Audit Of
Clinical Records In
Paediatric Head Injuries.

By

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A Research Report presented to the
Faculty of Health Sciences, University of the Witwatersrand

In partial fulfillment of requirements for the degree

of

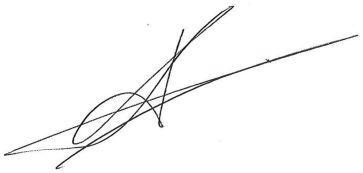
Masters of Science in Medicine in Emergency Medicine.

Completed: June2017.

Declarations:

I declare that this dissertation is my own work, with all assistance acknowledged. This dissertation is being submitted for the degree, Masters of Science in Medicine in Emergency Medicine, at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

I certify that the procedures used in this dissertation were approved by the Human Research Ethics Committee (Medical), of the University of the Witwatersrand.
Ethics approval number: M140764.



Jacobus Petrus van Niekerk.

Student number: 773358.

This 21st day of June 2017.

Dedications:

This dissertation is dedicated to:

- My 3 year-old daughter, Charlinaé, for her continuing love during the research.

- My parents, Kobus, and the late Marthie van Niekerk. For the opportunity to start my medical career. For their love and also their confidence in my abilities.

Acknowledgements:

This dissertation was possible because of the invaluable assistance of several people. I would like to use the opportunity to express my gratitude and appreciation to the following people. Without them, this study would not have been possible.

- Charlinaé van Niekerk 3 year-old daughter, for her continuing love and encouragement. Thank you for standing by me through tough times.
- Prof Efraim Kramer, Head of the Department of Emergency Medicine, and Dr Alison Bentley, Research Coordinator and Clinician (Sleep Expert), University of the Witwatersrand, Johannesburg, for their time and effort, knowledge and expertise, teaching me the principles of research.
- Dr Anita Groenewald, my supervisor and trauma doctor at the Life Wilgers Hospital, Emergency Department, for her knowledge, experience, time, encouragement and patience that she invested during my research.
- Mr Daan Slabbert, Hospital Manager, Netcare Montana Hospital in Pretoria, for allowing me the opportunity to involve the Trauma Unit of the Hospital.
- Med 24 Montana Trauma Unit and staff. Especially my colleagues and fellow directors, Drs Faan Rademeyer, Andries Coertze, Jaap Smit en Lize Gouws. They supported and motivated me throughout the process. Special mention should also be made of Me Charmaine Breedt. She helped me with the collection and organization of the patient files. She saved me weeks of administrative work.
- Last, but not the least, to God, my Heavenly Father, for the ability, motivation and passion to complete this study.

Abstract:

Head injuries are among the most common reasons children visit Emergency Departments (ED) worldwide (5). Head injuries seen in the ED can be categorized as minor, moderate or severe, as defined by the Glasgow Coma Scale (GCS) (3). Minor head injuries (MHI) are defined as a GCS of 13 to15 (6). The majority (>80%) of head injuries presenting in the ED, can be classified as MHI (5). When dealing with children who sustained a MHI, it is a challenge to determine whether there might be a potentially life threatening underlying injury to the brain (5,8,9).

The introduction of CT scan greatly improved the evaluation and management of MHI. The advantages include high accuracy and it is relatively fast to determine potential life threatening intracranial pathology. Disadvantages include cost, as well as high radiation doses associated with CT scans (8). To help decide whether a CT scan would be useful/diagnostic, a number of international validated CT scan rules/guidelines were developed (14,26). Effort should be made to reduce the number of CT scans done in the ED.

The aim of this study was to look at:

- The population of children that presented to the private Emergency Department in the North of Pretoria with the history of minor blunt head injury over a 12-month period.
- The management of children who presented with a minor blunt head injury in the Emergency Department studied.
- Any evidence of an International recognized guideline used in the decision to perform a CT scan in the Emergency Department studied.
- The incidence of positive CT scans that were done in the Emergency Department studied.

- Which of the international validated guidelines are best suited for the children that present to the Emergency Department studied in terms of compliance.

The study design was retrospective. The timeframe of data collected was 12 months. The sample size was 173 children.

The results showed that the population demographics of the children as well as the etiology and management of the minor head injuries that presented in the unit studied was comparable to most internationally recognized studies, both in developed and developing countries. In the emergency department studied, there was no evidence found to prove that validated guidelines were used in the decision process to order a CT scan or not.

We as emergency department doctors in South Africa need a cost effective, safe and sensitive guideline that is easy to incorporate in a private emergency department setting. We have to consider over investigation with the associated radiation risks of doing CT scans. We should also prevent under investigation and missing clinically significant intracranial pathology in minor head injuries. South Africa is a developing country and therefore financial constraints are a major factor in decision process of the management of all patients, including children with minor head injuries. Incorporating all data obtained and audited, as well as the international validated guidelines studied, it can be concluded that the PECARN Rule for minor head injuries would best be incorporated in the emergency department studied.

Glossary of Terms:

The following list is terms used as abbreviations in the dissertation:

ED.	-	Emergency Department(s).
GCS.	-	Glasgow Coma Scale.
CT scan.	-	Computed Tomography.
MHI.	-	Minor head injury/injuries.
PECARN.	-	Pediatric Emergency Care Applied Research Network.
NICE.	-	National Institute of Clinical Excellence guidelines.
USA	-	United States of America.
ATLS®	–	Advanced Trauma Life Support.
APLS®	-	Advanced Pediatric life Support.
Rad	-	Radiation Absorbed Dose.
mGY	-	Milligray.

List of Contents:

Chapter 1

Introduction:

1.1. Background of Head Injuries:

Hippocrates once said: "No head injury is too trivial to be ignored."

Head injuries are one of the most common reasons for patients to visit Emergency Departments (ED) worldwide. This is seen in both the private as well as public sector. It is also comparable in rural and urban environments (1).

When attempting to define head injuries one would find multiple terms that are used interchangeably, namely head injury, traumatic brain injury and concussion, although these are distinct entities. At present, there is still no consensus definition for the different clinical entities (2).

The definition of a traumatic head injury is: "Impairment of brain function as a result of mechanical force. The dysfunction can be temporary or permanent, and may or may not result in underlying structural changes in the brain." (2).

Head injuries seen in the Emergency Department can broadly be categorized as minor, moderate and severe injuries as defined by scores on the Glasgow Coma Scale (GCS) (3).

The GCS is also an important prognostic indicator, indicating outcome of head injured patients. The GCS is also widely accepted as a sensitive predictor of the efficacy of treatment for head injured patients (3,4). The GCS was published in 1974 and written by G Teasdale and B Jennett (4). There is differentiation between the GCS of adults and children. Marks get allocated for each of the responses, listed in Table 1 and 2 (5).

The GCS scoring system Adult and Children above 2 years of age:

Table 1: (4,5,6).

Response:	Score:	Best motor response:	Score:
Best eye response:		Obey commands.	6.
Spontaneous opening of eyes.	4.	Localize pain.	5.
Open eyes on command.	3.	Withdraws from pain.	4.
Open eyes on pain.	2.	Abnormal flexion.	3.
No eye opening, regardless of stimuli.	1.	Abnormal extension.	2.
Best verbal response:		No motor response.	1.
Orientated with normal speech.	5.		
Disorientated/Confused speech.	4.		
Only inappropriate words.	3.		
Incomprehensible sounds.	2.		
No verbal response.	1.		

The GCS scoring system (Child below 2 years of age):

Table 2: (4,5,6).

Response:	Score:	Best motor response:	Score:
Best eye response:		Infant moves spontaneously or purposefully.	6.
Spontaneous opening of eyes.	4.	Infant withdraws from touch.	5.
Open eyes to speech.	3.	Infant withdraws from pain.	4.
Open eyes on pain.	2.	Abnormal flexion (Decorticate).	3.
No eye opening, regardless of stimuli.	1.	Abnormal extension (Decerebrate).	2.
Best verbal response:		No motor response.	1.
Infant coos or babbles (Normal activity)	5.		
Infant is irritable and continually cries.	4.		
Infant cries to pain.	3.		
Infant moans to pain.	2.		
No verbal response.	1.		

At present most Emergency Departments worldwide use the GCS to categorize the presenting patient with a head injury (3). Currently, some Emergency Department doctors prefer more modern, but also more complex

scales. They claim that the GCS is not adequate enough, as it does not incorporate brainstem reflexes (3). These reflexes are very important in end of life decisions and therefore need to be incorporated (3). There is also controversy over the correct interpretation of the GCS in intubated patients in the clinical setting (3).

The definition of minor head injuries is still debated with no consensus definition available (2). In the Advanced Trauma Life Support Course (ATLS®), the definition is taught as a GCS of 13 to 15 (30). Some authors argue that a GCS of 13 might also be regarded as moderate head injury (6).

Because most of the Emergency Departments in South Africa use the principles, as taught in the ATLS®(30), for practical purposes, minor head injuries are defined as a GCS of 13 to15 (6). Moderate and severe head injuries have scores lower than 13 (6).

The majority (80% and more) of head injuries presenting in Emergency Departments worldwide, can be classified as minor (7). The probability of the presence of any intracranial abnormality in patients with minor head injuries is only 10% (1).

Life-threatening intracranial abnormalities that necessitate neurosurgical treatment on an extremely urgent basis are only 1% of the total population of patients presenting with minor head injuries (1). This is a worldwide trend (1). These statistics were presented by Vos PE, et al. when they updated the guidelines for managing minor head injuries in 2011 (1). Their method was to combine articles and guidelines found in data from MEDLINE, EMBASE and the Cochrane database from 2001 to 2009 (1).

1.2.Minor Head Injuries in Children:

When dealing with patients, especially children, with minor blunt head injury, it is still a major challenge for doctors who work in Emergency Departments all over the world to determine whether there is an underlying injury to the brain, especially one that could be potentially life threatening and would therefore require neurosurgical intervention (5,9).

About 25% of patients presenting to any Emergency Department in a first world country with a head injury are children (1).

According to the National Pediatric Trauma Registry, nearly half of all winter sport injuries in the United States are head injuries (10).

The mortality of minor traumatic brain injury are also less than 0.1% in the paediatric population (1).

1.3. Epidemiology of Minor Head Injuries in Children:

Age is important in the prediction of the susceptibility of a child for traumatic head injuries. When an age analysis was done in Taiwan, an industrialized first world country, and only looking at patients below the age of 18, patients under the age of 5 years had a higher risk of minor head injuries (11). Although beyond the scope of this study, the main reasons for this are the extreme anatomical and physiological differences in children under the age of 5. Children under the age of two were not studied or mentioned in the Taiwan study (11). This is also the reason why children under two years of age were excluded in this study. The very young child (<2years) carries an even higher susceptibility for head injury because of two main reasons. Firstly this group of patients still struggles with head control. Secondly there is a head size disproportion towards the rest of the body (12).

Numerous international studies showed that boys have a higher incidence of minor head injuries when compared to girls. Melo JRT, et al did a study in 2009, showing an incidence of 68,2% males against the 31.8% female patients who presented with minor blunt head injury (6). Boys are more exposed to the risks of sustaining a head injury (eg. Fall from a height) (6,11). After reviewing literature on incidence of injury, it was my conclusion that boys are at greater risk of minor head injuries because of their increased participation in outdoor activities, their greater impact of activity compared to girls and that boys generally participate in more dangerous activities compared to girls.

In future, magnetic resonance imaging (MRI) might influence the number of CT scans performed for head injuries. In the TRACK-TBI study (Transforming Research and Clinical Knowledge in Traumatic Brain Injury study), 30% of the patients with a normal CT scan after a minor head injury had an abnormal MRI. These abnormalities were structural in nature, and could not be detected by CT scan. At present, more studies are necessary to determine whether this would make a statistically significant difference to treatment in this patient group (31).

The introduction of the various available international guidelines has dramatically reduced the number of unnecessary CT scans (8,26,27).

The introduction of the New Orleans and/or Canadian CT Head Rule reduced the number of CT scans performed in the pediatric population studied in the Albert Einstein College of Medicine, New York (USA), by at least 10,9% (28).

1.4. Etiology of Minor Head Injuries in Children:

Taking numerous international studies in consideration, the two leading causes of minor blunt traumatic head injury are falls and pedestrian-vehicle accidents. This is true for developed and developing countries (6).

1.5. International Trends in the Treatment of Minor Traumatic Brain Injuries in Children:

All children presenting at an Emergency Department with the history of head injury should be evaluated thoroughly. This includes a full history taking, as well as comprehensive neurological examination. Generally one follows the protocol of courses such as “Advanced Trauma Life Support” (ATLS®) and “Advanced Pediatric Life Support” (APLS®) (1,30).

In the era before CT scan, Emergency Department doctors only had the history and clinical examination to go by. X-rays of the skull are not sensitive enough to exclude intracranial pathology after injury, particularly possible life threatening intracranial bleeds (13). An X-ray of the skull is still used in rural areas for evaluation of penetrating injuries, to look for radiopaque foreign objects and sometimes for suspected depressed skull fractures (13).

The introduction of CT scan as an imaging modality greatly improved the evaluation and thus clinical management of minor blunt head injuries (14). The advantages of a CT scan of the brain include a higher accuracy, compared to traditional X-ray evaluation, when reported and interpreted by a qualified radiologist. It is also a relatively fast way of determining potential life threatening intracranial pathology (14).

When following the principles of the ATLS® and APLS® guidelines, a large portion of these children should have a CT scan of the brain as it provides a relative quick and easy diagnosis. Currently, CT scan of the brain is seen as a gold standard investigation as part of the care of head injured patients. This includes minor head injuries (14).

Generally, it is advisable to re-evaluate all children with minor traumatic brain injury on an outpatient basis (1). This includes all children that were discharged

from hospital after admission for neurological observation (1). This should be done on all the children that underwent a CT scan, as well as those who did not (1). This should also be done within the first two weeks after the minor head injury (1). Children with persistent symptoms can then be referred to an appropriate specialist (neurologist/neurosurgeon) (1).

At present, biomarkers like the S100B test may be a good alternative to CT scan. Blood based biochemical markers, known as the S100B test, although still relatively new, are also reliable and correlates with the severity of head injury, when compared to CT scan (32).

The S100B is a protein, located in the glia cells. It enters the blood of the patient after injury to the central nervous system, but also after compromise of the blood brain barrier (32). It is definitely cost effective and there is no risk of radiation (15,32). Disadvantages of this method include: Unavailability to all centers, especially rural areas (15). There are also time constraints (15). The half-life of the S100B protein is only approximately 30 to 90 minutes (32). The sensitivity is therefore only good enough in the first 3 hours after the injury (32). Another concern is that more research is necessary to prove the sensitivity of the S100B biomarker (15).

1.6. Trend to over investigate:

Patients who present to the Emergency Department with a history of minor head injury and a GCS of 15, pose a challenge to the attending Emergency Department doctor as to whether the patient can be safely discharged, or should undergo further investigations. The reason for this is that most patients with a GCS of 15 are clinically well. However, up to 6.1% of these patients

could have intracranial bleeds, of which up to 0,6% needs neurosurgical intervention (16).

There are numerous arguments to support the liberal use of CT scan in the evaluation of children, presenting to Emergency Departments with the history of head injury (10).

The training of the attending Emergency Department doctor also influences the decision to do a CT scan or not. Different training centers have different opinions as to the indications for CT scan after blunt head injury (10).

It is a well known fact that it might be extremely difficult to evaluate preverbal children. CT scan is therefore an easy and comprehensive way to evaluate this subgroup of patients (10). It is also suggested that the liberal use of CT scans would decrease the number of intracranial injuries that are missed, in comparison to only evaluating the child on clinical basis (10). This might obviously have an effect on morbidity and mortality that can be prevented (10).

Most doctors would associate vomiting as an important symptom and would associate it with concussion and clinically significant head injury. Vomiting is extremely common in children that bumped their heads, both in clinically significant head injuries that would need surgical intervention, as well as clinical insignificant injuries (17). To prove this, in 2014, Dayan PS, et al did a study that showed that clinically significant brain injury on CT is extremely uncommon, with an incidence of 1,7%, in children that only had vomiting as presenting symptom after a minor head injury (17). This study should caution the Emergency Department doctor to act on one symptom alone.

Many emergency doctors tend to over triage children to support their decision to do a CT scan. This might partly be due to fear for any medico-legal consequences, particularly in a private health care system. Parents might also put pressure on the

attending Emergency Department doctor to do a CT scan irrespective of whether the CT scan is indicated or not (18).

1.7. Problems with over investigation:

Non-contrasted CT scanning is the radiological method of choice when evaluating any child with the history of head injury. CT scan usage in the last 20 years increased 20 fold in the United States alone (10). Numerous problems are associated with the over use of CT scans in the evaluation of minor head injuries. These include:

- Cost of CT scans.
- Radiation risk associated with CT scans.
- Potential complications of the sedation of children that need the sedation in order to do a CT scan (1).

A lack of knowledge among Emergency Department doctors regarding the validated guidelines is a major problem in the decision process whether to request a CT scan or not (18). This is a worldwide problem.

- **Cost:**

In a developing country like South Africa, cost of evaluation and treatment is always a major factor in the decision making process of the specific modality used in the evaluation and treatment of the patient (26). Most studies showed a reduction of cost when a specific international guideline is used in this decision making process (26,33).

- **Radiation risk:**

The attending Emergency Department doctor, when evaluating children with head injury, should always remember the associated risks of ionizing radiation. Children are inherently more vulnerable than adults to this radiation (19). Children therefore

might develop malignancies at a later stage of their lives because of this radiation effect. It should also be remembered that every exposure to ionizing radiation has a cumulative dose. The higher the radiation dose, the higher the risk would be to develop a malignancy as a direct result of the radiation (20). Literature suggests a typical CT scan of the brain delivers between 20mGy to 50mGy of radiation per CT scan series. This dose of radiation can also be translated as 2.0 to 5.0 rad of radiation per CT scan series. To put these numbers in context, this radiation dose correlates to 200 to 300 traditional chest X-ray's dose of radiation (35). The lower range of the radiation doses is the average doses of the newer low radiation CT scanners (35). Abovementioned dose intervals were used by numerous authors to try and study the radiation risks.

When studying specific radiation risks, most authors use theoretical risks by extrapolating data obtained from the atomic bomb survivors in World War 2. When extrapolated, the numbers are quite high. Theoretically malignancy might develop in 1 per 1250 CT scans in infants younger than 1 year. These numbers drop to 1 per 5000 CT scans in 10 year old children (10).

- **Sedation risks:**

Luckily the routine use of sedation, as well as complications of sedation is rare. In the study done by Atabaki, the complication rate of sedation for CT scan (excluding failed sedation), were 6.3%. The most common complication of sedation include nausea and vomiting (10).

1.8. International literature and guidelines to limit problems of over investigation:

International literature suggests the utilization of validated clinical guidelines to decide whether a patient needs a CT scan or not. These guidelines should decrease the number of CT scans that are performed, without compromising patient care. In

other words the number of CT scans necessary would decrease, while still maintaining a high sensitivity (1).

Most international guidelines share some common predictors of abnormal CT scans. Some of these include loss of consciousness, dangerous mechanism of injury, bleeding tendency in the injured patient and amnesia (16). In a Singapore study, published in 2013, out of all the predictors, the researchers determined the three most important of all the predictors to predict head injury with associated abnormal CT scan (16). The combination of loss of consciousness, amnesia and vomiting were associated with the highest probability for abnormal CT scan of the brain. It also resulted in a CT ordering rate of 53.4% of all minor head injuries seen (16).

Some of the most well known rules are The Canadian CT Head Rule (14,21), The New Orleans Criteria in Minor Head Injury (14,22), PECARN (Pediatric Emergency Care Applied Research Network) (23), The Kimberley Hospital Rule in South Africa (24) and The NICE-guidelines (National Institute of Clinical Excellence) (14,25).

PECARN (Pediatric Emergency Care Applied Research Network):

This was a long-term study to obtain evidence-based data on the best appropriate evaluation of head injured children in the Emergency Department. The study group wanted to develop a clinical decision rule, to do a CT scan or not, that would identify all children at high risk for intracranial injury that might need neurosurgery on an urgent basis. The same rule however, should also identify the children at no risk of clinically significant blunt head trauma (10). Nearly 44 000 American children under the age of 18 years were included. Blunt trauma was the common mechanism of injury in all the children enrolled. CT scans were done at the discretion of the attending doctor. The doctor needed to complete a clinical assessment form before he/she obtained the CT scan results. The children that were included all had a GCS of 14 or 15/15. In this study, 36.8% of the enrolled children were scanned. Only

11,2% of the scans had positive abnormal findings. Isolated skull fractures were the abnormal finding in 30% of the positive abnormal scans. Only 0,5% of the enrolled children underwent neurosurgery and only 0.1% of the enrolled children died as a result of the brain injury (10).

The result of the study was the development of prediction rules for the risk of clinically significant brain. High-risk children were divided into two age groups, below 2 years of age and above 2 years of age.

High-risk prediction rule:

Children of 2 years and above:

- GCS of 15 or below with abnormal mental status.
- History of loss of consciousness.
- History of vomiting.
- Severe/Dangerous mechanism of injury.
- Signs of base of skull fracture (Raccoon eyes, Battle Sign).
- Severe headache (10).

NICE – guidelines:

The National Institute of Health and Clinical Excellence (NICE) guidelines are currently used in the United Kingdom (14).

These guidelines give the Emergency Department doctor straight and to the point, best practice guidance, which should be used in the evaluation and management of all patients presenting with head injuries (14). The NICE-guidelines have different rules that apply for adults and children respectively.

NICE-guidelines: (Children)
GCS of 13,14 or 15 on assessment in the ED
Anterograde or retrograde amnesia lasting more than 5 minutes.
Abnormal drowsiness.
Three or more discrete episodes of vomiting.
Clinical suspicion of non-accidental injury.
Post-traumatic seizure with no history of epilepsy
Witnessed loss of consciousness lasting more than 5 minutes.
Suspicion of open or depressed skull injury or tense fontanels.
Any sign of base of skull fracture.
Any focal neurological deficit
In children <1 year, the presence of bruising, swelling or laceration longer than 5 cm.
Dangerous mechanism of injury.

(25)

The Canadian Head CT Rule:

This rule is valid for both adults and children (28). The Canadian Head CT Rule is more complex to use in the clinical setting partly because it is only applicable to patients with a GCS of 13 to 15/15, the patient should be older than 16 and should not be on warfarin or have a bleeding disorder. It is also not applicable to open skull fractures. To add to the complexity, the Canadian Head CT Rule further divides symptoms/signs as high risk for neurosurgical intervention and medium risk for brain injury to be detected by CT scan (22).

Canadian Head CT Rule:
Rule applies to patients with a GCS of 13/15 to 15/15.
Witnessed loss of consciousness.
Amnesia and/or confusion
High risk:
GCS < 15 after two hours after injury.
Suspected open/depressed skull fractures.
Any clinical sign of base of skull fracture.
2 or more episodes of vomiting.
65 years or older.
Medium risk:
Amnesia before impact of 30 minutes or more.
Dangerous mechanism of injury.

(22)

New Orleans Criteria for Minor Head Injuries:

This rule is valid for both adults and children (28).

In clinical practice, the New Orleans Criteria only applies when the child has a GCS of 15/15 and any one of the symptoms listed in the table (22).

New Orleans Criteria for Minor Head Injuries:
Criteria only apply when the GCS is 15/15.
CT scan required if any 1 of the following is present:
Headache.
Vomiting.
Older than 60 years.
Drug/Alcohol intoxication.
Persistent anterograde amnesia.
Visible trauma above the clavicle.
Seizures.

American Association of Neurologic Surgeons (AANS) Guidelines:

Although the AANS guidelines showed improved patient outcome, they were developed for the management of severe head injuries (36). The AANS Guidelines also increase resource expenditure (36), which would not fit into the limited available resources we have in South Africa as a developing country.

Kimberley Hospital Rule:

The Kimberley Hospital Rule was developed in the Northern Cape Province, South Africa. It is the largest of the provinces in South Africa, with the majority (80%) of people making use of the state managed public health service (24). This is therefore a large area of low socio-economic status. This province also faces huge resource deficits with regards to health care service. The Kimberley Hospital Rule in South Africa was an adoption of the principles of the NICE guidelines, but adapted for a

resource limited environment (24). The rule was developed after a study that was done in the Kimberley Public Hospital (24). The study was published is September 2013.The disadvantage of the Kimberley Hospital Rule however, is that it is only applicable to children over the age of 16 years (24). The first concern for this rule is the urgency of the CT scan. According to the rule you can divide patients qualifying for CT scan in two groups. The first group can be classified as very urgent. This is all of the patients who require an immediate CT scan or a CT scan within one hour of presentation (24). The second group is patients requiring an urgent CT scan within 8 hours of presentation to the Emergency Department (24).

The criteria to be classified as very urgent are:

- All patients with a GCS of below 13 and 16 years of age or above.
- Deterioration of the GCS by 2 points or more after the initial examination.
- Suspected fracture of the skull.
- Any focal neurological deficit.
- Any patient with a GCS of 13 or 14/15 with any one of the following:
    - Vomiting.
    - Seizure.
    - Coagulopathy or history of coagulopathy (24).

The criteria to be classified as urgent (Requiring CT scan within 8 hours) are:

- All patients with a GCS of below 15 and 16 years of age or above.
- All patients with a GCS of 15 with any one of the following:
    - Sudden onset of severe headache.
    - History of loss of consciousness.
    - Continuous vomiting (Exclude other causes of vomiting).
    - Seizure (Exclude other causes of seizures) (24).

1.9. Health Care Systems in South Africa with regards to Head Injuries in Children:

In South Africa there are two main health care systems. The first of these, is the state controlled and owned institutions (public sector), and secondly, the private sector. The private sector is owned and operated by major heath care companies and private medical practitioners.

At present, in the public sector, there are huge constraints with regard to equipment and human resources. Public sector facilities are mainly staffed by relatively junior doctors (24). The availability of CT scanners, costs and radiation risk is also a concern in both the public and private sectors (24).

At present, trauma affecting both adults and children is the second most common cause of death in South Africa (29).

With this in mind, we, as a developing country, need a protocol for the diagnosis, treatment and indications for CT scan for all head injuries.

Chapter 2

Methodology:

2.1 Aim of Study:

The aim of this study was to:

- Describe the population of children that presented to the private Emergency Department in the North of Pretoria with the history of minor blunt head injury over a 12-month period.
- Audit the management of children who presented with a minor blunt head injury in the Emergency Department studied.
- Audit any evidence of an International recognized guideline used in the decision to perform a CT in the Emergency Department studied.
- Audit the incidence of positive CT scans that were done in the Emergency Department studied.
- Describe which of the international validated guidelines are best suited for the children that present to the Emergency Department studied in terms of compliance.

2.2. Study Design:

The study design was retrospective, observational and transverse, with descriptive and comparative components.

2.3. Study Population:

The research took place in a private medium sized Emergency Department in the North of Pretoria. The hospital also received patients

from surrounding rural areas in Limpopo, Mpumalanga and North West Province. The population was all patients under 18 years, but above 2 years of age, who presented to the Emergency Department with the history of blunt head injury within the previous 24 hours. The timeframe of data studied was 12 months, from 1 January 2012 up to and including 31 December 2012.

2.4. Study Sample:

The sample consisted of all children under the age of 18, and above 2, who presented with minor head injury, (with or without CT scan) sustained within the last 24 hours. The sample size for the 12 months was 173 children.

Inclusion criteria for the sample were:

- All children between 2 and 18 years of age that were assessed in the Emergency Department for a minor blunt head injury.
- GCS on initial assessment by attending doctor of 13,14 or 15 out of 15.

Exclusion criteria were:

- All children with open/penetrating wounds to the head.
- All children referred from other hospitals that already had an evaluation and CT scan done.
- All children with known pre-existing intracranial pathology.
- Children that for various reasons should have had a CT scan done, as requested by the Emergency Department doctor, but did not go for the CT scan.

2.5. Detailed Description of Methods and Techniques Being Used:

The data was collected by reviewing clinical records of the children in the sample group, and CT scan reports from the private radiology department in the hospital. See Data Collection Sheet. (See Appendix 10.4).

2.6. Ethical Approval:

Formal approval was requested from the Human Research and Ethics Committee of the University of the Witwatersrand, Johannesburg. The research proposal was submitted and was approved. (See Appendix 10.1). Permission was granted by the Netcare Group, represented by the Hospital Manager of the hospital in which the emergency department studied is located. Permission was also granted by the private accident and emergency department practice, represented by one of the senior directors. Both parties gave written consent. (See Appendix 10.2 and 10.3).

2.7. Statistical Analysis:

It should be noted that various statistics software programs were utilized to analyze data obtained in the study. This included Instat®(Graphpad Inc. CA). A p-value of <0,05 was considered to be of statistical significance.

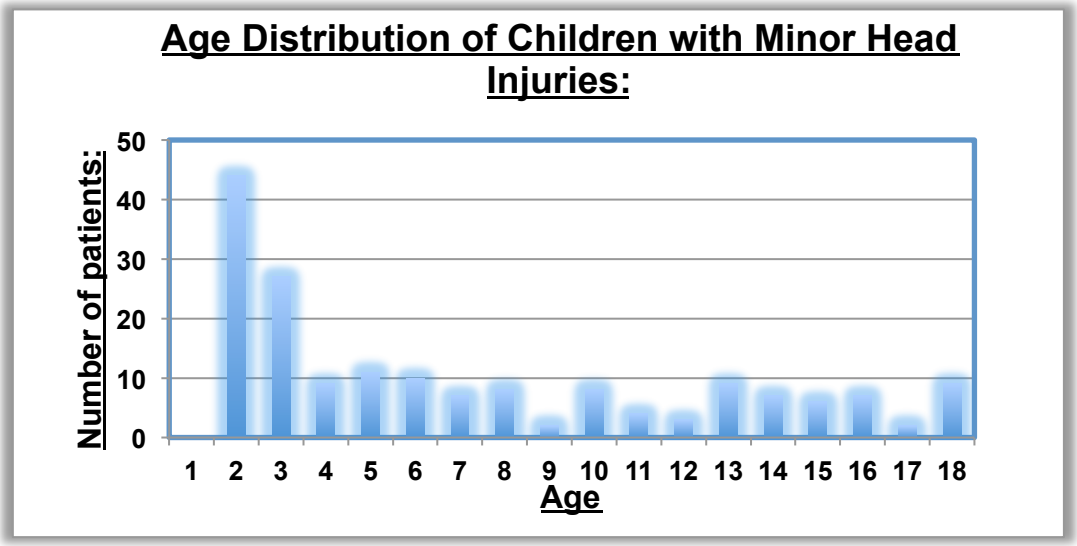
Chapter 3

Results:

3.1. Demographics:

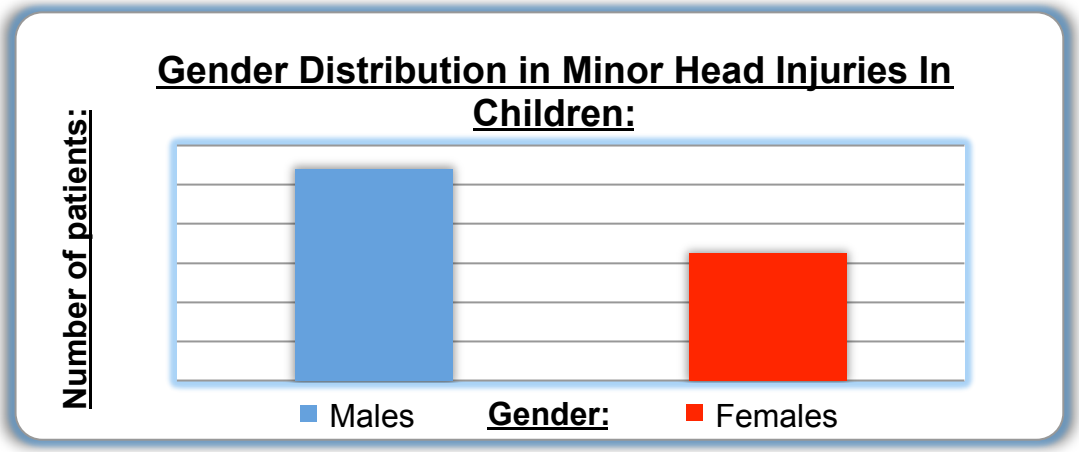
The average age of the children in the study was 6. Most of the injuries occurred in the 2 (25.4%) and 3 (15.6%) year age group. This represents 41% of the total population. The median age was 5 years.

Graph 1:



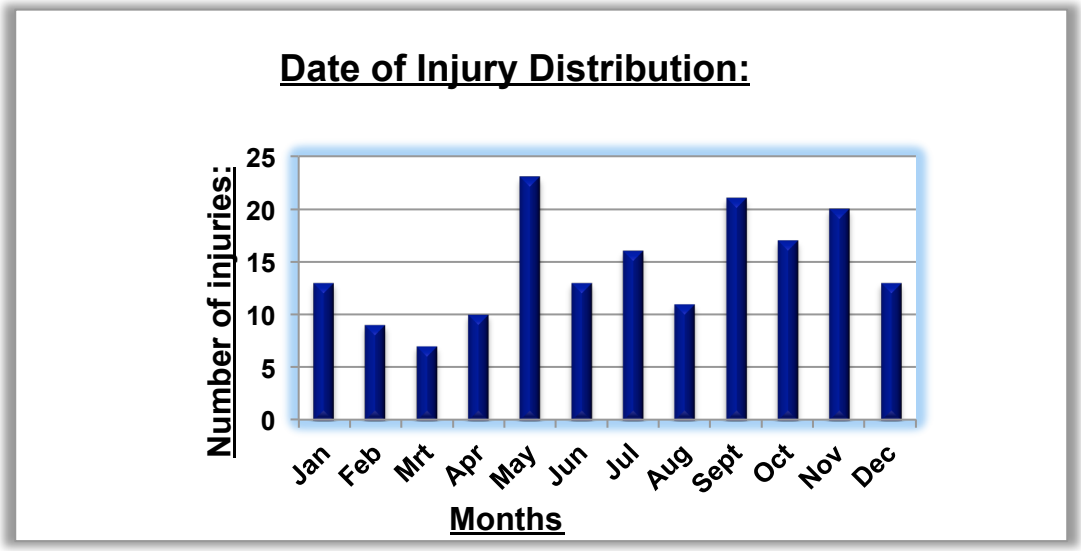
The gender distribution showed that boys (62.4%) were much more prone to injury than girls (37.6%).

Graph 2:



Most injuries occurred between September and December in the year studied (41%). There was a high incidence of injuries in May as well (13.3%).

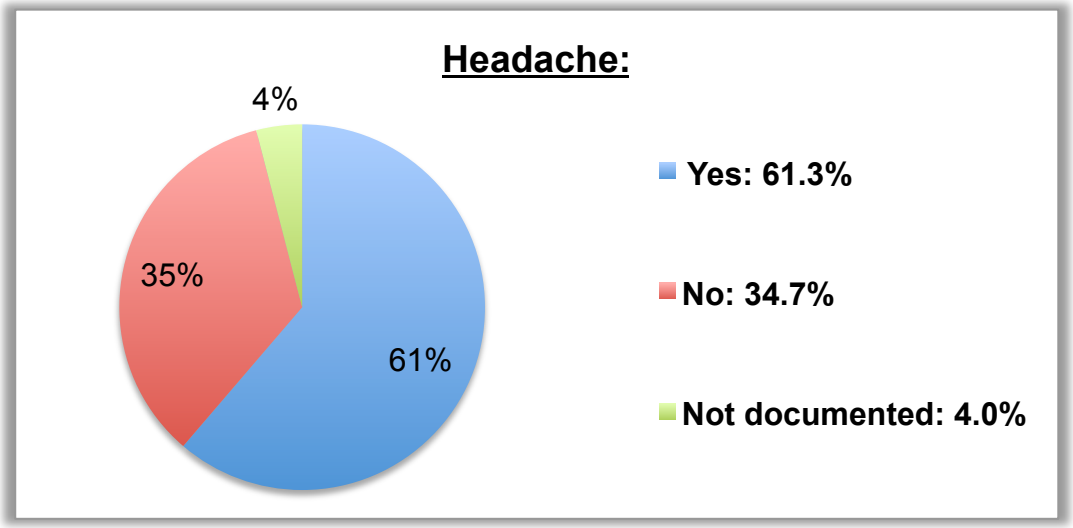
Graph 3:



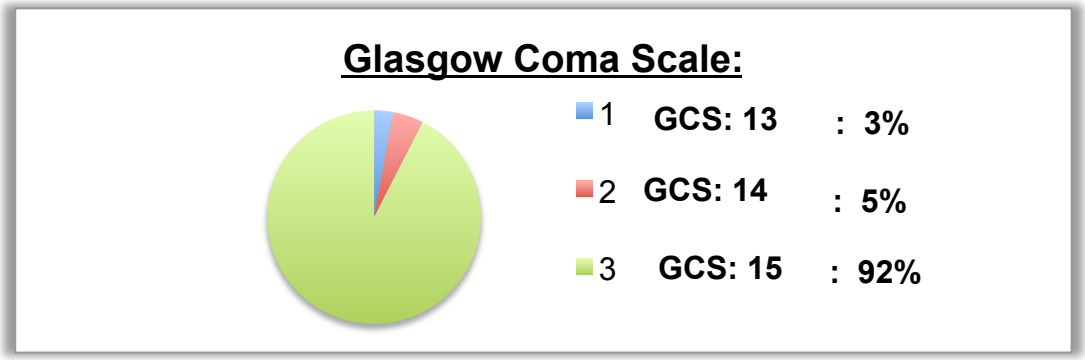
3.2. Clinical History And Examination Findings:

Graphs 4 to 17 illustrate the clinical history of injury, clinical symptoms and clinical signs of the patients who presented in the Emergency Department during the study.

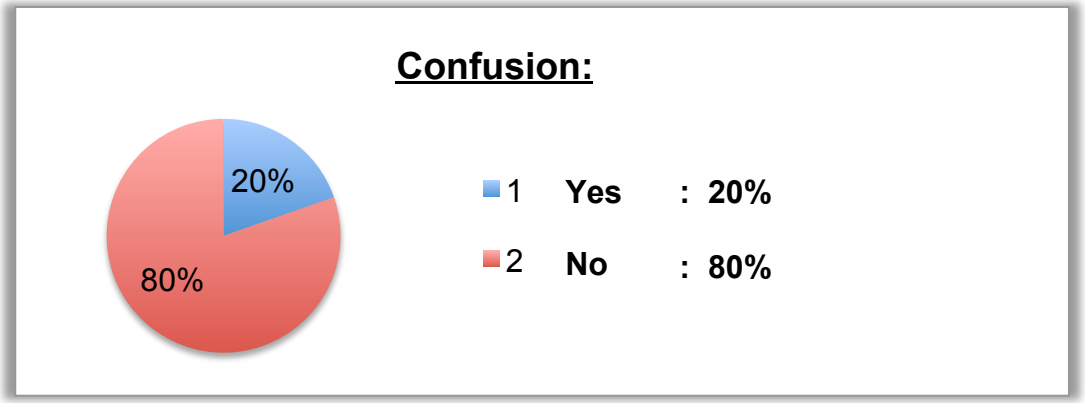
Graph 4:



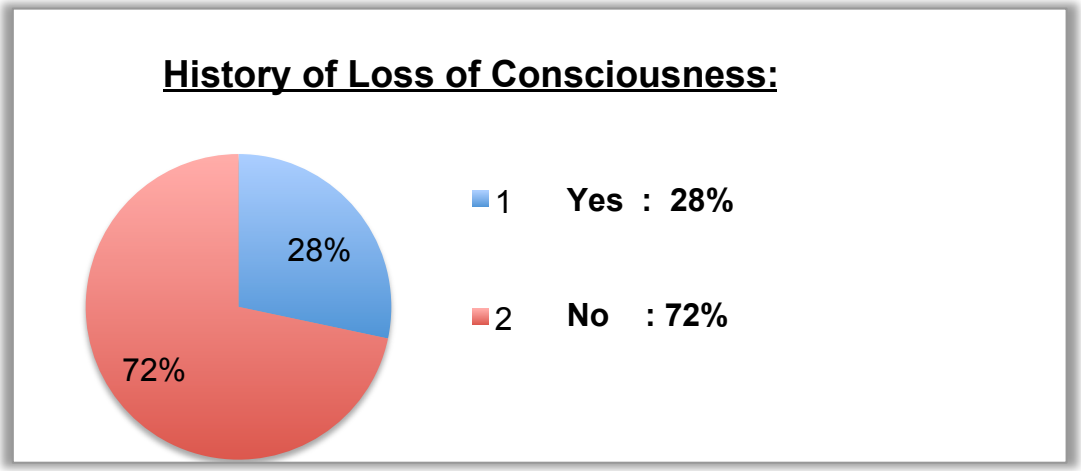
Graph 5:



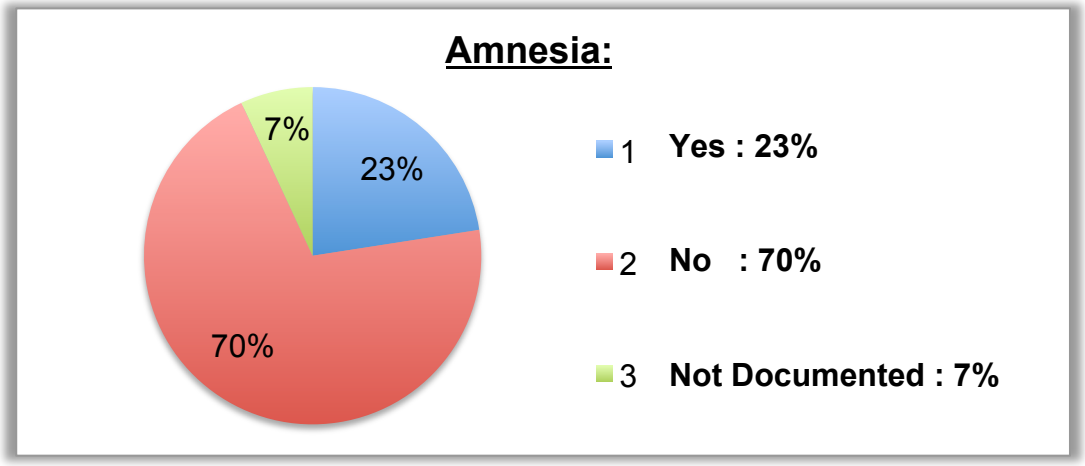
Graph 6:



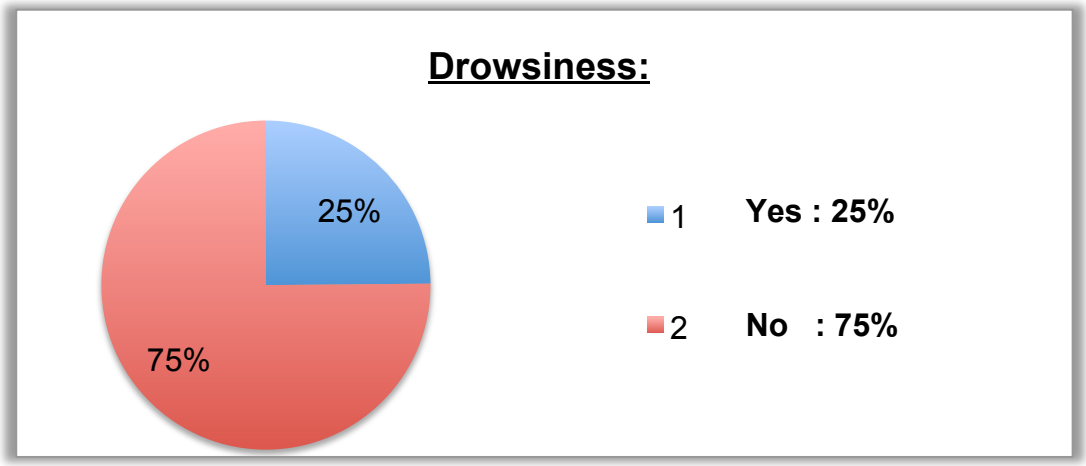
Graph 7:



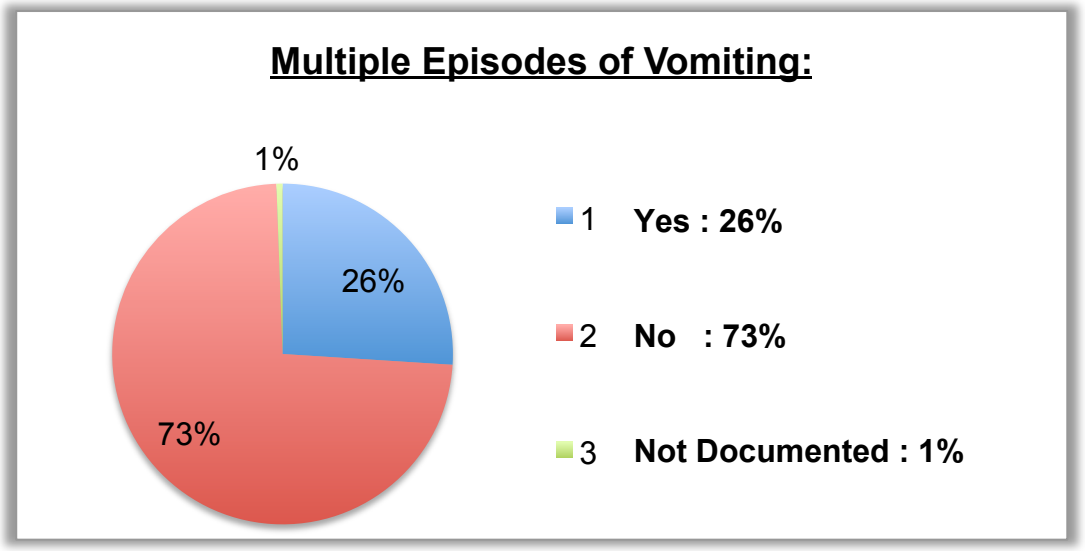
Graph 8:



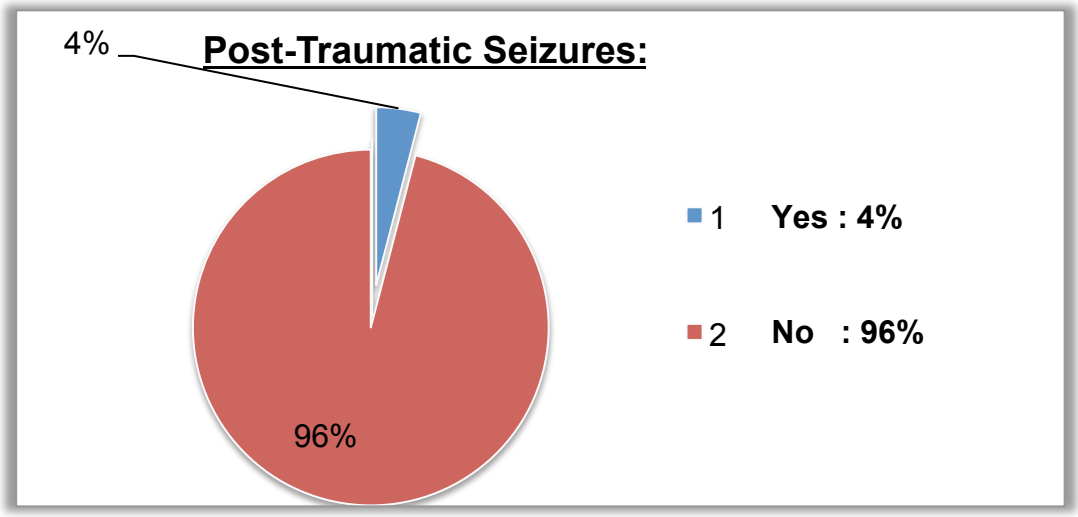
Graph 9:



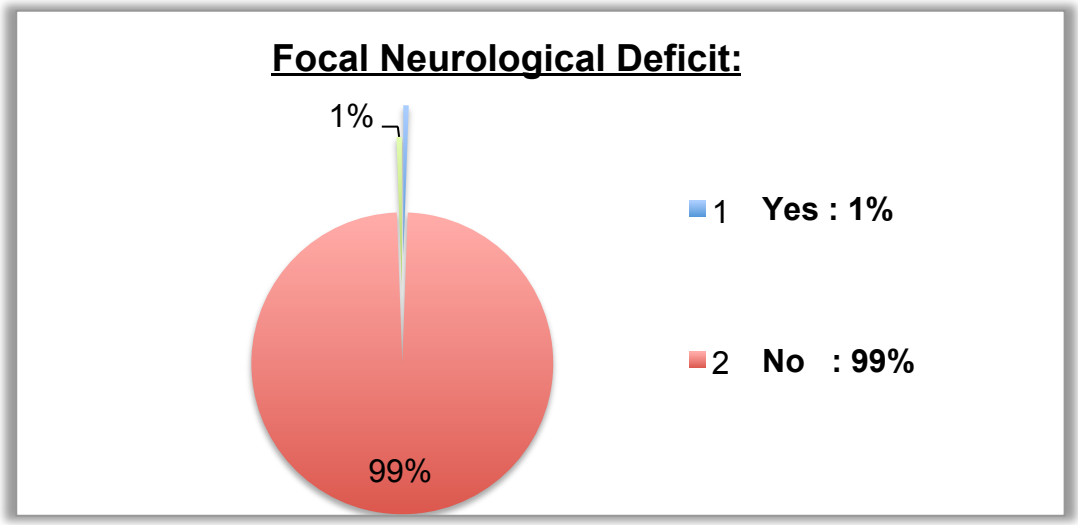
Graph 10:



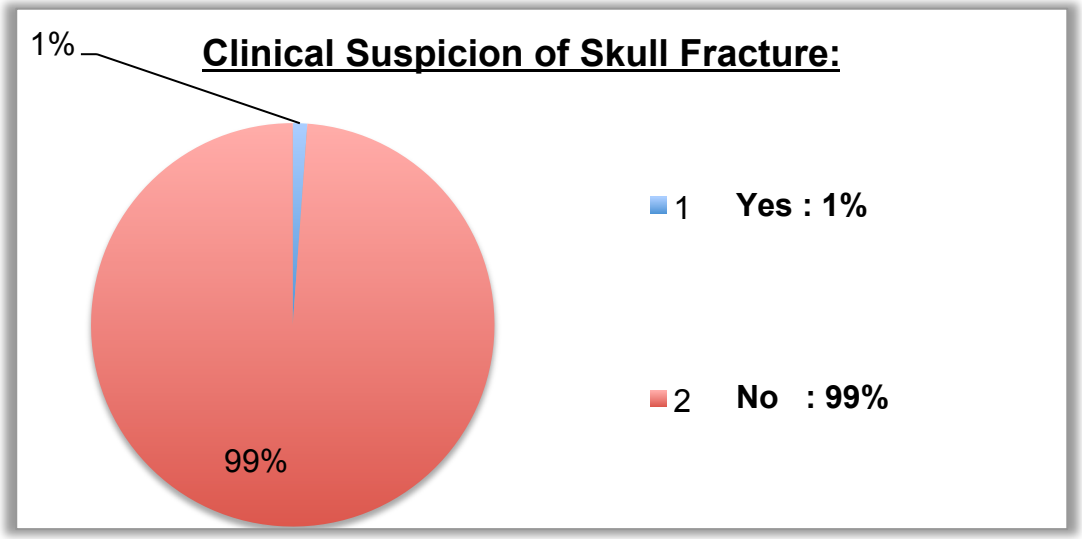
Graph 11:



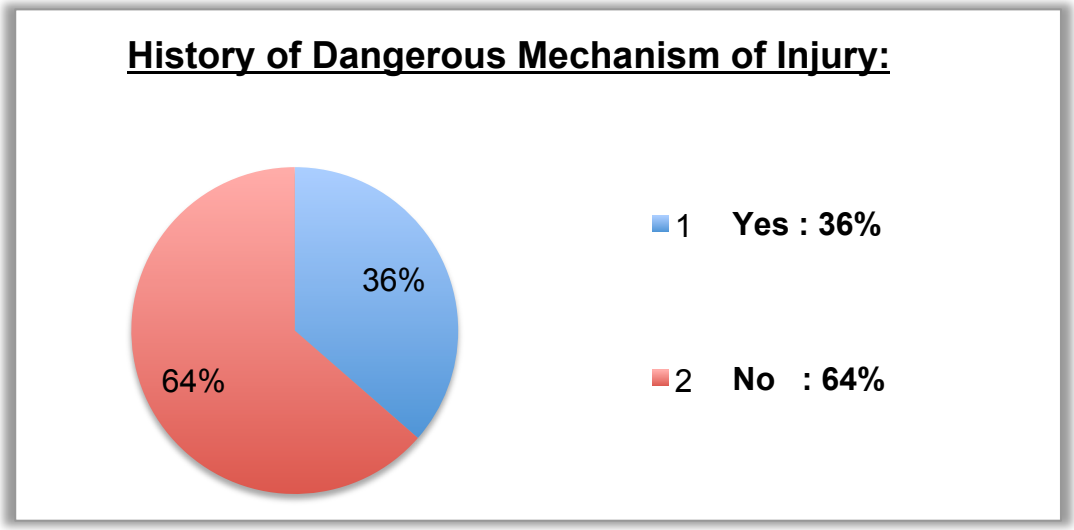
Graph 12:



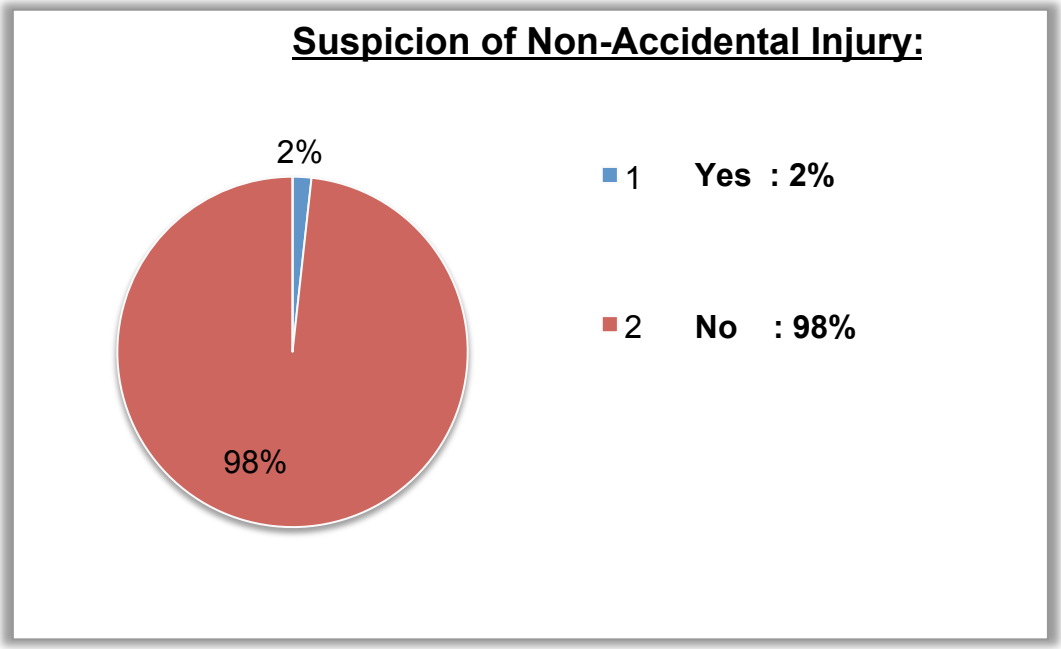
Graph 13:



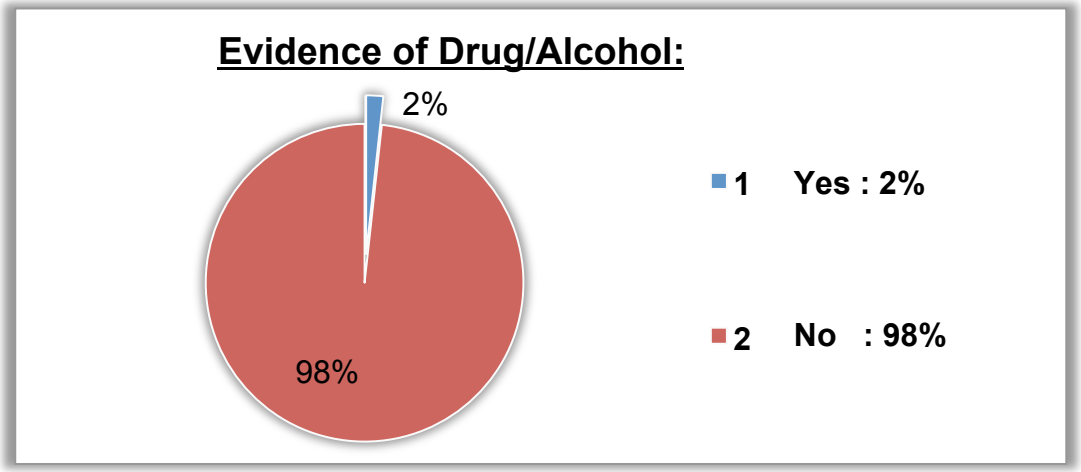
Graph 14:



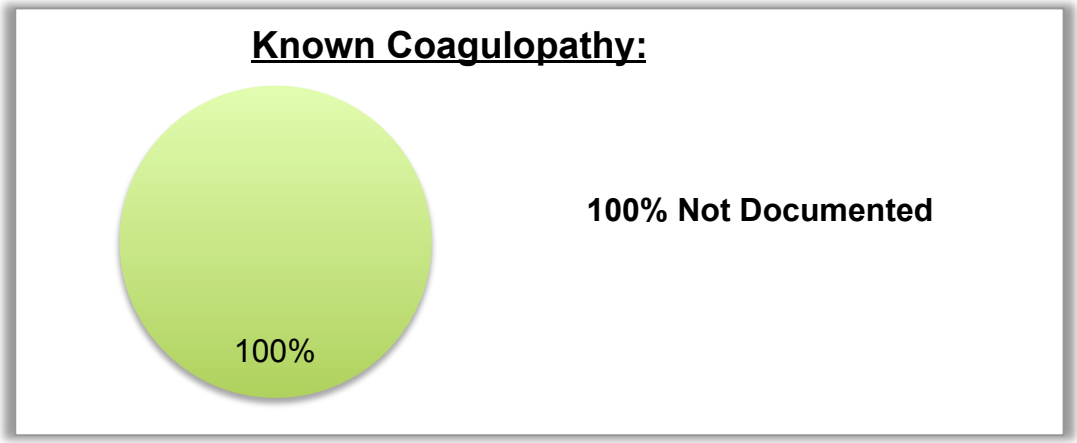
Graph 15:



Graph 16:



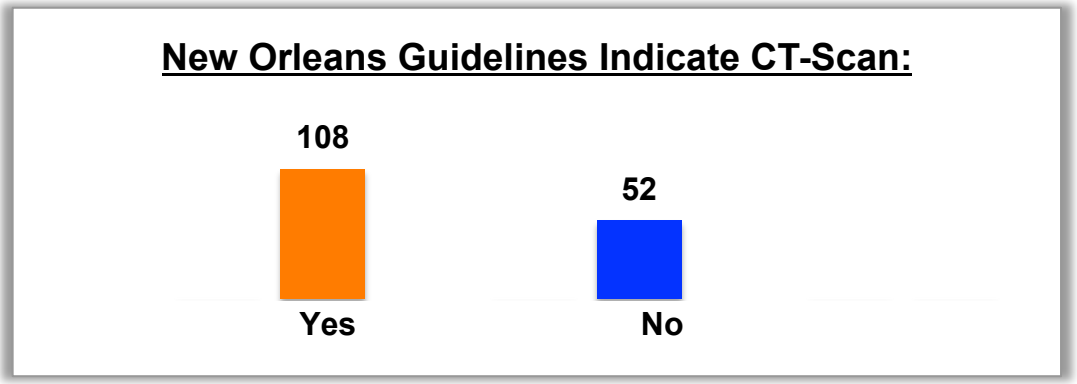
Graph 17:



3.3. CT - Guidelines:

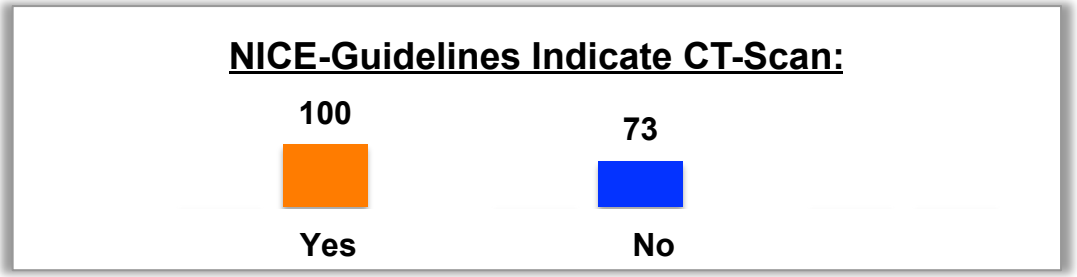
Graphs 18 to 24 illustrate the most well known internationally validated guidelines that were compared to the study population to establish which patients would require a CT scan according to the specific guidelines.

Graph 18:

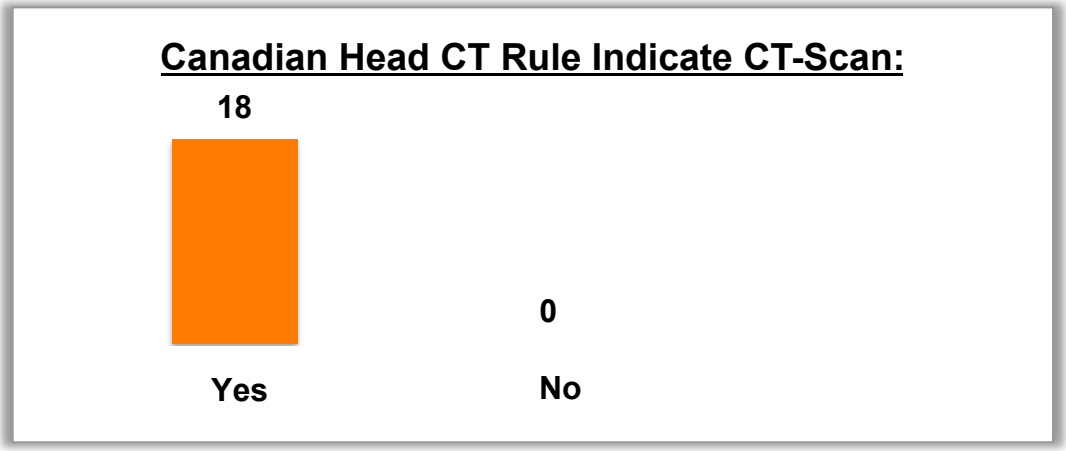


The study population here is only 160 patients, as the New Orleans Guidelines can only be applied to patients with a Glasgow Coma Scale of 15/15.

Graph 19:

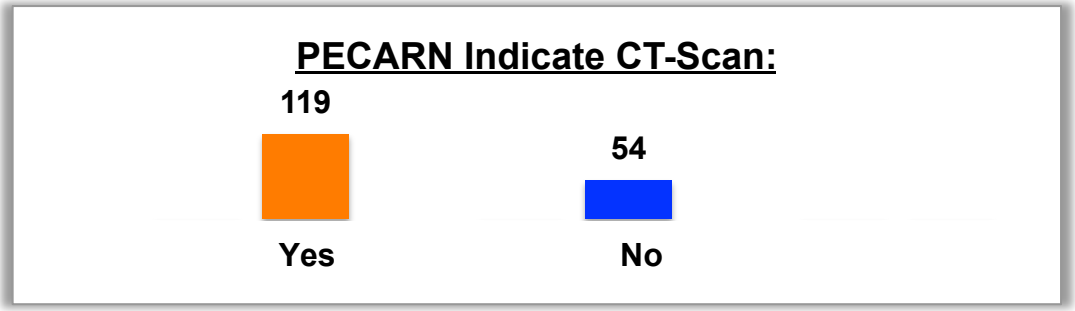


Graph 20:

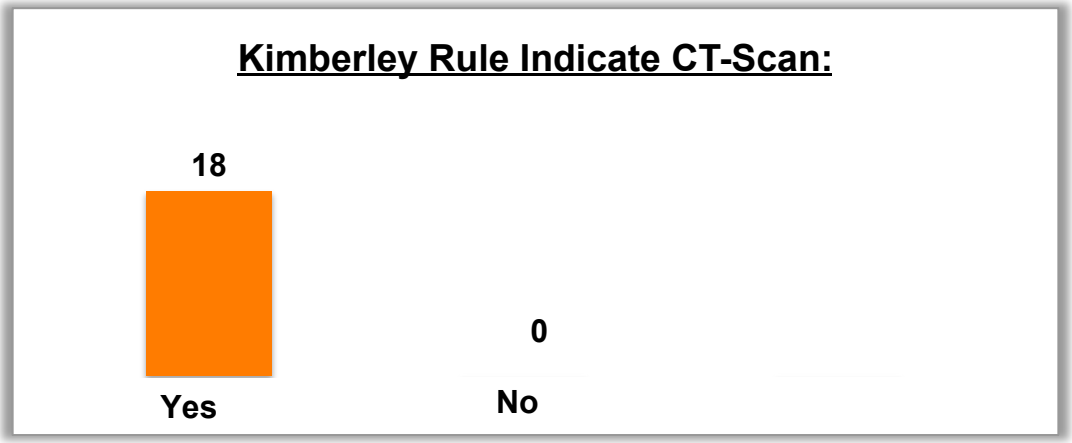


The study population here is only 18 because the Canadian Head CT-Rule can only be applied to patients from 16 years and onwards.

Graph 21:

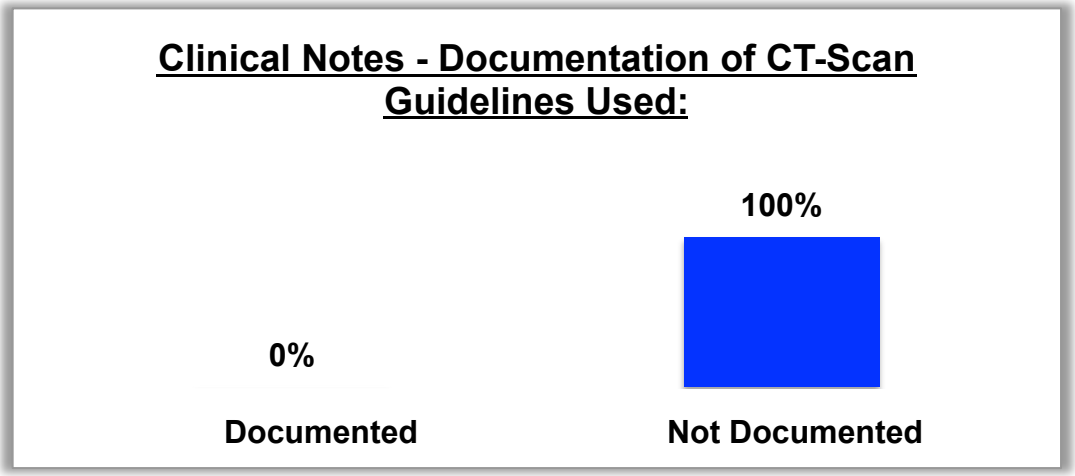


Graph 22:

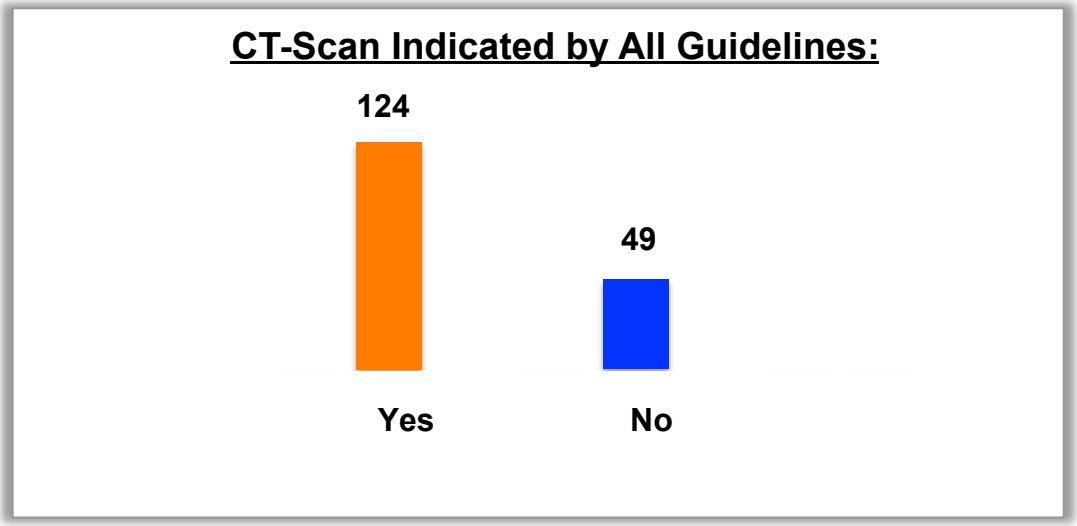


The study population here is only 18 because the Kimberley Rule can only be applied to patients from 16 years and onwards.

Graph 23:



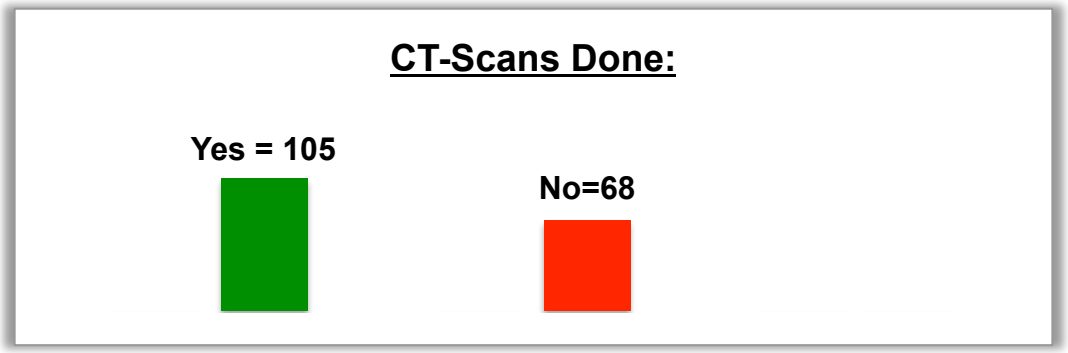
Graph 24:



3.4. CT - Scans:

CT scans were performed in 60,7%% of patients in the study population.

Graph 25:



Graph 26:

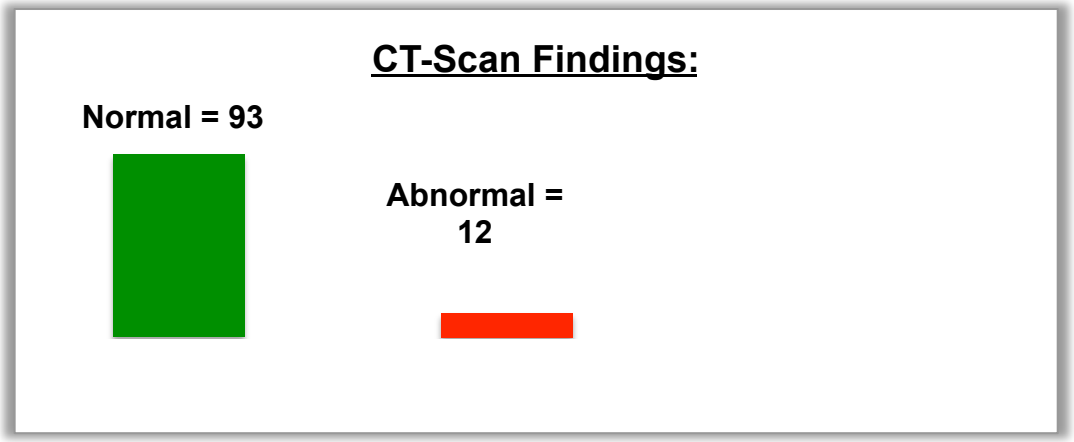


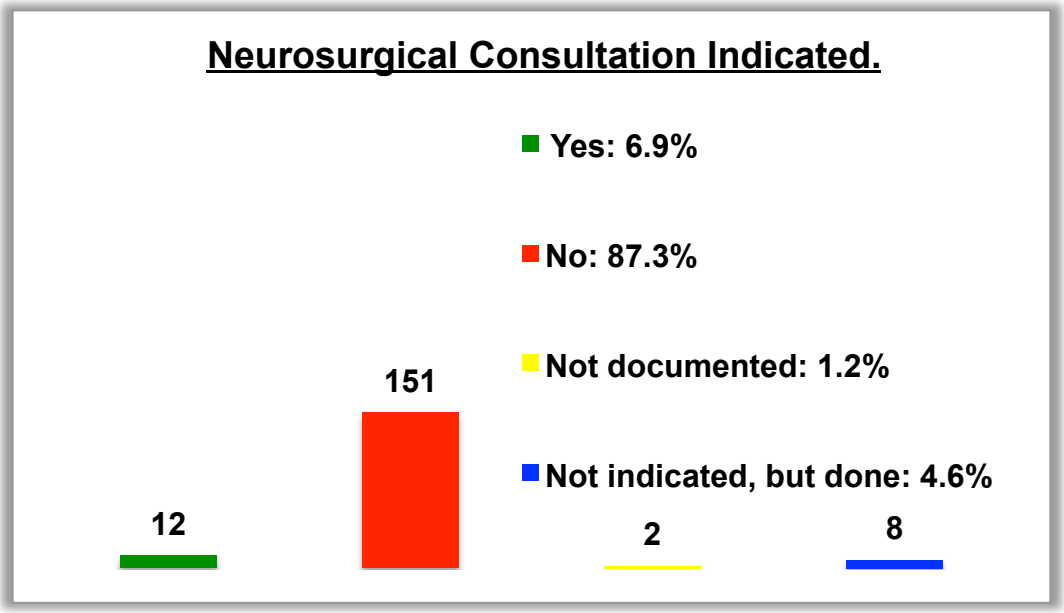
Table 1:
Specific abnormality:

Spesific abnormality:	*No:*
None:	93
Baseof skull fracture/Cerebral oedema:	1
Brain oedema:	1
Cerebral contusion:	1
Extradural bleed:	1
Intracranial bleed (Small pointbleed):	2
Linear skull fracture and subdural bleed:	1
Subdural bleed:	1
Skull fracture: Occipital.	1
Skull fracture with subarachnoid bleed:	1
Skull fracture with subdural bleed:	2

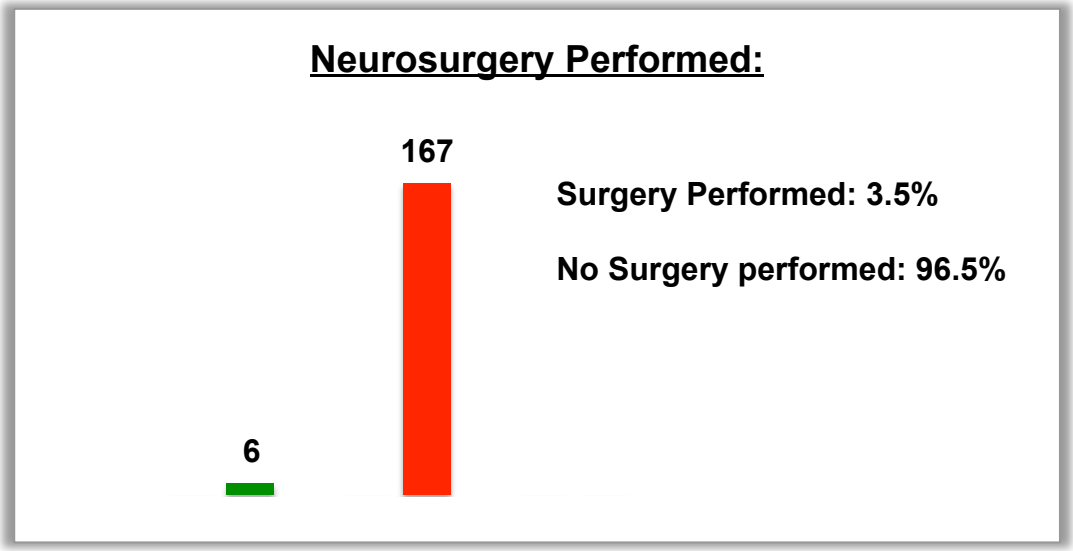
3.5. Neurosurgery:

There were 1,2% of patients in which neurosurgical consultation were possibly indicated, but these consultations were not documented by the attending Emergency Department doctor on duty.

Graph 27:



Graph 28:



3.6. General:

Table 2:
Mechanism of injury:

Mechanism:	*No:*
Alleged assault:	3
Ball against head:	2
Bump against basin:	1
Bump against friends head:	6
Bump against wall:	2
Fell at home:	43
Fell at Ice Rink:	5
Fell at School:	9
Fell from Chair:	8
Fell from Flight of Stairs:	3
Fell from height (<2m):	13
Fell from height (>2m):	5
Fell from moving trolley:	4
Fell in shop:	1
Fell off horse:	2
Fell off bed:	15
Fell off bicycle:	6
Fell off Jumping Castel:	2
Fell off Jungle Gym:	2
Fell off Moving vehicle:	3
Fell off Trampoline:	1
Karate Related:	1
Low Impact Motor vehicle accident:	1
Motor vehicle accident:	7
Motorbike accident:	2
Object fell on head:	5
Rugby:	20
Sport: (Hockey ball):	1
n = :	***173***

Graph 29:

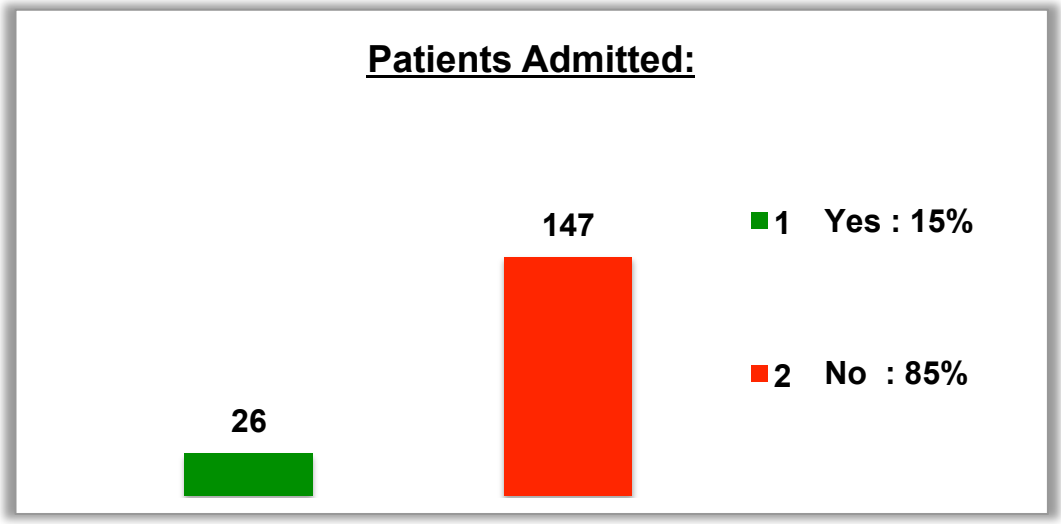


Table 3:
Attending Doctor's Final Diagnosis:

Diagnosis:	***Number:***
Soft Tissue Injury To The Face	4
Contusion Of The Scalp	18
Minor Head Injury	16
Concussion	123
Brain Oedema	1
Cerebral Contusion	1
Intracranial Bleed	2
Subdural Bleed	1
Extradural Bleed	1
Skull Fracture And Concussion	1
Base Of Skull Fracture /Cerebral Oedema	1
Skull Fracture And Subarachnoid Bleed	1
Skull Fracture And Subdural Bleed	3
Total:	***173***

Chapter 4

Discussion:

4.1. Demographics:

In the Emergency Department studied, 41% of the population of children presenting with minor head injuries were between 2 and 3 years of age.
The average age in the study was 6, with a standard deviation of 5 years as well as a mean of 5 years. This corresponds with the United States of America's figures. According to a research letter by Marin JR, et.al., published in The Journal of the American Medical Association, most patients seen in their study were also below the age of 3 (34).
The gender distribution in the Emergency department studied, showed that boys (62.4%) were much more prone to minor head injuries than girls (37.6%). When using a 95% confidence interval, and considering a p-value of <0,05 to be clinically significant, this gender distribution was comparable and noted in multiple studies in first world countries as well (35). There were no statistically significant difference between the Emergency Department studied and International trends.
When considering the monthly distribution of minor head injuries presenting in the Emergency Department studied, it was found that the highest incidence of injuries occurred during May and in the September to December timeframe. The increase in incidence during May might be due to winter sport activities like rugby and hockey that is associated with a higher incidence in sport related minor head injuries. The higher incidence during September to December might be due to spring and summer where outside temperatures are pleasant and children tend to spend more time engaging in outdoor activities.

4.2. Clinical History and Examination Findings:

The Glasgow Coma Scale was used to classify head injuries as minor, moderate or severe. By consensus a GCS of 13 to 15/15 were considered as minor head injuries. In the population studied, 92% of children evaluated had a GCS of 15/15. Important signs and symptoms were evaluated to aid in the decision process to do a CT scan or not. These signs and symptoms included headache, confusion, history of loss of consciousness, amnesia, drowsiness, multiple episodes of vomiting, post-traumatic seizures, focal neurological deficit, clinical suspicion of skull fracture, dangerous mechanism of injury, suspicion of non-accidental injury, evidence of drug/alcohol abuse and whether there is a known coagulopathy or not.

Signs and Symptoms.	Yes.	No.	Not Documented.
Headache.	61.3%	34.7%	4%
Confusion.	20%	80%	
History of Loss of Consciousness.	28%	72%	
Amnesia.	23%	70%	7%
Drowsiness.	25%	75%	
Multiple Episodes of Vomiting.	26%	73%	1%
Post-Traumatic Seizures.	4%	96%	
Focal Neurologcal Deficit.	1%	99%	
Clinical Suspicion of Skull Fracture.	1%	99%	
History of Dangerous Mechanism of Injury.	36%	64%	
Suspicion of Non-Accidental Injury.	2%	98%	
Evidence of Drugs/Alcohol.	2%	98%	
Known Coagulopathy.			100%

These figures correspond with most literature from first world countries as well. When using the Chi-square test, the p-value stayed below 0.05. These comparable results indicate that the incidence of important signs and symptoms are universal for minor head injuries worldwide.

4.3. CT-Guidelines:

Considering all the guidelines studied in this study, 71,7% of patients should have received a CT-scan. In the study, 60,7% of patients did actually receive a CT-scan. In South Africa, being a developing country, financial constraints, personal beliefs and opinions of parents as well as treating doctors might have influenced the difference in CT scan rate. Other reasons might include language difference, cultural differences and availability of facilities. The Canadian Head CT Rule could only be applied to patients of 16 years and above. This mean that only 18 patients could be evaluated using the Canadian Head CT Rule. Of these 18 patients, all 18 underwent a CT scan of the brain. Therefore 100% of patients in the population that could be evaluated by the Canadian Head CT Rule received a CT scan.

The other guidelines studied varied in indication rate and scan rate, ranging from 57,8% to 100%.

When evaluating the clinical notes of the attending Emergency Department doctor, there was no evidence of any guideline that were used in the decision process to decide on the indication for a CT-scan. The reasons for not documenting any specific guideline used might have been either the incomplete record keeping by the attending Emergency Department doctor, or that no specific guideline were used in the decision process. Incomplete record keeping will always stay a major problem in a busy emergency department like the emergency department studied. The attending emergency department doctor is under constant pressure to work faster than reasonably expected, as there is a high patient turnover. Emergency department doctors might also not be familiar with the newest guidelines available.

4.4. CT-Scans:

As mentioned, 60,7% of patients in the study population underwent a CT-scan. Of the 105 CT-scans done 88,6% were normal. Only 11,4% of the CT-scans was abnormal. Only 3,5% of patients in the total study population of 173 patients underwent neurosurgery. The literature in most international studies, done in first world countries suggest that about 90% of CT scans done on minor head injuries would be normal, with about 10% being abnormal. The data obtained in this audit correlates with international trends with no statistically significant difference (p-value <0,05). The incidence of neurosurgical intervention in this audit is much higher that mentioned in most studies. This might be due to the fact that there was a huge difference (11%) in the CT scan rate that were suggested by the majority of guidelines and the actual rate of CT scans done in the audit.

The specific abnormalities found on the abnormal scans were listed in Table 1.

4.5. Neurosurgery:

After evaluation of the data, it was found that neurosurgical consultation were indicated and done in 6.9% of the study population. In 1,2% there were no documentation of whether a neurosurgical consultation were done or not, although in these patients it might have been indicated. This number gives an indication of the incidence of incomplete clinical notes and record keeping by the Emergency Department doctor on duty. A possible reason for this might have been that in an extremely busy Emergency Department, the doctor on duty experienced severe pressure to finish notes quickly in order to get to the next patient. This is not only a local problem in the Emergency Department studied, but also a global problem in all busy Emergency Departments. In 87.3% of the study population no neurosurgical consultation were indicated. In 8 of the patients (4.6%), no neurosurgical consultation was indicated, but the

Emergency Doctor on duty consulted a neurosurgeon in any case. The reason for this might have been inexperience by the Emergency Doctor on duty, or fear of medico-legal action by the parents if clinical significant injury were missed.

4.6. General:

Multiple mechanisms of injury were observed through the study population. The specific mechanisms of injury were listed in Table 2.

The most significant mechanisms of injury were falls at home (25%) and secondly sport related injury. This observation is also in keeping with international trends observed in studies in first world countries. One notable difference is that most international studies also name motor vehicle accidents as one of the major reasons for minor head injury in children. In this study, it was noted that only 7.5% of the children in the study population, sustained a minor head injury because of a motor vehicle accident. This might be due to the fact that most studies naming motor vehicle accidents as a major cause were done in first world/developed countries. This study was done in a third world/developing country. The density of traffic as well as availability of motor vehicles in our country might be a cause for the low incidence noted in this study.

Only 26 (15%) of the study population were admitted. In 20 (11.5%) of the study population, the patients were only admitted for neurological observations. The patients admitted for neurological observations were all discharged after 24 hours of hospitalization with no complications or sequelae noted. All the patients that were admitted underwent a CT scan. Therefore, in this study, it was found that there is no reduction in the amount of CT scan requests when the attending Emergency Department doctor decided that a patient needs admission for neurological observations. This is in huge contrast

with a large study, done on 42 412 children in Boston, USA (19). In this study 14% of the children were only observed. Comparing the use of CT scans in the children observed versus the children that weren't observed, there was a drop of 3.9% in CT scan rate in the observed children. The reduction in CT scan use in this study was clinically and statistically significant (19). Proposed possible reasons for the apparent disconnect between the admission rate for neurological observations and the use of CT scans in this study might include the lack of the use of international validated decision guidelines. This fact in turn might influence the Emergency Department doctor on duty to overcompensate in the fear of missing a clinical significant head injury with associated medico-legal consequences. This is another excellent reason why international validated guidelines should be implemented in the Emergency Department studied.

When evaluating the attending Emergency Department doctor's final diagnosis, a variety of terms were used to describe blunt minor head injury. Concussion, mild head injury and contusion of the scalp were the most common descriptions. The interchangeable use of this terminology also supports the fact that a uniform definition of minor head injury is still lacking. A full list of final diagnosis was listed in Table 3.

Chapter 5

Limitations:

- The major limitation was that this study was done with retrospective data that was not validated. This fact however, does not invalidate the data that were used.

- Another limitation might have been the small study sample of only 173 patients. The small study sample was due to the fact that the study was done over only one year.

- The young child poses difficulty in proper neurological examination, especially if the attending Emergency Department doctor is not experienced in the examination of these patients. This might influence the opinion and decision of treatment protocol followed by the different Emergency Department doctors on duty at the time of presentation of the patient.

- Because of the multi-cultural society and 11 official languages, it is sometimes difficult to obtain a good history with regards to mechanism of injury and symptoms. This might have influenced the completeness of the clinical notes that were audited.

- Follow up of patients are not as well as it could have been because of geographical and socio-economic reasons. Some people give wrong or incomplete contact details at the time of presentation at the Emergency Department.

Chapter 6

Conclusion:

This retrospective study was done on paediatric patients who sustained minor head injuries within the 24 hours prior to presentation to the emergency department studied. The audit was done on 173 patient's clinical records that formed part of the study population. The age group ranged from 2 to 18 years. Concussion was the term most commonly used (71%) in the attending doctor's final diagnosis to describe the specific head injury. The 2-year and 3-year age group children were more prone to minor traumatic head injuries. This age group represented 41% of the total population. Boys (62.4%) were shown to be more prone to injury in comparison to girls (37.6%). Falling off heights at home were the most common mechanism of injury in the study population studied. Most of the injuries occurred in May, mainly because of winter sport activities like rugby. There was a peak in incidence of injuries in September and December due to the fact that it is summer and children tend to be more active, playing outside.

A total of 60,6% (n=173) of the patients received a CT scan. The majority (85%) of patients studied were not admitted. Only 3.5% (n=173) of the total study population underwent neurosurgical intervention.

Eighty-eight point six percent (n=105) of CT scans done were normal. Eleven point four percent (n=105) was abnormal. The incidence of positive CT scans was comparable to most articles that were studied. No evidence were found that suggest the use of any of the studied and well known international recognized validated guidelines in the decision making process to request a CT scan or not.

Considering all studied guidelines, 71.6% (n=173) of the patients qualified to receive a CT scan.

After evaluation of the PECARN Rule it was found that 68.7% of the study population met the criteria to receive a CT scan. This guideline is relatively easy to use and only differentiates between children below and children above two years of age. The PECARN Rule was studied extensively in the United States of America and proven to be very sensitive, safe and relatively cost effective when used in the emergency department.

To conclude, we as emergency department doctors in South Africa need a cost effective, safe and sensitive guideline that is easy to incorporate in a private emergency department setting. We have to consider over investigation with the associated radiation risks of doing CT scans. We should also prevent under investigation and missing clinically significant intracranial pathology in minor head injuries. South Africa is a developing country and therefore financial constraints are a major factor in decision process of the management of all patients, including children with minor head injuries. Incorporating all data obtained and audited, as well as the international validated guidelines studied, it seems that the PECARN Rule would best be incorporated in the emergency department studied.

Chapter 7

Bias:

1. Sample size was dependent on the Emergency Department doctor's personal opinion and clinical records of the doctor on duty.

2. No international validated guidelines were specifically noted or adhered to according to the clinical records of the Emergency Department.

3. The Emergency Department doctor on duty might have been influenced, by the parents/guardians of the patients, in the decision to do a CT scan or not.

4. Socio-economic status of the patient and their family might have influenced the decision to opt to observe the child rather than to do a CT scan.

5. The recording of clinical symptoms was not clear in some of the clinical records of the Emergency Department doctor on duty at the time of presentation of the patient.

6. The recording of clinical signs was not clear in some of the clinical records of the Emergency Department doctor on duty at the time of presentation of the patient.

Chapter 8

Recommendations:

Based on the design and results of this study, the following recommendations for further research are proposed:

- This study can be repeated with a larger study sample over a longer period of time. Follow-up and outcomes can also be included in this study.

- This study can be repeated comparing urban emergency departments to rural emergency departments. A study, comparing private sector emergency departments to state owned emergency departments could also be incorporated.

- Future studies to analyze and identify the barriers encountered in South Africa to adhere to international validated guidelines.

- More focused comparative studies can be done between the management of minor head injuries in South Africa as a developing country, compared to first world countries.

- Comparative studies to evaluate and compare the results of biochemical markers like S100B, CT-scan abnormalities found, the well known internationally validated guidelines and general outcome of patient care in a developing country like South Africa.

- To institute a head injury proforma for children, including the scoring system and tick-box symptom lists.

- Lastly, comparative studies on the cost-effectiveness of CT-scan of the brain versus hospital admission and observation for 24 hours for a population comparable to the population in this study, given the socio-economic constraints encountered in a developing country like South Africa.

Chapter 9

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* Although the title of the article was not properly translated, the full article is available in English.

Chapter 10

Appendix:

10.1. Ethics certificate:

R14/49 Dr Jacobus Petrus van Niekerk

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M140764

NAME: (Principal Investigator)	Dr Jacobus Petrus van Niekerk
DEPARTMENT:	Emergency Medicine Netcare Montana Hospital
PROJECT TITLE:	Comparison between Guidelines used to Evaluate Minor Blunt Head Injuries in Children
DATE CONSIDERED:	Adhoc
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Anita Groenewald

APPROVED BY: Professor P Cleaton-Jones, Chairperson, HREC (Medical)

DATE OF APPROVAL: 12/10/2015

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

10.2. Permission from Hospital:

Netcare Montana Hospital

Tel: +27 (0) 12 523 3000
Fax: +27 (0) 12 548 4646
Cnr Dr Swanepoel & Rooibos Streets, Montana Park, South Africa
PO Box 3115, Montana Park, 0159, South Africa
www.netcare.co.za

19 November 2013

LETTER OF PERMISSION TO CONDUCT RESEARCH IN A NETCARE FACILITY IN COMPUTED TOMOGRAPHY AND CLINICAL FINDINGS (COST IMPLICATIONS/RADIATION RISKS) IN CHILDREN WITH MINOR HEAD INJURIES IN A PRIVATE EMERGENCY DEPARTMENT,

To whom it may concern

Research undertaken by Dr JP van Niekerk in partial fulfilment of the Master in Science in Medicine in Emergency Medicine degree in Netcare Montana Hospital.

It is with pleasure that we inform you that your application to conduct research on Computed Tomography and Clinical Findings (Cost implications/Radiation risks) in Children with Minor Blunt Head Injuries in a Private Emergency Department, at Netcare Montana Hospital has been successful, subject to the following:

i) All information with regards to Netcare will be treated as confidential.

ii) Netcare's name will not be mentioned without written consent from the Academic Board of Netcare.

iii) Where Netcare's name is mentioned, the research will not be published without written consent from the Academic Board of Netcare.

iv) A copy of the research will be provided to Netcare once it is finally approved by the tertiary institution, or once complete.

v) All legal requirements with regards to patient rights and confidentiality will be complied with.

We wish you success in your research.

Yours faithfully

Daan Slabbert

Netcare Montana Hospital Manager

Netcare Hospitals (Pty) Ltd T/A Netcare Montana Hospital
Directors:
J Du Plessis, R H Friedland, K N Gibson
Company Secretary: L Bagwandeen **Reg. No.** 1996/006591/07

10.3.Permission from Emergency Department:

Med 24 MONTANA

Pr. No. 1529986
Reg. No.: 1994/004392/21

Montana Private Hospital
Cnr Rooibos Street and
Dr Swanepoel Street
Montana
PO Box 14813
Sinoville, 0129
Tel: 012 548 5025/26/33
Fax: 012 548 5025

Dr AF Coertze & Partners Incorporated

16 January 2014

To whom it may concern

LETTER OF PERMISSION TO CONDUCT RESEARCH IN COMPUTED TOMOGRAPHY AND CLINICAL FINDINGS (COST IMPLICATIONS / RADIATION RISKS) IN CHILDREN WITH MINOR HEAD INJURIES IN A PRIVATE EMERGENCY DEPARTMENT, INCORPORATING THE PRIVATE PRACTICE OF DR AF COERTZE AND ACCOCIATES.

Research undertaken by Dr JP van Niekerk in partial fulfilment of the Master in Science in Medicine in Emergency Medicine degree.

It is with pleasure that we inform you that your request to conduct research on ***Computed Tomography and Clinical Findings (Cost implications / Radiation risks) in Children with Minor Blunt Head Injuries in a Private Emergency Department*** has been successful, subject to the following:

1. All information with regards to the practice of Dr AF Coertze and Associates will be treated as confidential.
2. Dr AF Coertze and Associates' name will not be mentioned without the written consent of the directors of the company.
3. A copy of the research will be provided to Dr AF Coertze and Associates once it is finally approved by the tertiary institution, or once completed.
4. All legal requirements with regards to patient rights and confidentiality will be complied with.

We wish you success in your research.

Yours faithfully

Dr S.C. Rademeyer
Manager

2010

Dr. AF Coertze, ~~Dr. LM Gouws~~, Dr. SC Rademeyer, ~~Dr. JC van Zyl, Dr. C Steyn Kruger, Dr. T du Plooy~~, Dr. JP van Niekerk

10.4.Empty copy of datasheet:

Data Collection Sheet:

Patient number: _____.

Age: _____.

Gender: Male / Female.

Date of examination: _____.

Time of examination: _____.

Clinical examination findings:

Headache:	Yes / No / Not documented.
Glasgow Coma Scale less than 14:	Yes / No / Not documented.
Confusion:	Yes / No / Not documented.
History of loss of consciousness:	Yes / No / Not documented.
Amnesia:	Yes / No / Not documented.
Abnormal drowsiness:	Yes / No / Not documented.
Multiple episodes of vomiting:	Yes / No / Not documented.
Post- traumatic seizure:	Yes / No / Not documented.
Focal neurological deficit:	Yes / No / Not documented.
Clinically suspected skull fractures:	Yes / No / Not documented.
History of dangerous mechanism of injury:	Yes / No / Not documented.
Clinical suspicion of non-accidental injury:	Yes / No / Not documented.
Drug/Alcohol intoxication:	Yes / No / Not documented.
Known coagulopathy:	Yes / No / Not documented.

ED Doctor – Clinical examination findings:

_____

_____

_____

_____

_____

CT scan indicated according to any guidelines: Yes / No / Not documented.

What guidelines were used/if any:

_____

_____

_____

Was CT scan done: Yes / No / Not documented.

CT scan findings: Positive (Abnormal) / Negative (Normal).

Specific CT-scan abnormality:

_____

_____

Neurosurgery consultation indicated: Yes / No / Not documented.

Neurosurgery performed: Yes / No / Not documented.