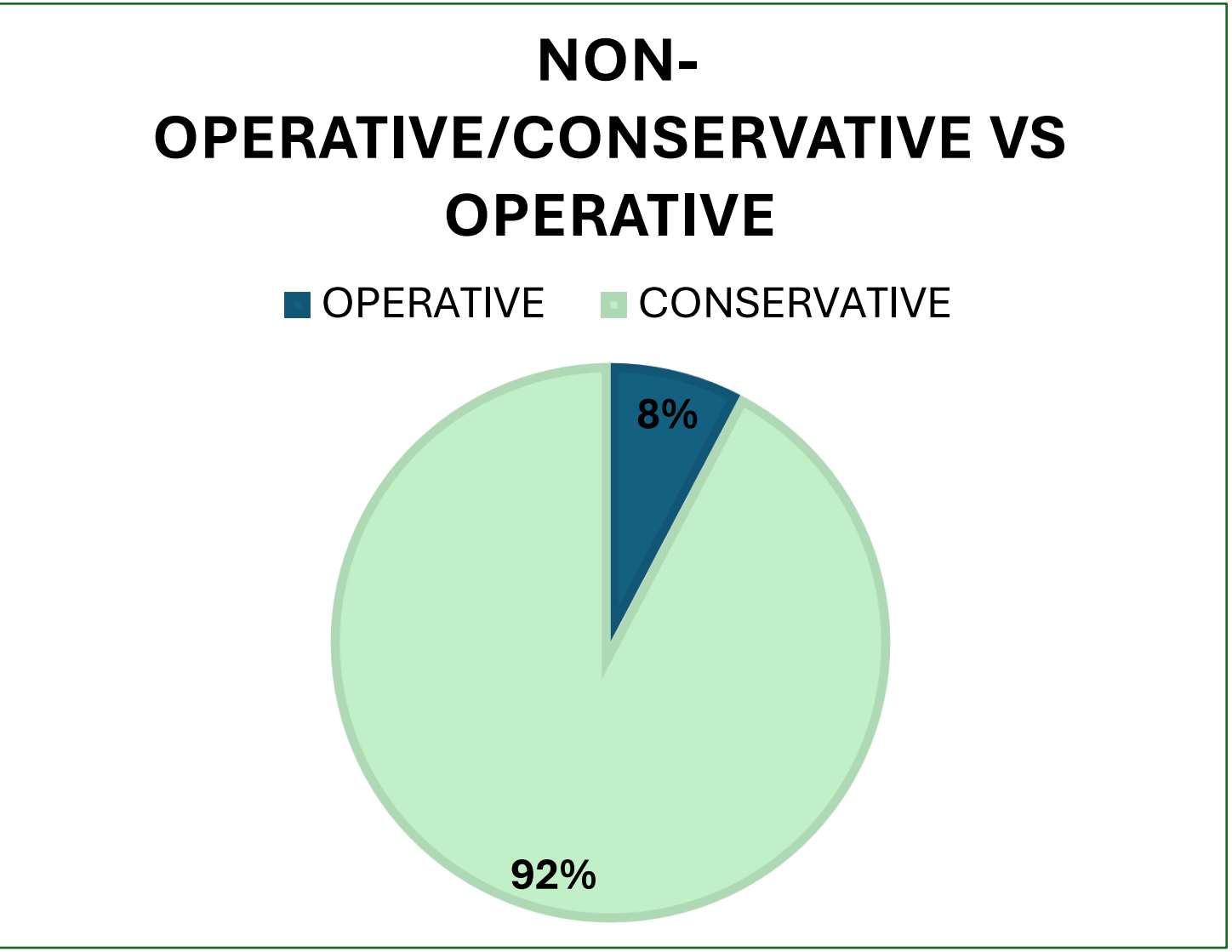
- FRACTURE PATTERNS(RESPONSES)
  - Vault - 20 temporal>parietal>frontal>occipital
  - Base of skull- 10

MANAGEMENT INDICATORS

- 3 out of 17 patients with severe head injury but with no indications for surgery were intubated and ventilated
- 2 out of the 3 (67%) died

8 out of 52 patients were managed in an HDU setting

OPERATIVE VS CONSERVATIVE



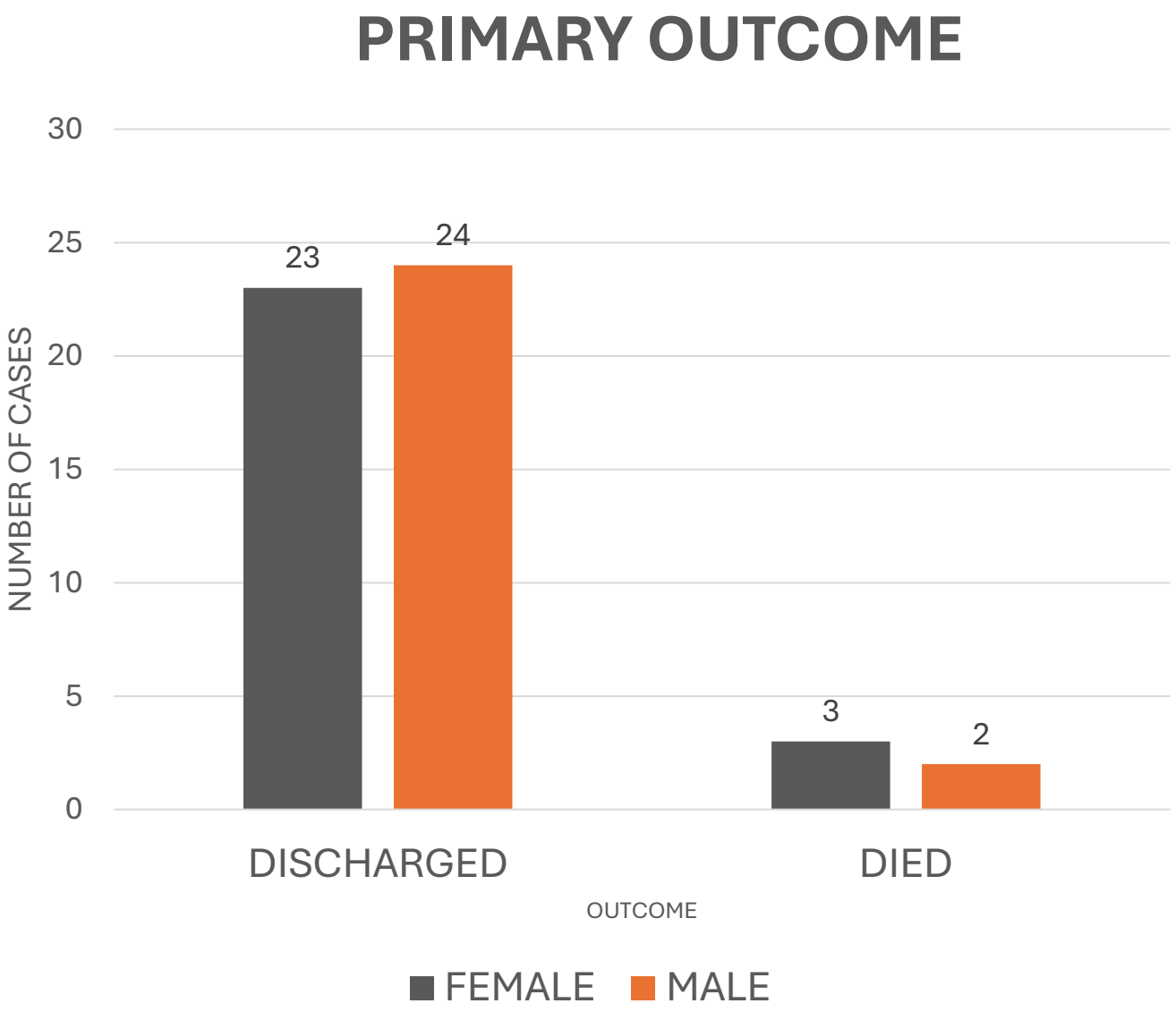
- Elevation and debridement of depressed skull fracture. N=2

- Craniotomy and evacuation of epidural hematoma. N=1

- Craniectomy, wound exploration and debridement of gun shot wound. N=1

OPERATIVE: 4 CASES

PRIMARY OUTCOME



Mortality rate of 9.6%(5 out of 52; f=3, m=2)

4 out of 5 mortalities were pedestrian injuries

Average duration of hospital stay: 11 days and correlates with severity of injury.

Mean GCS at discharge : 14

TBIs and the Road – How safe are the roads

- 73% of TBIs were road traffic related
- 63% of paediatric TBIs were pedestrian injuries
- Beyond the neurologic injury, many such injuries are physically disfiguring

Journal of Medical and Biomedical Sciences (2016) 5(2): 5-12

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ORIGINAL ARTICLE

Incidence of Traumatic Brain Injury in a Ghanaian Tertiary Hospital

A. Adam[1,2]; A. Alhassan[3] and I. Yabasin[2]

[1]Department of Surgery, [3]Department of Anatomy, School of Medicine and Health Sciences, University for Development Studies; [2]Department of Surgery, Tamale Teaching Hospital, Tamale, Ghana

Traumatic brain injury (TBI) is considered as one of the most silent epidemics and its incidence is rising worldwide due to injuries associated with the increased use of motor vehicles and bad road network, particularly in middle-income and low-income countries including Ghana. The aim of this study was to assess the incidence of TBI, cause of injury as well as outcomes of patient's care in the Tamale Teaching Hospital in Ghana. This retrospective study was carried out at the Tamale Teaching Hospital, the only Tertiary referral hospital in the whole of the savanna ecological zone of Ghana over 43 months from January 2009 to July 2012. All patients admitted into the hospital and diagnosed as having TBI were included in the study. The medical records of a total of 671 patients who were diagnosed with TBI were reviewed. Information regarding the age, sex, occupation and initial external cause of injury was retrieved. Data regarding length of hospital stay and treatment outcome were also retrieved. External cause of injury was classified according to International Classification of Diseases (ICD) guidelines as Road Traffic Accidents (RTA) (irrespective of type), fall from height, assault, gunshot, game or sport related accident and other causes. Road traffic accident accounts for relatively high incidence of hospitalized TBI. Majority of the patients were male within the 21-30 year age group. The high number of Intensive Care Unit (ICU) fatalities may indicate that more resources and facilities (intensive care nurses and equipment to monitor intracranial pressure) are needed to help in the management of cases particularly head injuries.
Journal of Medical and Biomedical Sciences (2016) 5(2), 5-12

Keywords: Head Injury, Trauma, Road Traffic Accident, Northern zone, Ghana

INTRODUCTION

Traumatic brain injury (TBI) has been defined as damage to brain tissue caused by external mechanical force. This is usually evidenced by: loss of consciousness due to brain trauma, or post traumatic amnesia, or skull fracture, or objective neurological findings that can be reasonably attributed to TBI on the initial physical or mental status examinations'(Nestvold *et al.*, 1988). Worldwide TBI is said to be a very serious public health and socio-economic problem and a major cause of death and lifelong disability especially among young adults. Studies have shown that the prevalence of TBI varies from different geographical locations (Nestvold *et al.*, 1988). In the USA, it is estimated that more than 5 million people suffer some form of TBI resulting in disabilities. In Europe it is estimated that there is an average incidence of 235 per 100,000, with most countries experiencing an incidence in the range of 150–300 / 100,000 per year (Tagliaferri *et al.*, 2006).

TBI commonly leads to neurocognitive deficits (such as impaired attention, inability to form visuospatial associations, or poor executive function) and psychological health issues. Research has shown that about 30–70% of TBI survivors develop depression and are more likely to exhibit increased impulsivity, poor decision making and impulsive aggressive behavior (Roozenbeek *et al.*, 2013). These types of impairments can affect interpersonal relationships and contribute to poor community, social and vocational integration and require long term placement in an institutional setting (Roozenbeek *et al.*, 2013).

Correspondence: *Abass Adam, Department of Surgery, Tamale Teaching Hospital and SMHS, University for Development Studies, Tamale, Ghana; E-mail:*

- Road traffic related accidents in over 90%
- Fall from height with 3.43%
- Assault(2.24%).
- Gunshot accounted for 2.09%

The grass is not so green on the other side

Resource constrained

Low Resourced Setting ??

Before referral ?

What is needed-
General strategies - Nationally

Implementing primary prevention strategies

- (Road safety campaign, School Sport Safety)

Establishing organized trauma systems

Preventing secondary injuries

Prompt diagnosis and treatment of intracranial hypertension

Priorities –as clinicians

Stabilize	Prevent	Utilize	Prioritize
Stabilize patient	Prevent secondary brain injury	Utilize available resources effectively	Prioritize ABCs • Airway management • Breathing and ventilation • Circulation and haemorrhage control • Disability assessment • Exposure and secondary survey

Adapt protocols to local context

Monitor

Rely on clinical skills and algorithms in the absence of readily available neuroimaging.

Transfer the child to a facility with neurosurgical capabilities when indicated

A detailed clinical evaluation – Our best bet in the low resource setting

- Peri-orbital , postauricular ecchymoses, CSF leak, anisocoria
- Scalp haematoma, crepitus, laceration, tense fontanelles,
- Fundoscopy- retinal haemorrhage , papilloedema
- Ear- Haemotympanum,
- Spine tenderness, extremity weakness
- Reflexes including anal and perineal reflexes

- Take clinical Photos

Non-Accidental Trauma

- Don’t forget non-accidental trauma
  - Multiple injuries in multiple locations at different stages of healing
  - Retinal haemorrhage
  - Bilateral chronic subdural haematomas

LABS

Cervical spine

Objective- Prevention of secondary brain injury

- Oxygenation and ventilation
  - Avoid hypoxia/hypercarbia, give supplemental Oxygen
- Blood pressure management
  - Prevent hypotension/hypertension
- Temperature control
  - Prevention fever
- Appropriate sedation and analgesia to reduce agitation
- Keep normal glucose and electrolytes
- Prevent/control seizures, retching ,

- Management of intracranial pressure
- Protection of cervical spine
- Monitoring and early intervention
- Timely transport for imaging and or referral to a Neurosurgical center

Neuroimaging in an imaging-constrained setting

- Some patients have clear indications for neuroimaging
- Sometimes the indication is not clear
    - Lifetime risk of cancer in a child under 1 who is radiated (CT scan) is 1:1500

- CHALICE- Children's Head Injury algorithm for the prediction of Important Clinical Events
- CATCH-Canadian Assessment for Tomography for Childhood Head Injury
- PECARN - Paediatric Emergency Care Applied Research Network Traumatic Brain Injury Algorithm
    - A clinical decision rule
    - Aims to identify children at very low risk of clinically important TBI (ci-TBI)
    - Guides decision to request a head CT scan
    - Aim: Avoid unnecessary radiation exposure in young children

Children's Head Injury Algorithm for prediction of Clinically Important Events (CHALICE)

- History
  - Witnessed LOC > 5 min
  - Amnesia >5 min
  - Abnormal drowsiness
  - >2 vomits post injury
  - Suspicion of non-accidental injury
  - Seizure (no hx of epilepsy)

- Mechanism
  - RTA , speed > 40 mph, patient is an occupant, pedestrian, cyclist
  - Fall, height > 3 meters
  - High speed projectile / object

Children's Head Injury Algorithm for prediction of Clinically Important Events (CHALICE)

- Examination
  - GCS < 14, (<15 if less than one year)
  - Penetrating injury, tense fontanelles, suspected depressed skull fracture
  - Focal neurologic deficit
  - Signs of base of skull fracture
  - Facial injury/ crepitus

Paediatric head trauma </= 2 years		
Risk stratification		Risk of ci-TBI
High Risk	Any of the following GCS</= 14, or altered mental status Palpable skull fracture Signs of basilar skull fracture Focal Neurologic exam Seizure	4.4 % REQUIRE A CT SCAN
Medium Risk	Not high risk, and any of the following Severe mechanism of injury High risk haematoma LOC >/= 5 seconds Not acting normally per parents	0.9% SCAN or observe for changes in clinical condition
Low risk	All others (not high or medium risk)	<0.02 % Can safely avoid CT Scan

Risk stratification Paediatric head trauma > 2 years		Risk of ci-TBI
High Risk	Any of the following GCS</= 14, or altered mental status Palpable skull fracture Signs of basilar skull fracture Focal Neurologic deficit Seizure	4.3 % REQUIRE A CT SCAN
Medium Risk	Not high risk, and any of the following Severe mechanism of injury History of LOC Severe headache vomiting	0.9% SCAN or observe for changes in clinical condition
Low risk	All others (not high or medium risk)	<0.05 % Can avoid a CT scan

CRITERIA

- CI-TBI Ruled out, Age < 2 years
  - Normal mental status
  - Normal behaviour per routine caregiver
  - No LOC
  - No severe mechanism of injury
  - No non-frontal scalp haematoma
  - No evidence of skull fracture

- Age >/= 2 years
  - Normal mental status
  - No LOC
  - No severe headache
  - No severe mechanism of injury
  - No signs of basilar skull fracture

Severe Mechanisms of Injury

- MVA with patient ejection
- Death of another occupant/
- Pedestrian or cyclist without a helmet, struck by a motorized vehicle
- Falls
  - From height > 3 feet (0.9metres) for children< 2 years
  - From a height >1.5 m (5 feet) for children > 2 years
- Head struck by high impact object

Altered mental status

- GCS 14
- Somnolence
- Repetitive questioning
- Slow response to verbal communication

Scalp haematoma and vomiting

- High risk scalp haematomas
  - Large > 2 cm
  - Boggy
  - Non frontal
  - Age < 6-12 months

- Vomiting
  - So common in the younger paediatric population
  - A poor discriminator of serious injury risk (<under 2 population)

- Act based on imaging findings

- Routine Follow Up CT (within 72 hours) ?
  - Repeat CT can routinely is not agreed on/ practiced
  - Yes ?
    - Delayed lesions, eg delayed epidural haematoma
  - No?
    - Transporting unstable patients - Haemodynamic instability
    - Increased ICP during transport
  - Repeat when indicated
    - Neurologic deterioration
    - Post procedural evaluation

Osmotic Therapy –
The head injury concoction?

- Commonest indications
  - Evidence of mass effect (focal neuro deficit, hemiparesis)
  - Clinical evidence of intracranial hypertension
  - Sudden deterioration prior to CT
- Not definitive therapy
- Not routine therapy

Osmotic Therapy

- The ideal candidate agent should reduce ICP while maintaining CPP
  - Mannitol (20%) may reduce CPP by its hypotensive effect
    - Other challenges
      - Acute renal failure
      - Rebound cerebral oedema
      - Pulmonary oedema

- 3% Hypertonic saline
      - Sodium overload -- volume overload – heart failure
      - Hyperchloraemic metabolic acidosis
      - Coagulopathy
      - ARDS

Original Investigation | Pediatrics

Comparison of Intracranial Pressure Measurements Before and After Hypertonic Saline or Mannitol Treatment in Children With Severe Traumatic Brain Injury

Patrick M. Kochanek, MD; P. David Adelson, MD; Bedda L. Rosario, PhD; James Hutchison, MD; Nikki Miller Ferguson, MD; Peter Ferrazzano, MD; Nicole O'Brien, MD; John Beca, MD; Ajit Sarnaik, MD; Kerri LaRovere, MD; Tellen D. Bennett, MD, MS; Akash Deep, MD; Deepak Gupta, MCH, PhD; F. Anthony Willyerd, MD; Shiyao Gao, PhD; Stephen R. Wisniewski, PhD; Michael J. Bell, MD; for the ADAPT Investigators

› J Neurotrauma. 2023 Jul;40(13-14):1352-1365. doi: 10.1089/neu.2022.0465. Epub 2023 May 11.

Comparative Effectiveness of Mannitol Versus Hypertonic Saline in Patients With Traumatic Brain Injury: A CENTER-TBI Study

Ernest van Veen [1 2], Daan Nieboer [2], Erwin J O Kompanje [1 3], Giuseppe Citerio [4 5], Nino Stocchetti [6 7], Diederik Gommers [1], David K Menon [8], Ari Ercole [8], Andrew I R Maas [9], Hester F Lingsma [2], Mathieu van der Jagt [1]

Affiliations + expand

PMID: 37014076 DOI: 10.1089/neu.2022.0465

Free article

3% Hypertonic Saline / Mannitol

- No significant difference in the time of onset
- 3% Hypertonic saline shows a longer duration of ICP reduction

- Questions that need answering –
  - What are the optimal infusion rates for these agents
    - E.g. Mannitol administered as a 5 minute bolus – ICP returned to pretreatment levels in a median time of 90 minutes
    - But when given over 20 – 30 minutes – no ICP rebound in 2 hours
    - Faster infusion ?? Faster renal elimination ?? Faster cerebral penetration?

SEIZURE PROPHYLAXIS

- 7-day seizure prophylaxis for early post-traumatic seizures
- Phenytoin
  - Keeping in mind drug-drug interaction
- Leviteracetam ??
  - Newer generation,
  - Decreased drug interaction/ better side effect profile
  - No loading required
  - No monitoring required ??
  - Cost/ availability especially with IV preparation

Who needs it ?

- Acute SDH, EDH, ICH, cortical haemorrhage
- Depresses skull fracture
- Penetrating head injury
- GCS <10
- History of alcohol abuse
- Seizure within the first 24 hours

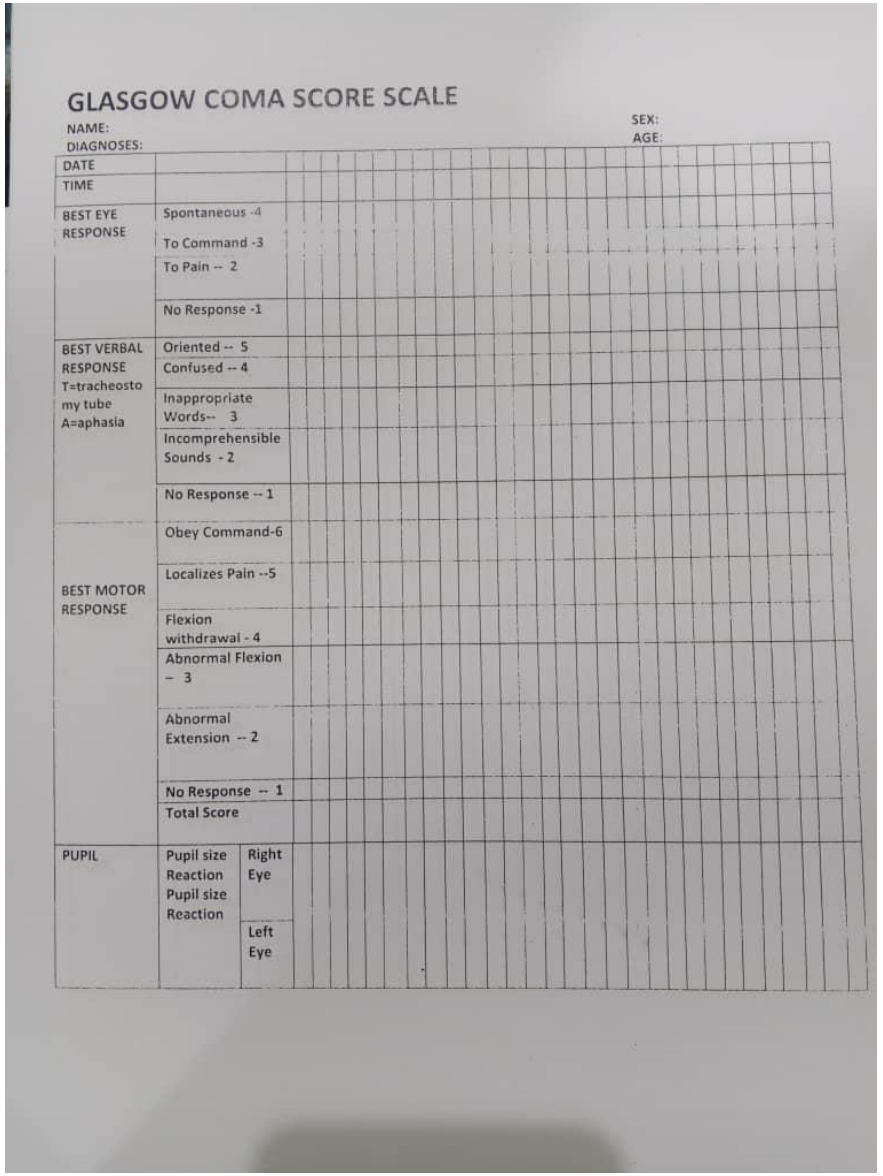
Treat seizures with short acting agents

Neuromonitoring

- Detection of evolving secondary events and correcting them before permanent injury occurs
  - Intracranial hypertension
  - Ischaemia
  - Worsening oedema

- Monitoring
  - ICP monitoring
    - Association between intracranial hypertension/ or systemic hypotension has been clearly demonstrated
  - Tissue oximetry
  - Microdialysis

Neuromonitoring



GLASGOW COMA SCORE SCALE

NAME: SEX:
DIAGNOSES: AGE:

DATE			
TIME			
BEST EYE RESPONSE	Spontaneous -4		
	To Command -3		
	To Pain -- 2		
	No Response -1		
BEST VERBAL RESPONSE T=tracheostomy tube A=aphasia	Oriented -- 5		
	Confused -- 4		
	Inappropriate Words-- 3		
	Incomprehensible Sounds - 2		
	No Response -- 1		
BEST MOTOR RESPONSE	Obey Command-6		
	Localizes Pain --5		
	Flexion withdrawal - 4		
	Abnormal Flexion – 3		
	Abnormal Extension -- 2		
	No Response -- 1		
	Total Score		
PUPIL	Pupil size Reaction	Right Eye	
	Pupil size Reaction	Left Eye	

Who to refer

- Focal neurologic deficit
- Fracture or signs of a fracture
- Penetrating injury
- High energy injury
- Deteriorating mental status
- Vulnerable paediatric population – infants/ young children
- Safeguarding concerns – non-accidental injury
- High risk – bleeding disorders/ anticoagulant
- Continuing concern by professional

- Others
  - Persistent headache

- Discuss soft indications when possible

Transfer of the head injured child – stabilization before transfer

Clinical concern	Items to check	Steps to remedy
Hypotension/ hypertension	BP	Replace volume
anaemia	HB/Hct	Transfuse if indicated
seizures	Serum elctrolytes/AED levels	Correct electrolyte derangement, Optimise AED
Fever/infection	WBC/ Septic screen	
Hypoxia/ hypoventilation	ABG	Airway/ Intubation
Spinal instability	Xrays/ CT sacn	Spine immobilization (spine board, sand bags, cervical collar

Follow up-

- Some of the follow up may occur in a resource –constrained setting

Long-term complications

- Effects of TBI on children vary widely
- Sometimes not obvious initially, but become apparent when cognitive and social activities increase.

    - Cognitive
        - Forgetfulness, difficulty learning new material, easy distractibility
    - Physical
        - Slowed reactions, lack of interest, increased sensitivity to light and noise
    - Emotional
        - Little or no expressed emotion, inability to deal with minor changes in the environment
    - Behavioural
        - Irritability

Reported symptoms during follow up

- Headache
- Dizziness
- Sensitivity to light
- Inability to concentrate
- Easy distractibility

Follow-up and Stepwise Return to Play/ Activity

- Levels of activity not always easy to define
  - Can my daughter now sweep?
  - Can she now fetch/carry water?
  - Can she return to school?
  - Can he play football?

Stepwise Return to Activity

- Rest until symptoms improve
- Light activity once symptoms begin to resolve
    - Modified school schedule
    - Moderate activity: jogging
- Moderate activity once symptoms are mild/nearly gone
    - Regular school schedule
- Regular activity once symptoms
    - Heavy non-contact activity,
- Practice and full contact
- Return to Play

Severity	Return to play
Very Mild	1 week
Mild	2 weeks
Complicated mild	3 months
Moderate	6 months
Severe	12 months

- In effect, the resource constrained physician may be involved in the management of TBIs throughout the course of the injury

CONCLUSIONS

- Pedestrian injuries are a prominent contributor to TBIs in our setting
- We need
  - training of requisite high caliber human resource – Neurosurgeons, Neurocritical Care physicians, Specialist Neurosurgical Nurses etc
  - Research into, and interventions for our local situation, including a nationwide effort to track pediatric head trauma with a standardised database.
  - Road safety advocacy with the relevant public/ government institutions

CONCLUSIONS

- Physicians in resource constrained settings must
  - Utilize available resources effectively
  - Rely on clinical skills and algorithms in the absence of readily available neuroimaging.
  - Adapt protocols to local context
  - Collaborate with less colleagues in less constrained settings to achieve better outcome

References

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