



Pattern and Predictors of positive head computed tomography scan in mild traumatic brain injury.

Dr. Hilina Taye Shita

Addis Ababa, Ethiopia

October, 2022



Pattern and Predictors of positive head computed tomography scan in mild traumatic brain injury at Addis Ababa Burn and trauma emergency hospital Addis Ababa Ethiopia

Dr. Hilina Taye Shita

Emergency and critical care medicine resident

Advisors:

1. Doctor Tesfaye Getachew

Assistant professor of emergency and critical care medicine

2. Doctor Dirjit Mamo

Assistant professor of emergency and critical care medicine

3. Doctor Abrham Tadele

Assistant professor of neurosurgery

4. Shimels Hussien Mohammed (MPH, MSC, PHD)

Assistant professor of public health and nutrition

This thesis is to be submitted to the department of emergency and critical care medicine for the partial completion of specialty training.

Declaration

I hereby declare that this is my original work and never been presented in this or any other university and all the source material used for this thesis have been duly acknowledged.

Name: Dr Hilina Taye (final year ECCM resident)

Signature:

Place: Addis Ababa

Submission date:

This thesis is to be submitted after approval by my advisers.

Acknowledgement

Foremost, I would like to thank the almighty God for his guidance in my life. And my sincere thanks and appreciations go to my advisors for their unlimited support during this thesis preparation. As well as, department of emergency medicine and critical care for giving me this opportunity in doing this research. I want to give my special thanks to Dr. Nebyu Samuel, Dr Ayalew Zewde, and Dr Menbu Sultan for their constructive comment and guidance.

Abstract

Background: - Mild TBI (traumatic brain injury) is one of the commonest causes of ED (emergency department) presentation. However, the use of head CT (computed tomography) scan for mild TBI is not justified properly and is an area of controversy for quite a long time.

Objective: - To analyse the patterns of positive head CT findings in patients with mild TBI and investigate the predictors of positive CT scan in mild TBI at AaBET hospital from April 15, 2022 to July 15, 2022.

Methodology: - A cross-sectional institution-based study was conducted at AaBET hospital, Addis Ababa, Ethiopia. The study included 407 patients presented to the emergency department with a diagnosis of mild TBI who underwent a head CT scan during a study period of April 15, 2022 to July 15, 2022. Exhaustive sampling technique was used to get the required sample size. Data was collected by structured questionnaire from patient's chart trauma registry and analysed by SPSS version 25.0. To know the association factor between dependent (prevalence and pattern of positive head CT) and independent variable binary logistic regression and multivariate logistic regression was done and p value < 0.05 at 95% CI was declared statistically significant association.

Result: - Out of 407 patients included in the study, majority of trauma cases sustained RTA 40.5%. Linear skull fracture was observed in 33.6%. Male patients 7.874 times [AOR= 7.874, 95% CI (1.886, 32.884)] more likely have positive CT scan than female patients. Patients arrive at ED within 7 - 24hr were 4.913 times [AOR= 4.913, 95% CI (1.99, 12.117)] more likely have positive CT scan result than a patient arrive within 6 hrs of arrival to the ED. Patients with unknown duration of LOC were 67.931 times [AOR=67.93, 95% CI (3.67, 1255.8)] more likely to have positive CT scan than patients with less than 5 minutes of LOC. Patients having ear/nose CSF leak and Vomiting were more likely to have a positive CT scan than those who didn't have those.

Conclusion: - Road traffic accidents were the major cause of trauma in which pedestrians were affected more. Sex, duration of time to arrive at the ED, presence of LOC, vomiting and ear/nose CSF leak are the designated variables predicting positive head CT scan in patients who sustained mild TBI.

Keywords: - prevalence, Pattern, predictor, mild TBI, positive CT

Table of Contents

Acknowledgement	ii
Abstract	iii
List of tables	vii
3. List of acronyms and abbreviations	ix
1. Introduction.....	1
3.1. 1.1. Background.....	1
3.2. 1.2. Statement of problem	1
3.3. 1.3. Significance of the study	2
2. Literature review	2
2.1. Definition and epidemiology	2
2.2. Causes of mild TBI	3
2.3. Prevalence and predictors of positive CT scan.....	3
2.4. Patterns of CT scan	6
3. Objective	8
3.1. General objective	8
3.2. Specific objective.....	8
4. Methodology.....	9
4.1. Study setting and period.....	9
4.2. Source and study population	9
Source of population	9

Study population	9
4.3. Study design	9
4.4. Sample size determination.....	9
4.5. Sampling technique.....	11
5. Variables of the study.....	12
5.1. Independent variable	12
5.2. Dependent variable	12
6. Operational definition	13
7. Data collection tool and procedure	14
7.1. Data analysis.....	14
8. Ethical considerations	15
9. Result.....	16
9.1. Socio-demographic characteristics	16
9.2.	16
9.3. Clinical profile	17
9.4. Mechanism of Trauma	18
9.5. Clinical presentation	19
9.6. CT scan Result.....	20
9.7. Patterns of CT scan findings.....	22
9.8. Neurosurgical operation	23
9.9. Out come	23

9.10.	Determinant factors	25
10.	Discussion	27
11.	Limitation and strength.....	30
11.1.	Limitation.....	30
11.2.	Strength.....	30
12.	Conclusion and recommendation	30
12.1.	Conclusion	30
12.2.	Recommendation.....	30
13.	Reference	32

List of tables

Table 1 Baseline characteristics of patients categorized based on the presence of ICH	5
Table 2 Abnormal CT scans in patients with mild head trauma.....	6
Table 3 sample size calculation for the above listed objective.....	10
Table 4 Socio-demographic characteristics of patient presented to AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15 th to July 15 th ,2022.	16
Table 5 - clinical profile of patents presented to AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15 th to July 15 th ,2022.	17
Table 6 mechanism of trauma with age category of patients presented to AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15 th to July 15 th ,2022.	18
Table 7: - Mechanism of trauma of patients visited AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15 th to July 15 th ,2022.	19
Table 8: - Prevalence of positive CT scan among different group of patients seen in AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15 th to July 15 th ,2022.	21
Table 9 :- Number of neurosurgical surgeries done for patients with abnormal CT scan visited AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15 th to July 15 th ,2022.	23
Table 10:- outcome of patients with mild head injury seen at AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15 th to July 15 th ,2022.	24
Table 11 multivariate analysis of independent variables with positive CT scan at AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15 th to July 15 th ,2022.	26

List of figures

Figure 1-patterns of head CT scan findings among patients with positive CT scan seen at
AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15th to July
15th,2022.....22

List of acronyms and abbreviations

AaBET - Addis Ababa Burn, Emergency and Trauma hospital

BSF – Basal skull fracture

CAD – Coronary Arterial Disease

CI – Confidence interval

CSF – Cerebro - Spinal Fluid

CT scan – Computed Tomography Scan

DAI – Diffused Axonal Injury

DM – Diabetic Mellitus

ED – Emergency Department

EDH – Epi-Dural Hematoma

FND – Focal Neurological Deficit

GCS – Glasgow Coma Score

HTN – Hypertension

ICH – Intracranial Cerebral Haemorrhage

ICB – Intracranial Bleeding

ICU – Intensive care unit

LOC –Loss of Consciousness

MOT –Mechanism Of Trauma

SAH – Sub Arachnoid Hematoma

SDH – Sub-Dural Hematoma

SPHMMC – Saint Paul’s, Millennium Medical College

TBI – Traumatic Brain Injury

1. Introduction

1.1. Background

The first CT scan was introduced by Godfrey Hounsfield in 1967 GC, since then it has come a long way in a fairly short period of time renovating much of the medical practise. It is a gold standard for initial evaluation and for follow up of acute traumatic brain injury, as it can be performed easily and quickly. However due to the cost and likely complication of radiation exposure, there has been a significant controversy on who needs to be scanned, in majority of mild TBI cases. (1)

Traumatic brain injury is a major public health problem both in developed and developing countries. Based on evidence from the global burden of disease study, the age standardise incidence rate of TBI was estimated to be 399 per 100,000 population globally, in 2016(2). In Africa, the projected estimate of TBI is somewhere between 6 and 14 million new cases in 2050. Higher values are estimated in the eastern part of the continent where Ethiopia is located(3). There are only few evidences on the prevalence of TBI in Ethiopia. The prevalence varies significantly across existing reports, ranging from 20% to 60% (4, 5). Evidence shows that TBI is on the rise in Ethiopia due to a rise in use of motor vehicles and the associated road traffic accidents, which are the major causes of the head injury in the country (4).

Based on the GCS(Glasgow Coma Scale)of the patient at presentation, TBI is classified as mild(GCS 13 to 15), moderate(GCS 9 to 12) and severe ($GCS \leq 8$) (6). Mild TBI is one of the most common classes of head injury seen in the emergency department, accounts nearly 70 to 80% of all head trauma cases and majority of them present with a GCS score of 15 (7).

Patients with mild TBI and GCS score of 13 and above create a greater diagnostic dilemma. Generous use of CT is advocated by some authors because clinical judgment may not be adequate to confidently discharge patients (8). Other suggest neurologic examination is best predictor for serious complication of minor head injuries so, patients with normal GCS, normal mental status and no FND, can be discharged safely (9).

1.2. Statement of problem

There are several health institutions in Ethiopia. Nonetheless, the actual prevalence is not known and there is no study done specifically to evaluate patterns and predictors of positive head CT findings in cases of mild TBI.

Head CT is an important imaging modality for patients with acute head injury. Its use is not properly justified in cases of mild TBI as it is in moderate and severe TBI. Abnormal finding is common in patients with mild TBI ranging from 4% to 80% although only small portion of them need neurosurgical intervention (10). So, its use should be justified to avoid unnecessary exposure to radiation and reduce hospital transfer cost together while being cautious not to miss significant CT findings (11). Its availability is also another issue in many parts of the world especially in resource limited areas. When to make a decision of referral from remote areas, is another dilemma for the clinicians (12).

In Ethiopia, one of the developing countries with a limited resource but a high burden of head trauma cases, patients are obliged to travel long distance to reach to the hospitals where CT is available. Transportation cost alone is estimated to account for 61.8 % of all medical and non-medical costs. Lost working hours of both the patient and at least three of their care takers is also significant according to the study done in Gondor hospital (13).

There are limited studies regarding the prevalence of mild TBI nationwide and almost no studies were found about the pattern and predictors of positive head CT scan in patients with mild TBI up to our search. The interest of this study arose from the need of using one of the important emergency imaging modalities; that is head CT with a clear indication and prevent patients from adverse effects of its overuse, by indicating the prevalence and pattern of the positive head CT scan and its predictors.

1.3. Significance of the study

Assessing the patterns and predictors of abnormal head CT findings in patients presenting with mild TBI is an important initial step to have a nationally approved guideline and a common consensus to whom head CT scan is appropriate.

This study aims first, to fill the gaps of different clinician's opinion regarding the use of head CT in mild TBI by providing the information on the prevalence of abnormal CT scan and its predictors among clinical presentations. Second, it will assist physicians working in remote areas of the country in their decision of patient referral in cases of mild TBI.

2. Literature review

2.1. Definition and epidemiology

The definition of mild TBI is an area of controversy for a long period of time and currently the widely accepted criteria is developed by Mild TBI Committee of the American Congress

of Rehabilitation Medicine, and revised by the World Health Organization (WHO) as a *“Glasgow Coma Scale score between 13 to 15 at 30 minutes post-injury, and one or more of the following symptoms: <30 min loss of consciousness; <24 hours post-traumatic amnesia (PTA); impaired mental state at time of accident (confusion, disorientation, etc.); and/or transient neurological deficit”* (14). The American congress of rehabilitation medicine expert opinion survey also planned to address, other ongoing controversy, whether mild TBI or other categorically more severe classification should be considered in the presence of intracranial findings attributed to the injury (15) (16).

Worldwide mild TBI is estimated to represent 70 to 90 percent of all treated TBI with the rate of hospital treatment mild TBI in adult patients is 100 to 300/100,000. Due. However, due to its mild nature most of the cases are not being treated at the hospital and that the actual rate is probably 600/100,000 (7).

2.2.Causes of mild TBI

The prevalence of Traumatic brain injury in general is increasing in both developed and developing countries. Many head traumas are of motor-related accidents, but the pattern of injury varies across regions: in high-income countries, individuals with TBI are generally motor vehicle occupants, whereas in middle- and low-income countries patients with TBI are often vulnerable road-traffic users such as pedestrians, cyclists, and motorcyclists (17). In Ethiopia the commonest cause of TBI is RTA accounting 21% followed by assault 18% (4).

2.3.Prevalence and predictors of positive CT scan

The prevalence of abnormal CT scan with mild TBI has wide range of variability which may be due to retrospective nature of the studies as well as due to the use of different GCS categories in their study.

Whether to have a CT scan for cases of mild TBI is controversy. Some advocate the liberal use of CT scan and others claim neurologic examination is best predictor of serious complication so patients with normal mental status and no FND can safely be discharged with no CT scan (8, 9).

French and Dublin reported CT findings from 316 patients who were scanned from a consecutive series of 1000 patients; of those patients who were alert and had normal neurological exams, 13% demonstrated intracranial abnormalities (18). From another article; where 912 patients with mild TBI and GCS of 13 to 15 were included, 15.8% of patients had positive CT scan (10).

Other study was done in 712 patients with mild TBI who had LOC or amnesia after blunt head trauma and with GCS score of 15; 9.4% of them had an acute trauma related lesion on the head CT. where 2 required neurosurgical intervention and one died. Older age, white race, signs of basilar skull fracture and being a pedestrian hit by a motor vehicle or victim of assault; were factors statistically correlated with CT abnormality. Therefor even with GCS of 15; regardless of age, clinical findings and mechanism of injury; a positive CT scan cannot be excluded in patients who have LOC or amnesia (19).

Higher rate of abnormal CT scan was observed in other studies; In a study done in 2018; south Africa, 460 patients with normal GCS but with LOC were included and 30.4% scans were abnormal where 7.2% were identified as clinically significant but with no need for neurosurgical intervention (20). According Kelly C. Bordinon and Walter Oleschko among 2000 cases of mild TBI with GCS score of 13 to 15, 25.9% of them were abnormal related to head trauma (21). Thiruppathy S, and Muthukumar N, also reported; from 381 patients with GCS Of 13 to 15, 38% of them had a positive CT scan from which there were six patients who showed neurological deterioration and one of them died (12).

Pierre Borczuk, in 1994 studied mild TBI patients with GCS of 13 to 14 about 8.2% were abnormal CT scans with only 0.8 % of them required neurological intervention. This 15-month study period included 1448 patients who underwent CT scan for mild TBI; prevail that if LOC or amnesia, a commonly suggested criterion for head CT, not used; would have missed two patients who require neurological intervention; one with multiple contusion causing midline shift plus impending Uncal herniation and the other large SDH; and 27 positive scans would have been missed if LOC or amnesia were the only criterion for CT scanning. On the other hand, 56 positive scans and one patient who required neurosurgery would have been missed if FND or GCS score of 14 or less is used as a scanning protocol. FND, signs of BSF, cranial soft tissue injury and older age > 60 years were classified among a high-risk group clinical variables for positive CT scan. It was also concluded that Pedestrians struck by cars ($P=.0004$) and bicyclists struck by cars ($P=.002$) were at risk for intracranial pathology (22).

In the other retrospective analytical study from Thailand conducted from 2013 to 2016 in patients with GCS of 13 – 15, 153 patients were included. The outcome variable was the presence or absence of ICH. Eighteen patients (11.76%) were found to have ICH. Four independent factors; history of hypertension, headache, loss of consciousness, and baseline GCS score, were associated with presence of intracranial hemorrhage in patients with mild

head injuries. Lower mean GCS score was seen in those with ICH 14.39 versus 14.85 than those with no ICH. With the ratio of 0.87 versus 0.47 respectively. The other three independent factors are illustrated below with their respected ratio's. (23)

Table 1 Baseline characteristics of patients categorized based on the presence of ICH

Factors	No ICH (n=135)	ICH (n=18)	<i>P</i> value
LOC	36(26.6)	14(77.8)	<0.001
Headache	33(24.63)	9(50.00)	<0.001
Hypertension	9 (6.67)	4 (22.22)	<0.049

In article which was published at Hahnemann university, a total 497 CT scans were performed to evaluate intracranial trauma in the ED; with the aim of determining the adequacy of the loss of consciousness, amnesia, Glasgow Coma Scale (GCS) score, and mechanism of injury in predicting intracranial findings. Among 302 patients with GCS of greater than 13, CT scan was abnormal in 18% of patients. LOC was recorded in 303 patients (61%) who underwent a CT scan, and it was abnormal CT in 33% of the cases. From 207 patients with motor vehicle collision, 37 % CT scans; from 69 patients sustained pedestrian hit by a car, 43% CT scans; from 80 assaulted patients, 28% CT scans; from 88 patients presented after a fall accident, 28% CT scans had positive CT scan (8).

The study done at Southern New Jersey, from 1986 to 1988, concluded 658 patients admitted for a mild head injury with GCS of 13 to 15 on admission, who experienced a brief loss of consciousness or amnesia after the injury. From 658 patients 454 had GCS of 15, 142 had GCS of 14 and 62 patients had GCS of 13. From 17.6% of abnormal CT scan abnormality was seen in 40%, 22.5% and 13% in patients with GCS score of 13, 14 and 15 respectively (16).

The table illustrated below shows lower GCS is associated with abnormal CT scan.

Table 2 Abnormal CT scans in patients with mild head trauma

GCS score	no of CT scan	Abnormal CT scans (%)
15	454	59(13)
14	142	32(22.5)
13	62	25(40.3)
Total	658	116(17.6)

2.4. Patterns of CT scan

In the study done in Iran, frequency of brain CT scan findings were assessed in patients with scalp laceration following mild traumatic brain injury (defined by GCS of 15). Among 94 patients, the common finding was subgalea hematoma in 76 (80.9%), followed by basal skull fracture 7(7.1%), linear skull fracture, brain contusion, subdural hematoma. concluded that scalp laceration was associated with intracranial injuries in about 20% (24)

In 1999, over a period of four months; a prospective study was conducted in a tertiary referral centre of neurosurgery in South Tamil Nadu. There were 381 cases of mild TBI with GCS of greater than 13. CT scan was abnormal in 38% of the cases. linear skull fracture was observed in (68%). Among intracranial abnormalities haemorrhagic contusion (41%) was common followed by depressed and elevated skull fracture (39%), EDH (29%), Pneumocephalus (18%), ICH (12%) and SDH (11%). In this specific study; admission GCS, FND and fracture detected by CT scan found to be statistically significant predictors of positive findings on CT scan (12)

A retrospective descriptive study done, between 2012 and 2014, at Groote Schuur Hospital (GSH) in the Western Cape of South Africa, clinical significance of any abnormalities found on CT head scans of 460 patients with MHI and GCS scores of 15/15 was analysed. From 460 scan reports, 320 (69.6%) showed no abnormality, while 140 (30.4%) showed abnormality. Of the 140 abnormal scans, 107 (23.3%) showed clinically non-significant abnormality, while 33 (7.2%) revealed clinically significant abnormality. Twenty-two (4.8%) of these clinically significant scans showed brain contusion and 11(2.4%) showed skull fracture with no SDH, EDH, shift or herniation (20).

Most previous studies done in mild head trauma bound their categories of patients to those with loss of consciousness or amnesia, which they believe without these features patients are not at a significant risk of trauma. However, the other paper reviewed here, which was performed

using a systematic search from MIDLINE and Cochrane library, 23,079 patients were identified with the aim of assessing the accuracy of symptoms and signs in identifying severe intracranial findings in patients with minor head trauma. From those patients with severe intracranial finding, which is 7.1%, It was concluded that a combination of history and physical examination features in clinical decision rules (Canadian CT head rule and New Orleans criteria) can identify patients with minor head trauma at low risk of severe intracranial injury and findings including Skull fracture, GCS score of 13, two or more vomiting episodes, decrease in GCS score and pedestrians hit by motor vehicles may help identify those with increased risk of severe intracranial injuries (25).

There are different published articles on the patterns of head CT findings of mild TBI and association of clinical presentations with an abnormal CT scan. Arising from these articles many countries have designed their guidelines to solve the dilemma of clinicians on the use of head CT scan in mild TBI (4)(5)(14).

In Ethiopia, we were able to find one guideline which was prepared by the neurosurgery department of Mekelle university, Ayder campus, on when to refer patients for head CT after a head trauma and regarding the indications of neurosurgical interventions. 27

3. Objective

3.1.General objective

- ✓ To determine the prevalence, patterns of positive CT scan and associated factors of positive CT scan in patients with mild TBI at AaBET hospital, Ethiopia from 15th April, 2022 to 15th July, 2022

3.2.Specific objective

- ✓ To indicate the patterns of positive CT scan
- ✓ To compare predictors of positive head CT scan findings

4. Methodology

4.1.Study setting and period

Institution based cross-sectional study was conducted at AaBET hospital, Arada sub city, Addis Abeba, Ethiopia from April 15,2022 to July 15,2022. The hospital was inaugurated as a public hospital under SPHMMC in 2015, and it is one of the first health sectors with an entire trauma unit. It includes departments in EMCC, neurosurgery, orthopaedics, traumatology and an academic program in plastic and reconstructive surgery. It has a well-structured emergency and ICU setup with more than 50 beds in the ED organized as red, orange and yellow green with 11 ICU beds and 3 semi-ICU beds. It provides 24 hours 7 days a week service with a comprehensive laboratory and radiography units. The later provide ultrasound, X-ray and CT scan service.

4.2.Source and study population

Source of population

All mild TBI patients who presented at the emergency unit.

Study population

All patients who fulfil the inclusion criteria presented to the emergency department with mild TBI and with head CT scan done.

Inclusion criteria

- ✓ All patients with mild TBI seen during the data collection period
- ✓ Those with head CT scan at initial visit

Exclusion criteria

- ✓ Those with previous intracranial CT abnormality not related with current trauma
- ✓ Patients with moderate and severe TBI

4.3.Study design

Institution based cross sectional study was conducted in AaBET hospital.

4.4.Sample size determination

The sample size for the study is determined by assuming similar studies which were conducted in India Showing that 38 % prevalence of positive CT scan (12). The sample size is calculated using a single population proportion formula.

$$n = \frac{Z_{\frac{\alpha}{2}}^2 P (1 - P)}{d^2}$$

Where; - n = minimum sample size

P= Proportion of prevalence

d = margin of error = 5%

$Z_{\alpha/2}$ = critical value for normal distribution at 95% confidence interval= 1.96 ($\alpha = 0.05$).

Table 3 sample size calculation for the above listed objective

Variables	Proportion	Calculated sample size	Non response 10%	Final sample size
Prevalence	38%	370	37	407

Considering the last objective, which is comparing predictors in relation to the positive CT scan, sample size was calculated using two population proportion formula.

$$(n) = (Z_{\alpha/2} + Z_{\beta})^2 * (p_1(1-p_1) + p_2(1-p_2)) / (p_1 - p_2)^2$$

where: -

$Z_{\alpha/2}$ = critical value for normal distribution at 95% confidence interval= 1.96 ($\alpha = 0.05$)

Z_{β} = critical value of the normal distribution at β (e.g. for a power of 80%, β is 0.2 and the critical value is 0.84)

p_1 (abnormal CT) and p_2 (normal CT) are the expected sample proportions of the two groups.

From the above calculated sample size 407 the largest sample which is our final sample size.

4.5.Sampling technique

Exhaustive sampling technique was used to select the 407 study elements. Data collected from all mild TBI patients with CT scan who visited during data collection period until the minimum required sample size is obtained. If the minimum sample size required is not met the data collection period was planned to be prolonged accordingly.

5. Variables of the study

Independent variable

- ✓ Sociodemographic data
 - Age, sex
- ✓ Chronic medical illness
 - DM, Hypertension, CAD
- ✓ Mechanism of trauma
 - The manner at which the injury occurred (e.g., RTA, FDA, hit by a stick...)
- ✓ Clinical presentation
 - constellation of physical signs or symptoms associated with the trauma (e.g., LOC, amnesia, headache, External soft tissue injury, Ear and nose CSF leak ...)

Dependent variable

- ✓ Patterns of the head CT scan results
- ✓ positive CT scan findings

6. Operational definition

- ✓ Mild TBI Is defined as a GCS score of 13 to 15

- ✓ Abnormal CT/ positive CT scan is a CT scan with current trauma related findings (SDH, EDH, SAH, parenchymal contusion, cerebral oedema, cerebral herniation, DAI, ICB, pneumocephalus, skull fracture)

- ✓ Pattern of positive CT scan – findings of the positive CT scan which are listed as abnormal CT (e.g., SDH, EDH, skull fracture ...)

- ✓ Predictors of positive CT scan – it is the general name given for independent variables (MOT, clinical presentation, chronic medical illness, sociodemographic variables) which we assumed might affect the presence of CT scan finding in patients with mild TBI.

7. Data collection tool and procedure

Questionnaire was prepared using English language adopted from previous literature which contains sociodemographic data, mechanism of trauma, and clinical presentation, filled from the patient chart trauma registry. The head CT scan images collected were reported by a radiologist.

Data quality control

Preliminary test on a 5% sample size outside of the study area was done. Training was given for data collectors and supervisors. During data collection questionnaires were reviewed for completeness, accuracy and consistency by the principal investigator every day.

Data analysis

After the data collection the data was cleared, coded and entered to computer by using epi info Version 3.5.3 and SPSS version 20.0.0 for analysis. Descriptive statistics was done, including frequency, percentage, and mean. Crude and adjusted odds ratio (AOR) was analysed with a 95% confidence interval (CI). Binary logistic regression was used to see association between dependent and independent variables. Those variables with p-value of ≤ 0.05 on binary logistic regression were further considered for multivariate logistic regression to determine independent associations of each variable and control confounding variable. P-value < 0.05 was declared a statistically significant association.

8. Ethical considerations

Ethical clearance and approval to conduct the research was obtained from St. Paul Hospital Millennium Medical College and department of emergency medicine and critical care, Addis Ababa. Study holds no harm to study population and the confidentiality was guaranteed.

9. Result

9.1. Socio-demographic characteristics

A total of 407 CT scan images of patients with mild TBI were analysed. 320(78.6%) of patients were male and 87(21.4%) were female which is 3.7: 1 ratio. The mean age was 30.20, with a range of 1 to 85 years. 203 (49.9%) of patients were from Addis Ababa, 184(45.2%) were from Oromia, 9 (2.2%) were from Amhara, 9(2.2%) were from SNNPR, 1(0.2%) were from Siddama and 1(0.2%) were from Benishangul. Most patients, 239(58.7%) presented within 6 hours.

Table 4 Socio-demographic characteristics of patient presented to AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15th to July 15th,2022.

Variables	Number	Percent
Age		
0-5	22	5.4
6-15	30	7.4
16-25	121	29.7
26- 35	114	28.0
36-45	66	16.2
46 -55	22	5.4
56 - 65	21	5.2
>65	11	2.7
Sex		
Male	320	78.6
Female	87	21.4
Address		
Addis Ababa	203	49.9
Oromia	184	45.2
Amhara	9	2.2
SNNPR	9	2.2
Siddama	1	0.2
Other (Benishangul)	1	0.2
Duration of time arrive to ED		
0-6 hr		
6- 24 hr	239	58.7
>24hr	88	21.6
Unspecified	72	17.7
	8	2

Clinical profile

Out of 407 patients 372 (91.4%) were from Yellow Green and 35(8.6%) were from orange triage category. There were no patients triaged to red side with the diagnosis of mild TBI during the period of the study.

Findings of the study indicate that majority of patients 392(96.3%) did not have any chronic medical illness, 7(1.7%) patients had HTN, 2(0.5%) patients had DM and 6(1.5%) patients had other chronic medical illness like Epilepsy, Psychiatric illness and RVI. Majority 405(99.5%) patients did not take any anticoagulant drug. Out of 407 patients, 179(44%) patients were self-referred, 92 (22.6%) referred from government hospitals, 126(31%) were referred from health centres and 10(2.5%) were referred from private health facilities.

Table 5 - clinical profile of patents presented to AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15th to July 15th,2022.

Variables	Number	Percent
Chronic Medical Illness		
None	392	96.3
HTN	7	1.7
DM	2	0.5
Other	6	1.5
Epilepsy	2	0.5
Psychiatric illness	2	0.5
RVI	2	0.5
Anticoagulation		
None	405	99.5
Aspirin	2	0.5
Mechanism of referral		
No response	241	59.2
With communication	14	3.4
Without communication	6	1.5
Direct without referral	146	35.9
Source of referral		
No response	179	44
Government Hospital	92	22.6
Health centre	126	31
Private Health facility	10	2.5

Mechanism of Trauma

The major mechanism of trauma were RTAs 165(40.5%), 136 (33.4%) were assault, 94(23.1%) were FDA, 10 (2.5%) were hit by falling object and 2(0.5%) were from other mechanism.

Out of 165 RTA 132 (80%) occurred in the 16 - 45 age group and 2 (1.2%) occurred in those above 65 years of age group. From those 94 patients who sustained FDA, majorities 20 (21.2%) occurred in the 26- 35 age group and 5 (5.3%) in those above 65 years of age group. Out of 136 Assault, the majority 98 (72.0%) trauma occurred in the 16 - 35 age group.

Table 6 - mechanism of trauma with age category of patients presented to AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15th to July 15th,2022.

		RTA	FDA	Assault	Hit by Falling Object	Others	Total
Age	0 – 5	6	12	4	0	0	22
	6 – 15	10	15	5	0	0	30
	16 – 25	49	13	54	4	1	121
	26 – 35	45	20	44	4	1	114
	36 – 45	38	14	14	0	0	66
	46 – 55	9	6	7	0	0	22
	56 – 65	6	9	6	0	0	21
	above 65	2	5	2	2	0	11
Total		165	94	136	10	2	407

Out of 165 RTAs, 155 (93.9%) were from motor vehicles. From those RTAs 82 (49.7%) were pedestrians, 64 (38.8%) were passengers and 19 (11.5%) were Drivers. From assault mechanism 44 (34.4%) were hit by stick, 6 (4.7%) were hit by a metal rod, 54 (42.2%) were hit by stone, 23(18%) by sharp object and 1(0.8%) were unknown. Out of 94 FDA 44 (46.8%) were from height, 38(40.9%) were from standing height, 10 (10.6%) into a ditch and 2(2.1%) were Unknown.

Table 7: - Mechanism of trauma of patients visited AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15th to July 15th,2022.

Variables	Number	Percent
RTA		
Motor vehicle	155	93.9
Bicycle	10	6.1
RTA		
Pedestrian	82	49.7
Passenger	64	38.8
Driver	19	11.5
Assault		
Hit by stone	54	42.2
Hit by stick	44	34.4
Sharp object	23	18
Hit by metal	6	4.7
Unknown	1	0.8
FDA		
Height	44	46.8
Standing	38	40.9
Into ditch	10	10.6
Unknown	2	2.1

Clinical presentation

LOC was observed in 176(43.2%) of patients and from these 86(37.2%) had duration of LOC <5 min. The next common complaint experienced by patients 139 (34.2%) was headache. Among those 407 patients 371(91.2%) had GCS of 15, 29(7.1%) patients had 14 GCS and 7(1.7%) patients had 13 GCS at ED presentation.

Table 7: - Clinical presentation of patients visited AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15th to July 15th,2022.

Variables	Number	Percent
Clinical Presentation		
LOC		
Yes	176	43.2
No	231	56.8
LOC		
<5 Min	86	37.2
5-30 Min	80	34.6
>30 Min	57	24.7
Unknown	8	3.5
Vomiting	69	17
Headache	139	34.2
FND	12	2.9
Intoxicated	30	7.4
Seizure	14	3.4
Ear/Nose CSF leak	10	2.5
bruising behind the ears	4	1
bruising around the eye	3	0.7

CT scan Result

284 (69.8%) patients had normal head CT scan while 123(30.2%) had abnormal head CT findings related to their current trauma.

Out of these positive CT scan results majority 110 (89.4%) were male, 45(36.6%) age group were 26-45 years, majority 43(35%) patients present within 6hr CT scan results were positive.

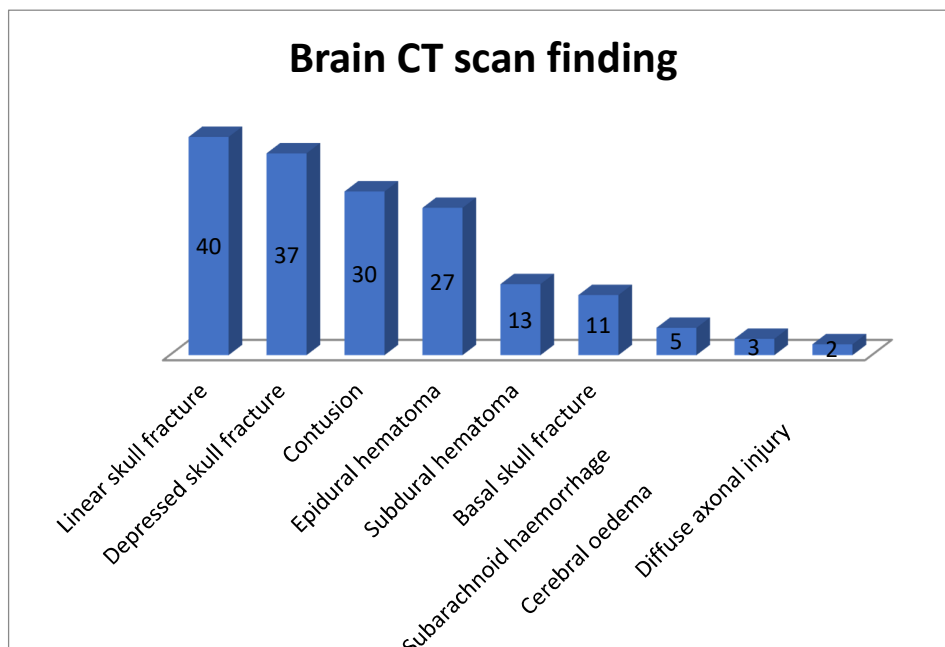
Table 8: - Prevalence of positive CT scan among different group of patients seen in AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15th to July 15th,2022.

Variable	Positive CT scan	Negative CT scan
Sex		
Male	110 (89.4%)	210(73.9%)
Female	13 (10.6%)	74(26.1%)
Age		
0 – 5	6(4.8%)	16(5.6%)
6 -15	13(10.5%)	17(6%)
16 – 25	41(33.3%)	80(28.1%)
26 – 35	31(25.2%)	83(29.2%)
36 -45	14(11.3%)	52(18.3%)
46 -55	7(5.7%)	15(5.3%)
56 -65	6(4.8%)	15(5.3%)
Above 65	5(4%)	6(2.1%)
Duration		
0 – 6 hr	43(35%)	196(69%)
7 – 24 hr	40(32.5%)	48(16.9%)
>24 hr	40(32.5%)	32(11.3%)
Unspecified	0	8(2.8%)
Chronic medical illness		
None	118(95.9%)	274(95.9%)
HTN	2(1.6%)	5(1.8%)
DM	0	2(0.7%)
Other	3(2.4%)	3(1.1%)
Anticoagulation		
Aspirin	0	2(0.7%)
None	123(100%)	282(99.7%)
Mechanism of trauma		
RTA	31(25.2%)	134(47.2%)
FDA	31(25.2%)	63(22.2%)
Assault	57(46.3%)	79(27.8%)
Hit by falling object	3(2.4%)	7(2.5%)
Others	1 (0.8%)	1(0.4%)
GCS		
13	4(3.3%)	3(1.1%)
14	17(13.8%)	12(4.2%)
15	102(82.9%)	269(94.7%)

Patterns of CT scan findings

Linear skull fracture was the commonest brain CT scan finding in 40 of patients accounting for 33.6% among positive CT scan results. Out of these 40 patients 20 of them had isolated linear skull fracture and the remaining occurred in combination with other findings, 7 of them had contusion, 6 of them had SDH with linear skull fracture. Next most common finding is depressed skull fracture 37 (31.1%), Contusion in 30 (25.2%) patients, Epidural hematoma in 27 (22.7%), Subdural hematoma in 13 (10.9%) patients and Diffuse axonal injury in 2(1.7%) patients.

Figure 2-patterns of head CT scan findings among patients with positive CT scan seen at AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15th to July 15th,2022.



Neurosurgical operation

Neurosurgical operations were done for a total of 26 (21,1%) patients with positive head CT finding. Out of these 26 patients, elevation of DSF was done for 13 (50%) patients and 11 (42.3%) of them had epidural hematoma evacuation surgery. Subdural hematoma evacuation was done for 4 (15.4%) and decompressive craniotomy for 1 (3.8%) with other neurosurgical surgery done for 4 (15.4%) patients.

Table 9 :- Number of neurosurgical surgeries done for patients with abnormal CT scan visited AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15th to July 15th,2022.

Variables	Number	Percent
Elevation of DSF	13	50
Epidural evacuation	11	42.3
Subdural evacuation	4	15.4
Decompressive craniotomy	1	3.8
Other (debridement)	4	15.4

Out come

From the total 407 cases 371(91.2%) of patients were discharged home and of these 370(99.7%) had GCS of 15. 18(4.4%) patients transferred to other hospital, 17(4.2%) patients went home against medical advice and only 1 (0.2%) patient died.

Table 10:- outcome of patients with mild head injury seen at AaBET hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15th to July 15th,2022.

Variable	Number	Percent
Discharge	371	91.2
GCS13	4	1
GCS14	23	6.2
GCS 15	344	92.9
Transferred to other hospital	18	4.4
GCS13	2	11.1
GCS14	5	27.7
GCS 15	11	61.1
Went home against medical advice	17	4.2
GCS13	0	
GCS14	1	5.9
GCS 15	16	94.1
Died		
GCS13	1	0.2

9.2.Determinant factors

In order to investigate the association of independent variables with positive head CT scan both bivariate and multivariate analysis were used. In Bivariate analyses sex, duration of time to arrive at ED, mechanism of trauma, duration of LOC, vomiting, ear/nose CSF leak, FND and GCS at presentation were significantly associated with Positive CT scan result. In the multivariate analysis sex, duration of time to arrive at ED, LOC, vomiting and ear/nose CSF leak were retained as determinant of Positive CT scan.

Male patients 7.874 times [AOR= 7.874, 95% CI (1.886,32.884)] more likely to have positive CT scan than female patients. Patients arrive at ED within 7 - 24hr were 4.913 times [AOR= 4.913, 95% CI (1.99,12.117)] and patients arrive at the ED after 24 hrs were 5.33 times [AOR=5.33,95% CI (2.131,13.332)] more likely have positive CT scan result than a patient arrive within 6 hrs of arrival to the ED. Patients with unknown duration of LOC were 67.931 times[AOR=67.93,95% CI(3.67,1255.8)]more likely to have positive CT scan than patients with less than 5 minutes of LOC. Vomiting was associated with positive CT scan 7.4 times [AOR=7.411,95% CI (2.94,18.67)]more than those patients with no vomiting. Patients having era/nose CSF leak were more likely to have a positive CT scan than those who didn't have it. [AOR=11.916, 95% CI (1.9,74.6).

Table 11- Multivariate analysis of independent variables with positive CT scan at AaBET
hospital ED, Addis Ababa, Ethiopia, with mild TBI from April 15th to July 15th,2022.

Variables	CT Scan result		COR (95% CI)	AOR (95% CI)	P value
	Negative (n=284)	Positive (n=123)			
Sex					
Female	74	13	1	1	
Male	210	110	2.982 (1.58, 5.61) *	7.8749 (1.886,32.884) *	0.005
Duration					
0 – 6 hr	196	43	1	1	
7 – 24 hr	48	40	3.798(2.227,6.478) *	4.913 (1.992,12.117) *	0.001
>24 hr	32	40	5968(3.22,10.07) *	5.33 (2.131,13.332) *	.000
Unspecified	8	0	00	00	.999
Mechanism of trauma					
RTA	134	31	1	1	
FDA	63	31	2.12(1.19,3.80) *	1.675 (.605,4.643)	0.321
Assault	79	57	3.12(1.86,5.23) *	3.095 (1.294,7.405) *	.001
Hit by falling object	7	3	1.85(.45,7.57)	2.923 (.234,36.513)	.405
other	1	1	4.32(.263,71.03)	00	1.0
LOC					
<5 Min	66	20	1	1	
5-30 Min	48	32	2.291.125,4.304) *	1.703(.726,3.993)	0.221
>30 Min	31	256	2.77(1.344,5.7) *	1.173(.459,2.996)	0.739
Unknown	1	7	23(2.68,199.142) *	67.931(3.675,1255.842) *	0.005
Vomiting	27	42	4.936(2.86,8.5) *	7.411(2.941,18.674) *	0.000
FND	4	8	4.87(1.44,16.489) *	5.164(.800,33.318)	0.84
Ear/Nose CSF leak	2	8	9.8(2.05,46.89) *	11.916(1.903,74.615) *	0.008
GCS at presentation					
GCS 13	3	4	3.52(.774,15.98)	6.425(.031,1334.462)	0.494
GCS 14	12	17	3.73(1.72,8.09) *	2.895(.926,9.047)	0.068
GCS 15	269	102	1	1	

*Is given to those variables with p value less than 0.05

10. Discussion

This study attempted to assess the prevalence and pattern of positive head CT scan, and predictors for positive CT scan in patients with mild TBI who visited AaBET trauma centre. This study revealed that 30.2% of patients with mild TBI had an abnormal CT scan. The prevalence in our result can be compared with the study done in South Africa in patients with GCS of 15 which showed 30.4% prevalence of positive head CT scan. As the South African study only included those with GCS 15, we can estimate the prevalence would be higher than this if GCS of 14 and 13 were used (20). This estimation of higher percent value can be observed in the study with 38% of prevalence which was done in India in patients with GCS 13 and above (23). Most other studies showed lower prevalence of positive head CT scan compared to our study, ranging from 9.4% to 25.9% (12, 20, 22, 25). We can see there is a wide range of differences on the prevalence of positive CT scan as this may be due to the use of various definitions on mild TBI and the need to involve only a particular group of patients with some specific clinical presentation. It is conceivable that methodological differences among those studies and ours may account for such differences.

Majority of patients seen at the trauma centre for mild TBI during the study period were male patients compared to females with 3.7:1 ratio. Our study is consistent with other studies as male predominance was witnessed in different studies. The above mentioned study done in India showed comparable results with a male to female ratio of 3.7:1 (23). Other study done in Ethiopia also showed male predominance with 4:1 ratio (5). Our study showed that there was predominance of mild trauma injury to the head in the young population than in older patients. Where the mean age was 30.2 ± 15.4 , the majority were between 16 to 45 years of age 73.9%. This result is similar with other studies done in developing countries; Iran, Brazil etc. (12, 21). Although this is in contrast to studies which are coming out from developed nations. It was described by Bob Roozenbeek, Andrew I. R. Maas and David K. Menon on their paper, there is a shift towards older age of patients with TBI has been observed (17).

Road traffic accidents were the most common cause of trauma in this study 40.5 %, the majority occurred in the age group of 16 to 45 years of age. It was the least common cause among those above the age of 65. From all road traffic related accidents 93.9% of them were from motor vehicle accidents and among all pedestrians 49.7% were victims of the trauma. This result was also seen comparably with the study done in both low income and high-

income countries. In developed nations most of the population is motor vehicle occupant whereas in developing nation patients with head injury are vulnerable road traffic users such as pedestrians, cyclists and motorcyclists (17, 19, 22). This socioeconomic difference might be the cause for the difference seen in the studies done on different groups of population. In our case since the study is done in one of the developing African countries it is true that pedestrians account for the majority of the road related accidents.

Similar to the systematic meta-analysis done in Ethiopia our result showed assault was the next common mechanism of trauma accounting for 33.4% of the study group. (4)

The pattern of brain CT findings in mild head trauma observed across the previous studies is not consistent. Some studies classify findings on the CT scan as clinically significant and clinically not significant. Others did not include linear skull fracture as a positive finding (19). Our study included all possible CT scan findings other than soft tissue swelling as it is not reported often. In this study we were able to find linear skull fracture as a common CT scan findings among the study group which accounts for 33.6% this result is consistent with the study done in Iran and India. In these studies, it was shown the commonest CT finding being linear skull fracture.

Due to different study population groups, it is difficult to make generalizations among previous reports regarding indications for neuroimaging. In our study some of the sociodemographic and clinical profiles were seen as predictors of positive head CT scan. Sex, duration of time to arrive ED, presence of LOC, vomiting, and ear/nose CSF leak designated to have association. In previous studies some variables were detected to be predictors while other variables were written as not predictors in other literatures. This variability again can be from the broad definition of mild TBI across the studies or the different proportion of prevalence on positive CT scan findings. The other reason can be the percentage of patients included in the study having these clinical profiles is not consistent. Taking an example of two studies, one which is done in patients with GCS greater than 13, presence of loss of consciousness, vomiting and ENT bleeding were not associated with positive CT scan. On the other hand, it was observed GCS score (lower GCS), FND, and skull fracture, to have significant association with positive CT scan (12). The similarity of our study to this particular study is that mechanism of trauma, seizure, and age were not designated to have association. Although there is a difference as the presence of LOC and ENT bleeding have association in our study. The second study in New York showed older age, white race, signs

of basal skull fracture and some of trauma mechanisms had strong association however, clinical presentations including headache, Amnesia and FND have no role in predicting positive CT scan (19). This study has similarity to our study in that FND and Headache were not seen as predictors of positive head CT. Although one of the signs of basal skull fracture (ear/nose CSF leak) is one among the predictors in our study. The other widely used criterion, a Canadian head CT rule in patients with minor head trauma, which is similar to our study in that it includes vomiting and signs of BSF as determinants of positive C scan.(26)

11. Limitation and strength

11.1. Limitation

One of the limitations of the study is that it is a single centre study which we can't make generalizations. It was also not possible to make a comparison with studies done in the country as there is a lack of published research. As it is a cross sectional study it was not possible to show cause and effect relation among variables. It was difficult to reason out why some variables were not able to predict positive CT scan.

Some of the variables discussed to be predictors of positive head CT scan were not quantified. Vomiting for example should have been classified based on frequency as other literatures did.

11.2. Strength

This study is the first in its kind to be done in the country and it could pave the way for other further studies in the future. it includes all age groups and tries to include all possible variables to see the association with positive CT scan.

12. Conclusion and recommendation

Conclusion

Road traffic accidents were the major cause of trauma in which pedestrians were affected more. Linear skull fracture is the most common CT finding among those patients. Sex, duration of time to arrive at the ED, presence of LOC, vomiting and ear/nose CSF leak are the designated variables predicting positive head CT scan in patients who sustained mild TBI.

12.1. Recommendation

On the bases of the findings of this study the following recommendations were made

For road traffic safety office and individual road traffic users

Since the majority of trauma causes are RTA from which pedestrians are commonly affected followed by assault and in most of the accidents, the youngest group of the population is the victim. Appropriate preventive measures for road traffic safety and precautions need to be strictly followed.

For emergency professionals

It seems reasonable to take the results of the study into account while deciding on ordering a head CT scan for a patient presenting with mild head trauma, having the listed clinical parameters as a predictor for positive CT scan. However, it should be taken into account that we are not rejecting variables, listed as not predictor variables, which are to be taken into the clinical decision of the emergency professional to order a CT scan. For example, it is logical to have a CT scan for patients with GCS of 13 and 14 which our result couldn't show the association.

For future researchers

It will be more valuable if further studies can be done in multiple centres across the country to include large sample size. It is hard to find CT scan in many parts of the country, doing more research and finding the true predictors will allow us to have a clear guideline to use particular indication for head CT scan and decide on which patients with mild TBI need to be referred to trauma centres with CT scan.

13. Reference

1. Martino S, Reid J, Odle T. Computed Tomography in the 21st Century: Changing Practice for Medical Imaging and Radiation Therapy Professionals. Albuquerque, NM: American Society of Radiologic Technologists. 2008.
2. James SL, Theadom A, Ellenbogen RG, Bannick MS, Montjoy-Venning W, Lucchesi LR, et al. Global, regional, and national burden of traumatic brain injury and spinal cord injury, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet Neurology*. 2019;18(1):56-87.
3. Wong J, Linn K, Shinohara R, Mateen F. Traumatic brain injury in Africa in 2050: a modeling study. *European journal of neurology*. 2016;23(2):382-6.
4. Abate SM, Abafita BJ, Bekele T. Prevalence of Traumatic Brain Injury Among Trauma Patients in Ethiopia: Systematic Review and Meta-Analysis. *Annals of African Surgery*. 2021;18(1):10-7.
5. Fasika Amdeaslasie M, Mizan Kidanu M, Anteneh Tadesse M, Wondwosen Lerebo M. HEAD INJURY ADMISSIONS AT A REFERRAL HOSPITAL IN ETHIOPIA.
6. Esselman PC, Uomoto J. Classification of the spectrum of mild traumatic brain injury. *Brain Injury*. 1995;9(4):417-24.
7. Cassidy JD, Carroll L, Peloso P, Borg J, Von Holst H, Holm L, et al. Incidence, risk factors and prevention of mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *Journal of rehabilitation medicine*. 2004;36(0):28-60.
8. Harad FT, Kerstein MD. Inadequacy of bedside clinical indicators in identifying significant intracranial injury in trauma patients. *The Journal of trauma*. 1992;32(3):359-61; discussion 61.
9. Mohanty S, Thompson W, Rakower S. Are CT scans for head injury patients always necessary? *The Journal of trauma*. 1991;31(6):801-4; discussion 4.
10. Iverson GL, Lovell MR, Smith S, Franzen MD. Prevalence of abnormal CT-scans following mild head injury. *Brain Injury*. 2000;14(12):1057-61.
11. Zahabi SS, Rafiei H, Torabi F, Salehi A, Rezaei B. Evaluation of causes of brain CT scan in patients with minor trauma. *International Journal of Surgery Open*. 2020;27:220-4.
12. Thiruppathy S, Muthukumar N. Mild head injury: revisited. *Acta neurochirurgica*. 2004;146(10):1075-83.
13. Asmamaw Y, Yitayal M, Debie A, Handebo S. The costs of traumatic head injury and associated factors at University of Gondar Specialized Referral Hospital, Northwest Ethiopia. *BMC public health*. 2019;19(1):1-7.
14. Lefevre-Dognin C, Cogné M, Perdrieau V, Granger A, Heslot C, Azouvi P. Definition and epidemiology of mild traumatic brain injury. *Neurochirurgie*. 2021;67(3):218-21.
15. Silverberg ND, Iverson GL, Arciniegas DB, Bayley MT, Bazarian JJ, Bell KR, et al. Expert panel survey to update the American Congress of Rehabilitation Medicine definition of mild traumatic brain injury. *Archives of physical medicine and rehabilitation*. 2021;102(1):76-86.
16. Sc S. Ross SE: The value of computed tomographic scans in patients with low risk head injury. *Neurosurgery*. 1990;26:638-40.
17. Roozenbeek B, Maas AI, Menon DK. Changing patterns in the epidemiology of traumatic brain injury. *Nature Reviews Neurology*. 2013;9(4):231-6.
18. French B, Dublin A. The value of computerized tomography in the management of 1000 consecutive head injuries. *Surgical Neurology*. 1977;7(4):171-83.
19. Jeret JS, Mandell M, Anziska B, Lipitz M, Vilceus AP, Ware JA, et al. Clinical predictors of abnormality disclosed by computed tomography after mild head trauma. *Neurosurgery*. 1993;32(1):9-16.
20. Singata C, Candy S. Is computed tomography of the head justified in patients with minor head trauma presenting with Glasgow Coma Scale 15/15? *SA Journal of Radiology*. 2018;22(1):1-5.
21. Bordignon KC, Arruda WO. CT scan findings in mild head trauma: a series of 2,000 patients. *Arquivos de neuro-psiquiatria*. 2002;60:204-10.

22. Borczuk P. Predictors of intracranial injury in patients with mild head trauma. *Annals of emergency medicine*. 1995;25(6):731-6.
23. Yuksen C, Sittichanbuncha Y, Patumanond J, Muengtaweepongsa S, Aramvanitch K, Supamas A, et al. Clinical factors predictive for intracranial hemorrhage in mild head injury. *Neurology research international*. 2017;2017.
24. Hamrah H, Mehrvarz S, Mirghassemi AM. The Frequency of Brain CT-Scan Findings in Patients with Scalp Lacerations Following Mild Traumatic Brain Injury; A Cross-Sectional Study. *Bulletin of Emergency & Trauma*. 2018;6(1):54.
25. Easter JS, Haukoos JS, Meehan WP, Novack V, Edlow JA. Will neuroimaging reveal a severe intracranial injury in this adult with minor head trauma?: the rational clinical examination systematic review. *Jama*. 2015;314(24):2672-81.
26. Stiell IG, Wells GA, Vandemheen K, Clement C, Lesiuk H, Laupacis A, et al. The Canadian CT Head Rule for patients with minor head injury. *The Lancet*. 2001;357(9266):1391-6.



27. Head Injury
Guideline for North

Questioner

Questioner identification number: _____

Sociodemographic

1. MRN: _____
2. Sex
 - A. F
 - B. M
3. Age - _____
4. Address
 - A. Addis Abeba
 - B. Oromia
 - C. Amhara
 - D. SNNP
 - E. Siddama
 - E. Others, specify _____
5. Duration of time to arrive ED after the trauma

Clinical profile of the patient

6. Chronic medical history
 - A. HTN
 - B. DM
 - C. Stroke
 - D. CAD
7. Anticoagulation
 - A. Aspirin
 - B. clopidogrel
 - C. NSAID
 - D. Warfarin
 - E. other _____
8. Triage category;
 - A. Red
 - B. Orange
 - C. Yellow/Green
9. How was the referral
 - A. With communication
 - B. With out communication
 - C. Direct without referral
10. From where is patient referred
 - A. Referred from Government hospital
 - B. Referred from Health centre
 - C. Referred from private health facility

Mechanism of trauma variables

11. What is the mechanism of trauma;
 - A. RTA
 - B. FDA
 - a. From a hight
 - b. In to a ditch
 - c. From a standing
 - C. Assault
 - a) Hit by a stick
 - D. Gunshot injury
 - E. Hit by Falling object

- b) Hit by metal road
- c) Hit by a stone
- d) A sharp object F. Others, specify_____

12. If the answer for question number 11 is RTA, specify the type;

- A. Motor vehicle B. Motor bicycle
- C. Railway D. others, specify _____

13. If the answer for question number 11 is RTA, how was the mechanism;

- A. Pedestrian B. Passenger C. Driver
- D. Other -----

Clinical presentation variables

14. Clinical presentation to ED

- A. LOC a. < 5 min b. 5 min to 30 min c. > 30 min d. unknown
- B. Vomiting C. Headache
- D. FND E. intoxicated
- F. Seizure
- G. Ear/Nose CSF leak H. bruising behind the ears I. bruising around the eye

15. GCS at ED presentation

- A. 13 B. 14 C. 15

16. Pupil's size and reactivity to light

- A. Right - size _____ - reactivity_____
- B. Left – size _____ - reactivity _____

Pattern of positive CT variables

17. Is brain CT scan abnormal?

- A. Yes B. No

18. If yes to number 17

- A. finding related to current trauma B. finding shows pre-existing insult /

19. Brain CT scan findings; more than one option is possible;

- A. Normal F. Linear skull fracture

- B. Epidural hematoma
 - C. Subdural hematoma
 - D. Subarachnoid haemorrhage
 - E. Brain herniation
 - F. Cerebral oedema
 - G. Diffuse axonal injury
 - G. Depressed skull fracture
 - H. Basal skull fracture
 - I. Contusion
 - J. Mention if combined
20. Is the neurosurgical operation is done? A. Yes B. No
21. If the answer is yes for question number 20, What was the type of surgery;
- A. Epidural evacuation
 - B. Subdural evacuation
 - C. Decompressive craniotomy
 - D. Elevation of DSF
 - E. Others, specify-----
22. How was the outcome of the Patient;
- A. Died
 - B. Transferred to other hospital with GCS of _____
 - C. Discharged home with GCS of _____
 - D. Went home against medical advice with GCS of _____
23. How long was the total duration of stay;_____

