# What is the association between the Glasgow Coma Scale score, mechanism of injury and computed tomography findings in neurosurgically relevant head injury patients.

Dr Kavishka Sewnarain

Student number : 204500855

Submitted in partial fulfilment of the requirements for the degree of Master of Medicine (Radiology) in the School of Clinical Medicine, University of KwaZulu-Natal.

Supervisor : Dr J Maharajh

March 2017

# DECLARATION

I, Dr Kavishka Sewnarain , declare as follows:

1. That the work described in this dissertation has not been submitted to UKZN or any other institution for the purposes of any academic qualification, whether by myself or any other party.

2. That my contribution to the project is as follows:  Researching, formulating and writing up the protocol, collecting data, downloading images, analysing data and writing up the findings and conclusion. Dr Z. Ally and Dr P Parag have assisted in research and data collection

3. This dissertation does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.

4. This dissertation does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:

a) Their words have been re-written but the general information attributed to them has been referenced;

b) Where their exact words have been used, their writing has been placed inside quotation marks and referenced.

5. This dissertation does not contain text, graphics or tables copied and pasted from the internet, unless specifically acknowledged, and the source being detailed in the dissertation and in the references section.

## ACKNOWLEDGEMENTS

The author would like to thank the following individuals for their assistance:

| Name | Department | Contribution |
|---|---|---|
| Dr J. Maharajh (Senior specialist) | Radiology – King Edward Hospital Durban | Supervisor |
| Dr A Sewnarain | Medical officer | Assisted with logistics |
| Dr Wonga Nombula | Radiology- RK Khan hospital Durban | Assisted with logistics |
| Ms Fikile Nkwanyana (Statistician) | UKZN | Assisted with statistics |
| Mr Boikhutso Tlou (Statistician) | UKZN | Assisted with statistics |
| My lovely parents Radhika and Preethlall Sewnarain | | Psychosocial support |

# TABLE OF CONTENTS

# CHAPTER 1

## Introduction

***Background:*** Head injury occurs very commonly in a developing country like South Africa. The first assessment often made during the examination of such a patient is the Glasgow Coma Scale (GCS). Very often patients present to clinics and institutions without radiological facilities and the GCS is the basis on which patients are transferred to centres with computed tomography (CT) scan facilities.

There have been cases of patients with a GCS of 15 having significant CT findings and needing neurosurgical procedures. Certain parameters such as older age, male gender, and fall as a mechanism of injury have been thought to be potential predictors of positive CT findings.

There are however no studies that provide patterns of CT findings at the various GCS levels, and the association between mechanism of trauma and CT findings. Most studies done are on patients with GCS of 13, 14, and 15. In addition there are no South African studies on GCS and mechanism of injury as a predictor of CT findings in head injury patients.

***Objectives:*** The objective of this study is to compare patients GCS at presentation, mechanism of injury and CT findings in neurosurgically relevant head injury patients. This will assist clinicians on initial contact to determine the severity of head injury. This is especially important in rural areas to determine the severity and urgency for which patients should be transferred to regional and tertiary hospitals. If it is found that CT findings and neurosurgical intervention is more prevalent in certain GCS groups or certain mechanisms of injury then there should be a high index of suspicion in these groups. This will assist in transferring patients to relevant centres and using adequate imaging modalities based on GCS and mechanism of injury.
Further objectives include to determine the patterns of CT findings at various GCS ranges, i.e.: GCS of 3-6; 6-9; 9-12; 12-15 and to determine the patterns of CT findings in patients with various mechanisms of injuries and compare this to the relevant

literature. The study should determine the likelihood of various types of CT findings with the GCS and mechanism of injury

***Problem statement and literature review:*** The leading cause of death among those aged between 1-24 years is related to trauma [1] Head injury caused by trauma is a leading cause of disability in the world. The incidence of traumatic brain injury (TBI) in South Africa is estimated to be 1.5 to 3.5 times that of the estimated global rate. In South Africa about 89 000 new traumatic brain injuries are reported annually [3]. TBI is more common in males than females [2]

The commonest cause of head injury is motor vehicle accident (MVA) [1-3], followed by bicycle or pedestrian vehicle accident (PVA), falls and violence [2, 3].

CT scans are utilized in the evaluation of intracranial structures non-invasively and is the imaging of choice for diagnosis, evaluation and determination of prognosis in patients with acute head trauma [1]. Many hospitals and clinics where patients present do not have CT scanners available and medical staff assess patients clinically and based on this assessment patients are either sent to centres that have CT facilities or are managed conservatively.

The GCS is currently the most widely used method for assessing consciousness and is used to classify TBI into mild, moderate and severe [4]. GCS scores ranging from 13-15 are regarded as mild, 9-12 moderate and 3-8 severe [3] By determining the patients level of consciousness on arrival and CT findings, the patients current condition can be evaluated, appropriate intervention planned and prognostic outcome predicted[1].

Most patients presenting to hospitals have minor head injury [2, 4]. In the United States approximately 80% of patients with head trauma have minor head injury [5]. Patients with a GCS of 15 are said to have minor head injury and those with a GCS of 13 and 14 are said to have mild head injury [2].

There is much controversy regarding whether patients with GCS 15 and minor head injury require CT imaging [5]. Less than 10% of patients with minor head injury have positive CT findings and less than 1% require neurosurgical intervention [2, 5, 6].

Some authors debate the financial cost of doing CT imaging in these patients. However the cost of a CT scan is less than the cost of admission for neurological observation in these patients [6]. In a study done by M Saboori et al, 93.2% of patients with a GCS of 15 had normal CT scans. From the 6.8% (46 patients) of patients with abnormal results, 4 of the 46 patients needed surgical intervention, the non-surgical injuries included localised subarachnoid haemorrhage (SAH) of 2mm, small contusion of 5mm, subdural haematoma of 3mm and isolated pneumocephalus [2].

In patients with a GCS of 15, another study by Kisat et al, 29.2% of patients had positive CT findings and 4.2% underwent a neurosurgical procedure. Of these 2.5% had a therapeutic procedure whilst 1.7% had a diagnostic procedure [5].

Despite the positive findings in patient with GCS of 15 being relatively low, the presence of positive findings and need for neurosurgical intervention remains an area of concern. Significant brain injury and need for a CT scan cannot be excluded in patients with minor head injury despite GCS 15 and normal complete neurological examination at presentation[7].

Older age male patients with a history of fall are considered risk factors for positive CT findings in patients with GCS 15 [5]. Those with history of fall had a higher likelihood of positive CT findings than those with history of MVA in patients with a GCS of 15. [5]

It was noted that the presence of skull fractures or intracranial haemorrhage was accompanied with lower GCS in patients [8]. The presence of skull fractures regardless of GCS will place patients into high risk groups [9]. However, patients with GCS of 13-14 are recommended to have CT done even without evidence of skull fracture if there are abnormal central nervous system (CNS) examination and presence of cranio facial injuries[9].

In minor head injury patients, non MVA including pedestrian injury, fall from height, falling object and assault are significantly associated with the need for neurosurgical intervention and should be categorised as high risk minor trauma and therefore require urgent CT when stable[9].

The finding of midline shift on CT scan, regardless of the underlying lesions and the presence of mixed lesions are accompanied with lower GCS scores[1]. The idea behind patients with mixed lesions and midline shift regardless of the background lesion having a lower GCS is that, it may be due to major energy transmission, diffuse brain damage and compression of brainstem structures[1].

The presence of intraventricular haemorrhage in patients was associated with the finding of lower levels of consciousness being obtained with an average GCS of 10.33 noted in these patients[1].

According to a study done by Morgado FL et al, the incidence of mild TBI was 82.4%, moderate TBI was 2.0% and severe TBI being 15.6%. In patients with mild TBI, subgaleal hematomas were seen in 66.6% of cases and cranio facial fractures in 28.5%. In moderate TBI the most common finding was of subgaleal haematoma (100%). Bone fracture, subarachnoid haemorrhage, area of cerebral contusion with haemorrhagic suffusion and diffuse cerebral oedema were seen in approximately 50% of cases. In severe TBI he noted an increase in all of the CT findings, with a 100% rate of abnormalities, the most common being subarachnoid haemorrhage (SAH) in 62.5%, craniofacial fractures in 62.5%, basilar fractures in 37.5%. An association of 3 or more findings were seen in 68.7% of patients. Fifty percent of the patients with diffuse cerebral oedema had severe TBI[4].

Patients with TBI and low GCS scores have more severe CNS injuries with more devastating effects and present with a tendency for haemodynamic instability[4]. A need for intubation was noted in all patients with severe TBI.

In another study by Siasios J et al, all patients with GCS < 13-14 required neurosurgical intervention [6].

Patients with subdural haemorrhage (SDH) or SAH or midline shift and an abnormal third ventricle had significantly lower GCS and were more severely injured [10]. Extradural haemorrhage (EDH) presence was not associated with the GCS total or severity of injury on admission. The most common localisation of intracerebral haemorrhage (ICH) and contusions, EDH and SDH were in the frontal, temporal and parietal parts respectively[1].

Subdural haematomas are associated with a worse GCS score and prognosis. Intracranial hematomas have been associated more frequently than diffuse brain injury with neurological deterioration. The lesion size is very important and increasing lesion size may compress and distort vital structures in the diencephalon and upper brainstem[11].

A lower GCS and certain CT findings including SAH, midline shift > 3mm and mass lesions are poor prognostic factors after closed head injury[1].

The presence of CT scanners in every major hospital and neurosurgical units is very important. It was noted that in some parts of Europe up to 33% of severe traumatic brain injured patients do not reach a hospital with a neurosurgical unit and there is therefore a 26% increase in mortality.

South Africa has a high incidence of trauma and the mechanism of injury here is often different than that seen in first world countries. There is not much research regarding the various mechanisms of injury in South Africa and the associated CT findings. A study which combines GCS and the mechanism of injury in patients and attempts to correlate this with CT findings will benefit in categorising TBI patients into high and low risk.

This study will be of value to the clinicians who use patients GCS at presentation and mechanism of injury on initial contact to determine the severity of head injury. This is especially relevant in rural areas to determine the severity and urgency for which patients should be transferred to regional and tertiary hospitals.

Ethical approval for this study was obtained from the Biomedical Research Ethics Committee (BREC), University of KwaZulu-Natal. A retrospective chart review at Inkosi Albert Luthuli Central Hospital (IALCH), Durban, South Africa was performed after permission was obtained from the KwaZulu-Natal department of health and the Inkosi Albert Luthuli Central Hospital allowing access to patient records. As discussed with the statistician, a randomised review of 100 charts of the patients from January

2011 until December 2011 was done. The randomised chart review was done on 100 patients between the ages of 18 to 65 years who had CT scans for closed head injury.

There is extremely limited literature that provides patterns of CT findings at the various GCS levels and finding the association between mechanism of trauma and CT findings. Most studies done are on patients with GCS of 13, 14, and 15. In addition there are no South African studies on GCS and mechanism of injury as a predictor of CT findings in head injury patients. This study aims to correlate the GCS at presentation and mechanism of injury in neurosurgically relevant patients with CT findings. This will assist to determine the severity and urgency for which patients should be transferred to regional and tertiary hospitals with imaging and neurosurgical facilities.

## REFERENCES


1. M. Naseri MD ATM, A.R. Moghaddas MD. Correlation of CT scan findings with the level of consciousness in acute head trauma. Iranian Journal of Radiology. 2005 June 2005(125-129);2:5.

2. Saboori M, Ahmadi J, Farajzadegan Z. Indications for brain CT scan in patients with minor head injury. Clinical neurology and neurosurgery. 2007 Jun;109(5):399-405. PubMed PMID: 17350162.

3. World Head Injury Awareness Day : 20 March 2010 20 March 2010. Available from: http://www.kznhealth.gov.za/headinjury.htm.

4. Rossi FlMlA. Correlation between the Glasgow Coma Scale and computed Tomography imaging findings in patients with traumatic brain injury. Radiologia Brasileira. 2011;44:7.(35-41)

5. Kisat M, Zafar SN, Latif A, Villegas CV, Efron DT, Stevens KA, et al. Predictors of positive head CT scan and neurosurgical procedures after minor head trauma. The Journal of surgical research. 2012 Mar;173(1):31-7. PubMed PMID: 21872271.

6. Siasios J, Foutzitzi S, Deftereos S, Karanikas M, Birbilis T. The traumatic brain injury: diagnosis and management at emergency department by general surgeon. A retrospective critical analysis on the use of the CT head scan. Turkish neurosurgery. 2011;21(4):613-7. PubMed PMID: 22194124.

7. Vilke GM, Chan TC, Guss DA. Use of a complete neurological examination to screen for significant intracranial abnormalities in minor head injury. The American journal of emergency medicine. 2000 Mar;18(2):159-63. PubMed PMID: 10750921.

8. Kung WM, Tsai SH, Chiu WT, Hung KS, Wang SP, Lin JW, et al. Correlation between Glasgow coma score components and survival in patients with traumatic brain injury. Injury. 2011 Sep;42(9):940-4. PubMed PMID: 21067749.

9. Abdul Latip LS, Ahmad Alias NA, Ariff AR, Shuaib IL, Abdullah J, Naing NN. CT scan in minor head injury: a guide for rural doctors. Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia. 2004 Nov;11(8):835-9. PubMed PMID: 15519858.

10. Wardlaw JM, Easton VJ, Statham P. Which CT features help predict outcome after head injury? Journal of neurology, neurosurgery, and psychiatry. 2002 Feb;72(2):188-92; discussion 51. PubMed PMID: 11796768. Pubmed Central PMCID: 1737755.

11. Kido DK, Cox C, Hamill RW, Rothenberg BM, Woolf PD. Traumatic brain injuries: predictive usefulness of CT. Radiology. 1992 Mar;182(3):777-81. PubMed PMID: 1535893.

# CHAPTER 2

## What is the association between the Glasgow Coma Scale score, mechanism of injury and computed tomography findings in neurosurgically relevant head injury patients.

Prepared according to the Instructions for Authors of South African Journal of Radiology (SAJR)

***Significance of work:*** There is extremely limited literature that provides patterns of CT findings at the various GCS levels and determining the association between mechanism of trauma and CT findings. Most studies done are on patients with GCS of 13, 14, and 15. In addition there are no South African studies on GCS and mechanism of injury as a predictor of CT findings in head injury patients. This study aims to correlate the GCS at presentation and mechanism of injury in neurosurgically relevant patients with CT findings. This study will assist to determine the severity and urgency for which patients should be transferred to regional and tertiary hospitals with imaging and neurosurgical facilities.

***Author's details :*** Dr Kavishka Sewnarain, Department of Radiology, University of KwaZulu-Natal, South Africa. E-mail- kav.trinity@gmail.com. Tel. no. +2761 467 3635/ 0399760183 Address: 12 Rahle Road Scottburgh South 4180.

***Corresponding Authors :*** Dr Zain Ally, Radiologist, Lake Smit and Partners Durban. South Africa. E-mail-allyzain@gmail.com. Tel.no. 0833249324, Address 19 Silverton Musgrave Durban.

Dr Priya Parag, Department of Radiology, University of KwaZulu-Natal, South Africa. E-mail-PriyashiniPar@Ialch.co.za , Tel no 0836556084, Address No10 Paarey Close Izinga Ridge Umhlanga

***Summary :*** 2762 words, 16 pages, 4 graphs,8 figures

**ABSTRACT**

***Background****:* There is extremely limited literature that provides patterns of CT findings at the various GCS levels, and finding the association between mechanism of trauma and CT findings. Most studies done are on patients with GCS of 13, 14, and 15. In addition there are no South African studies on GCS and mechanism of injury as a predictor of CT findings in head injury patients. This study aims to correlate the GCS presentation and mechanism of injury in neurosurgically relevant patients with CT findings and therefore assist to determine the severity and urgency for which patients should be transferred to regional and tertiary hospitals with imaging and neurosurgical facilities. The hypothesis is that GCS and mechanism of injury can be used to predict CT findings to triage patients into risk categories.

***Objectives:*** The objective of this study is to compare patients GCS at presentation, mechanism of injury and CT findings in neurosurgically relevant head injury patients and thus assist clinicians on initial contact to determine the severity of head injury. This is especially relevant in rural areas to determine the severity and urgency for which patients should be transferred to regional and tertiary hospitals. Further objectives include to determine the patterns of CT findings at various GCS ranges, i.e.: GCS 3-6; 6-9; 9-12; 12-15 and to determine the patterns of CT findings in patients with various mechanisms of injuries and compare this to relevant literature. The study should determine the likelihood of various types of CT findings in relation to the GCS and mechanism of injury.

***Method:*** A retrospective chart review was done of 100 randomized patients, between the ages of 18 and 65 years, with blunt head trauma seen at Inkosi Albert Luthuli Central Hospital (IALCH) over a one year period. Medical records were analyzed to determine the patients who met the inclusion criteria. In patients with blunt head trauma, the initial GCS, mechanism of injury, CT imaging findings and if neurosurgical intervention was required, were recorded.

***Results:*** A total of 100 randomly selected patients were included in this study. From this study, 48% of patients presented to hospital due to assault, 21% from MVA, 12% due to a fall, 17% from PVA and 2% from other uncategorised injuries. From the 100 patients in this study, 15% of patients presented with a GCS between 3-6, 23% between 7-9, 22% between 10-12 and 40% presented with GCS between 13-15. Further assessment showed no significant correlation between GCS at presentation and CT findings in neurosurgically relevant head injury patients (P>0,05). There is furthermore no significant correlation of mechanism of injury and CT findings with the exception of subarachnoid haemorrhage. There is a significant correlation with the presence of subarachnoid haemorrhage on CT and history of assault or pedestrian vehicle accident (P=0,015).

***Conclusion:*** There should be a high index of suspicion of intracranial injury in patients with a history of assault or pedestrian vehicle accident. It is advised that patients with history of assault or pedestrian vehicle accident, as a mechanism of injury, receive CT imaging. Due to there being no significant correlation between GCS at presentation and CT findings, a GCS between 13-15 in a patient should not be seen as an exclusion criteria for imaging.

## Introduction

The leading cause of death among those aged between 1-24 years is trauma related (1). Head injury caused by trauma is a leading cause of disability in the world. The incidence of traumatic brain injury (TBI) in South Africa is estimated to be 1, 5 to 3,5 times higher than that of the estimated global rate. In South Africa about 89 000 new traumatic brain injuries are reported annually [3].

The commonest cause of head injury is MVA [1-3], bicycle or vehicle pedestrian accident, falls and violence [2, 3] respectively.

The GCS is currently the most widely used method for assessing consciousness and is used to classify TBI into mild, moderate and severe [4]. GCS scores ranging from 13-15 are regarded as mild, 9-12 moderate and 3-8 severe [3]. By determining the patients level of consciousness on arrival and CT findings, the patients current condition can be evaluated, appropriate intervention planned and prognostic outcome predicted[1].

There is much controversy regarding whether patients with GCS 15 and minor head injury require CT imaging [5]. Literature shows less than 10% of patients with minor head injury have positive CT findings and less than 1% require neurosurgical intervention [2, 5, 6]. However not much literature in this situation is currently available for South Africa.

Some authors debate the financial cost of doing CT imaging in these patients. However the cost of a CT scan is less than the cost of admission for neurological observation in these patients [6]. Literature shows that patients with GCS 15 have more often a normal CT scan and a lower incidence of neurosurgical intervention [2, 5]. This information is however not based on the South African population and there is much concern regarding management of patients with a GCS of 15. This study was conducted in Inkosi Albert Luthuli Central hospital which is a quaternary public sector academic hospital in Durban South Africa that receives referrals from Kwa Zulu Natal and part of the Eastern Cape.

South Africa has a high incidence of trauma and the mechanism of injury here is often different than that seen in first world countries. There is not much research regarding the various mechanisms of injury in South Africa and the associated CT findings. This study combines GCS findings and the mechanism of injury in patients and attempts to correlate this with CT findings. The objective of the study is to categorise TBI patients into high and low risk and assist clinicians on initial contact to determine the severity of head injury. This is especially relevant in rural areas to determine the severity and urgency for which patients should be transferred to regional and tertiary hospitals.

## Method

Ethical approval for this study was obtained from the Biomedical Research Ethics Committee (BREC), University of KwaZulu-Natal. A retrospective chart review was conducted at Inkosi Albert Luthuli Central Hospital (IALCH), Durban, South Africa after permission was obtained from the KwaZulu-Natal department of health and the Inkosi Albert Luthuli Central Hospital allowing access to patient records.

A retrospective descriptive study was done. As discussed with the statistician, a randomised review of 100 charts of the patients with blunt head injury from January 2011 until December 2011 was performed using the inclusion and exclusion criteria mentioned below.
The first 20 patients from each month was selected and the exclusion criteria implemented to reduce numbers. Thereafter if there were too many patients in the sample group, every second patient was selected. If the sample group was too small, every 21st patient from each month was selected and the process continued until a group of 100 was achieved.

**Inclusion Criteria**

1. Patients in the age group 18 to 65 years
2. Closed head injury patients

**Exclusion Criteria**

1. Open head injury
2. Other medical causes that could account for the decrease in level of GCS

The data does not contain any patient identifying information and a random yet sequential numerical code was used to save information. The information was saved in a password protected computer that only I have access to. Data recorded included patients age, sex, GCS at presentation, mechanism of injury, CT findings and if neurosurgical intervention was required.

## Results :

A total of 100 randomly selected patients were included in this study. From this study 48% of patients presented to hospital due to assault, 21% from MVA, 12% due to a fall, 17% from PVA and 2% from other uncategorised injuries. With 48% of patients presenting to radiology secondary to assault, the role of radiology in management of assault patients is clearly evident.

From the 100 patients in this study, 15% of patients presented with a GCS between 3-6, 23% between 7-9, 22% between 10-12 and 40% presented with a GCS between 13-15. Most patients present to the emergency department with a higher GCS, and this is the category at which determining the need for a scan or neurosurgical intervention is most questioned.

A total of 33 percent of patients presented with midline shift. The largest percentage of patients with midline shift was in the GCS 13-15 category (42,42%) and in those with a history of assault (63,64%).

A total of 27% of patients presented with an extradural haemorrhage. The GCS 13 -15 category had the highest percentage of patients ( 48,15%) and the highest incidence was amongst those with history of assault (51,85%).

A total of 26% of patients presented with a subdural haemorrhage. There was an equal incidence in the GCS 7-9, 10-12, and 13-15 group (30,77%). Patients with a history of assault had the highest incidence of subdural haemorrhage (46,15%)

A total of 29% of patients presented with a subarachnoid haemorrhage. The highest incidence was in the GCS 7-9 group ( 31,03%) and those with a history of assault (27,59%).

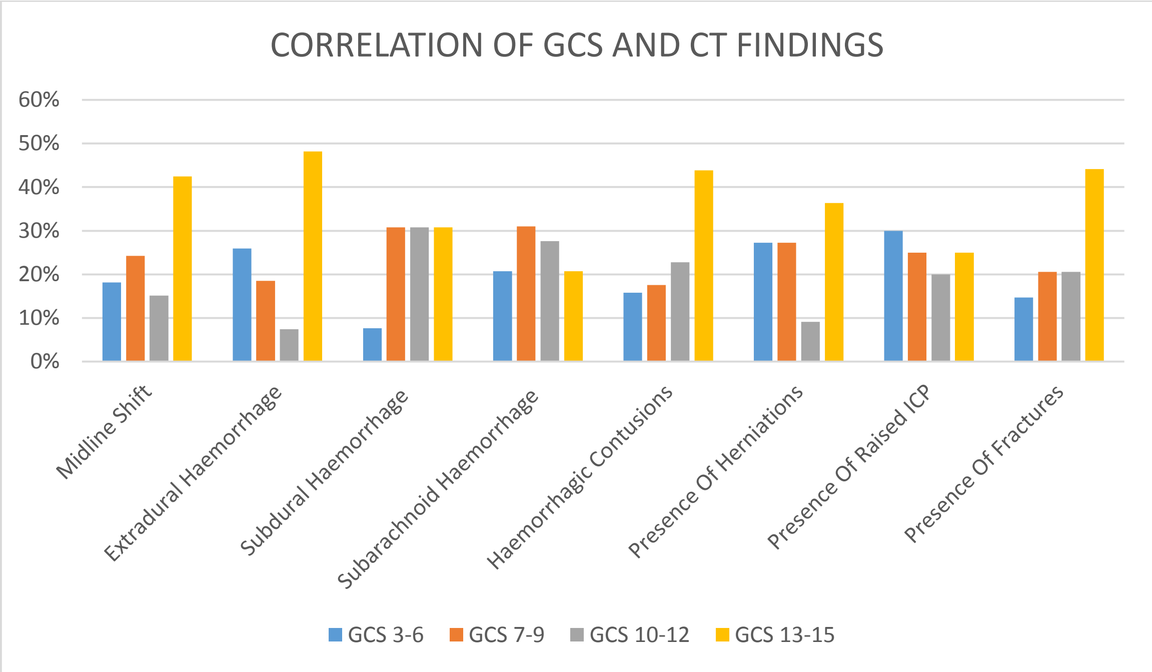
A total of 57% of patients presented with haemorrhagic contusions. The highest incidence was in the GCS 13-15 group (43, 86%) and those with history of assault (49,12%).

A total of 11% of patients presented with intracranial herniations. The highest incidence was in the GCS 13-15 group (36, 36%) and those with histories of assault and PVA (36,36%).

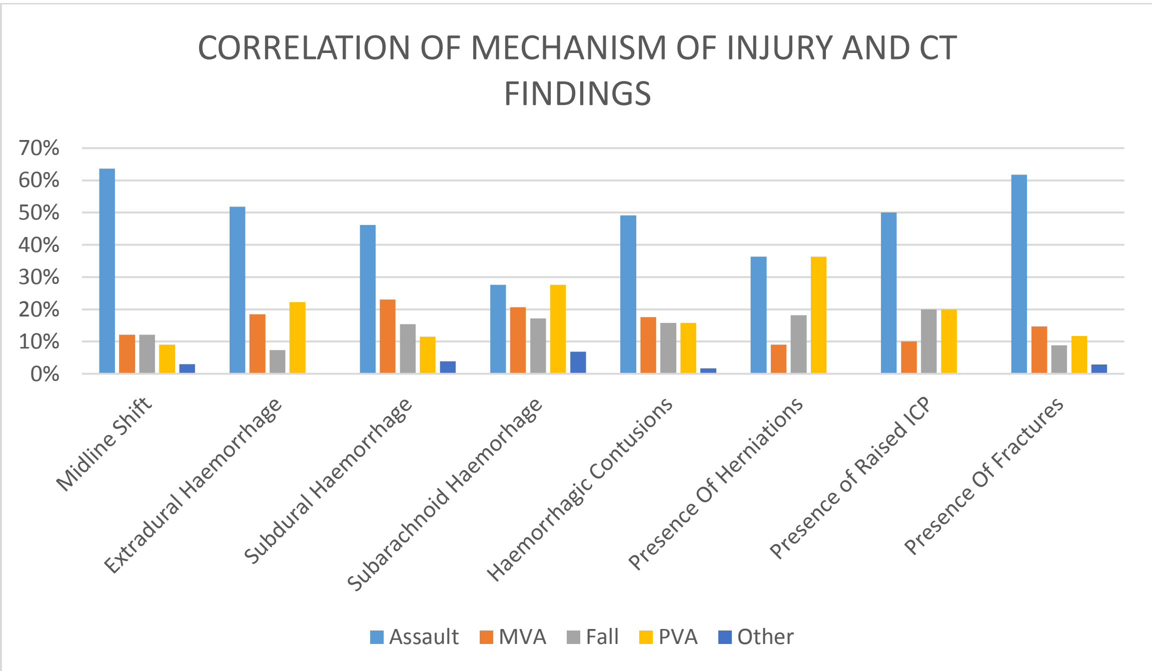
A total of 20% of patients presented with features of raised intracranial pressure. The highest incidence is in the GCS 3-6 category (30%) and those with history of assault (50%).

A total of 34% of patients presented with cranial vault fractures. The highest percentage is in the GCS 13-15 category (44,12% ) and those with history of assault (61,76%).

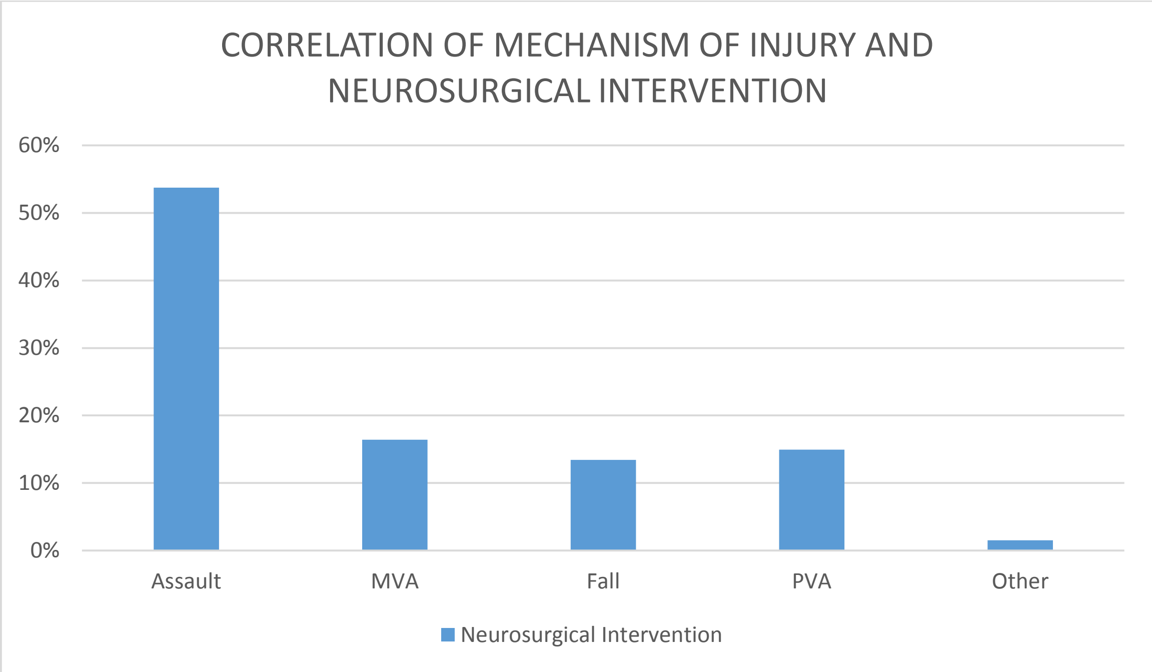
The largest percentage of patients requiring neurosurgical intervention was in the GCS 7-9 and GCS 13-15 categories (28,36%) as well as in those with a history of assault (53,73%) compared to other mechanisms of injury.



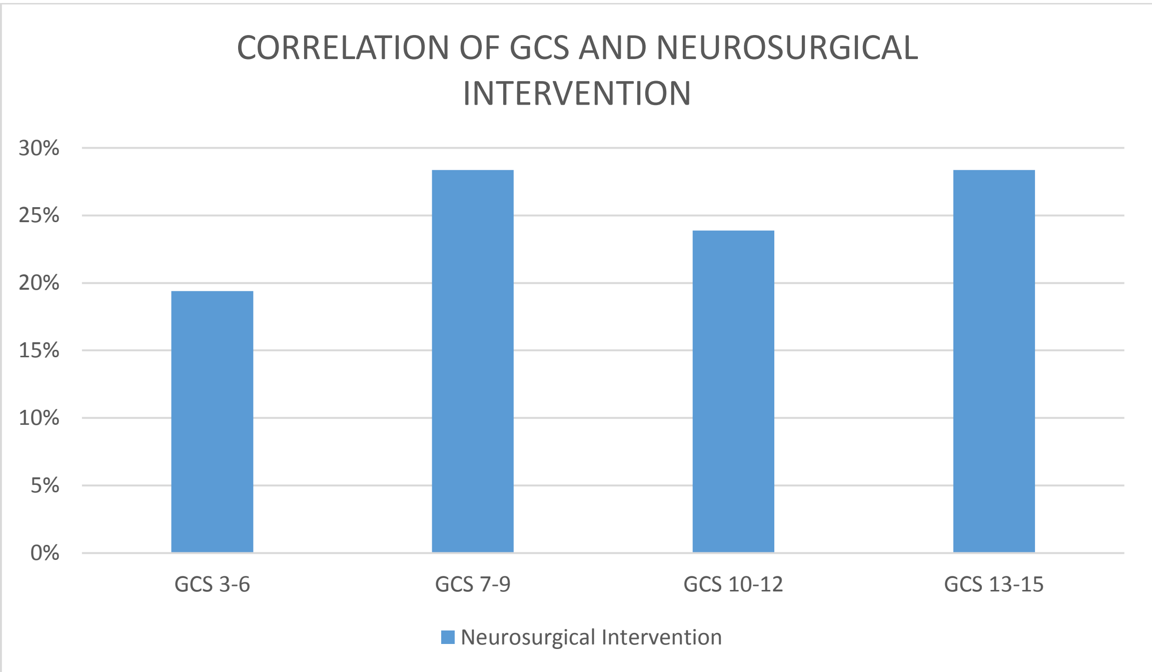

Graph 1 shows the spectrum of CT findings at the various GCS categories.




Graph 2 shows the spectrum of CT findings with the various mechanisms of injury.




Graph 3 shows the incidence of neurosurgical intervention with the various mechanisms of injury.




Graph 4 shows the incidence of neurosurgical intervention with the various categories of GCS at presentation.

## Discussion

Head injury occurs very commonly in a developing country, like South Africa. An estimate of 89 000 cases of new traumatic brain injuries are reported annually in South Africa [1]. The first assessment often made during the examination of such a patient is the GCS. Very often patients present to clinics and institutions without radiological facilities and the GCS is the basis on which patients are transferred to centres with CT scanners.

Naser et al showed that motor vehicle accidents were the leading cause of head trauma in Iran[2]. Our study shows the leading cause of head trauma to be due to assault. With 48% of our patients presenting to radiology secondary to assault, the role of radiology in management of trauma patients is clearly evident.

The GCS is currently the most widely used method for assessing consciousness and is used to classify TBI into mild, moderate and severe [4]. GCS scores ranging from 13-15 are regarded as mild, 9-12 moderate and 3-8 severe [3]. Despite the positive findings in patient with GCS of 15 being relatively low, the presence of positive findings and need for neurosurgical intervention remains an area of concern. Significant brain injury and need for CT scan cannot be excluded in patients with minor head injury despite GCS 15 and normal complete neurological examination at presentation[7].

Our study in particular demonstrates that there is no significant correlation with GCS at presentation and CT findings in neurosurgically relevant head injury patients. Our study demonstrated the highest incidence of midline shift, extradural haemorrhage, haemorrhagic contusions, intracranial herniations and cranial vault fractures occurred in the GCS 13-15 group, this is not in keeping with previous studies that state the finding of midline shift on CT scan, regardless of the underlying lesions are accompanied with lower GCS scores[1]. This study further found that the highest incidence of subdural haemorrhage occurred in the GCS 7-9, 10-12 and 13-15 group. Most subarachnoid haemorrhages occurred in the GCS 7-9 group and most scans with features suggesting raised intracranial pressure occurred in the GCS 3-6 category.

This research did not study the differences in the frequency and type of injury compared to other countries.

Our findings in this study did not replicate other studies that stated the presence of skull fractures or intracranial haemorrhage was accompanied with lower GCS in patients [8]. Previous studies found that presence of skull fractures regardless of GCS will place patients into high risk groups [9].

This research did not access the size of the fracture(s) or intracranial haemorrhage. This research correlated the GCS at presentation and no attempt was made to correlate the GCS with the type of resuscitation.

Literature shows patients with subdural haemorrhage (SDH) or SAH or midline shift and an abnormal third ventricle had significantly lower GCS and were more severely injured [10]. Subdural haematomas are associated with a worse GCS score and prognosis. Intracranial hematomas have been associated more frequently than diffuse brain injury with neurological deterioration. The lesion size is very important and increasing lesion size may compress and distort vital structures in the diencephalon and upper brainstem[11].

In minor head injury patients, non MVA including pedestrian injury, fall from height, falling object and assault are significantly associated with the need for neurosurgical intervention and should be categorised as high risk minor trauma and therefore require urgent CT when stable[9].

Our study found that the highest incidence of midline shift, extradural haemorrhage, subdural haemorrhage, subarachnoid haemorrhage, haemorrhagic contusions, raised intracranial pressure and presence of cranial vault fractures was found in the group with assault as a mechanism of injury. Presence of intracranial herniation was most prevalent in the groups with pedestrian vehicle accident and assault as a mechanism of injury. There is a significant correlation with the presence of subarachnoid haemorrhage on CT and history of assault or pedestrian vehicle accident (P=0,015). This is indicative that history of assault or pedestrian vehicle accident as a mechanism of injury is a risk factor for CT findings of intracranial injury and it is advised that irrespective of their GCS at presentation, these patients should undergo a CT scan.

This study additionally found that the highest incidence of neurosurgical intervention was found in the GCS 7-9 and 13-15 group and in patients with history of assault as a mechanism of injury.

Limitations of this study include that due to Inkosi Albert Luthuli Central Hospital being a referral center for other hospitals, majority of the patients are referred due to the high suspicion of intra cranial injury. Therefore the number of normal CT scans in this study will be lower than expected at other centers. This is a retrospective study.

## Conclusion

The Glasgow Coma Scale Score should not be the only criterion for requesting a CT scan. Other factors such as history of loss of consciousness and duration of loss, amnesia in addition to the low and high risk as discussed in the research should be considered. An extradural hematoma is classically described as patients who “talk and die”. Head injury pathophysiology is not static and CT features may deteriorate with time.

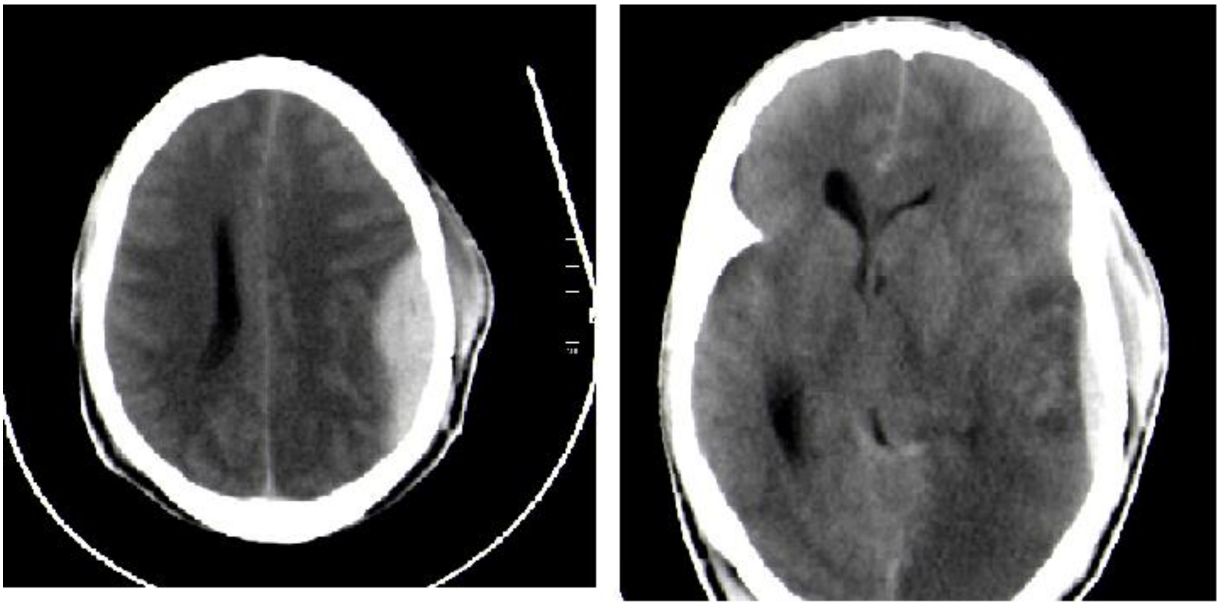
South Africa has a high incidence of trauma and the mechanism of injury here is often different than that seen in first world countries. Our study demonstrates that most patients presenting with traumatic head injury had a history of assault as a mechanism of injury. Majority of presenting patients had an initial GCS in the category between 13-15. There was no significant correlation between GCS at presentation and CT findings in neurosurgically relevant head injury patients. However the presence of many types of intracranial injuries were most prevalent in the GCS 13-15 group. A history of assault as a mechanism of injury was noted to have the highest prevalence of many types of intracranial injuries. There was a significant correlation with the presence of subarachnoid haemorrhage on CT and history of assault or pedestrian vehicle accident. Neurosurgical intervention was highest in the GCS 7-9 and 13-15 group as well as those with history of assault.

It is therefore advised that GCS should not be used as a criterion when deciding if patients qualify for CT imaging and a patient with a GCS of 15 should not be denied a CT or neurosurgical referral based on their GCS alone. Furthermore there should be a high index of suspicion in patients with a history of assault or pedestrian vehicle accident as a mechanism of injury and these patients should receive CT imaging with the potential of neurosurgical referral.

A prospective study may reduce but not completely eliminate neurosurgical relevant injuries requiring a CT scan.

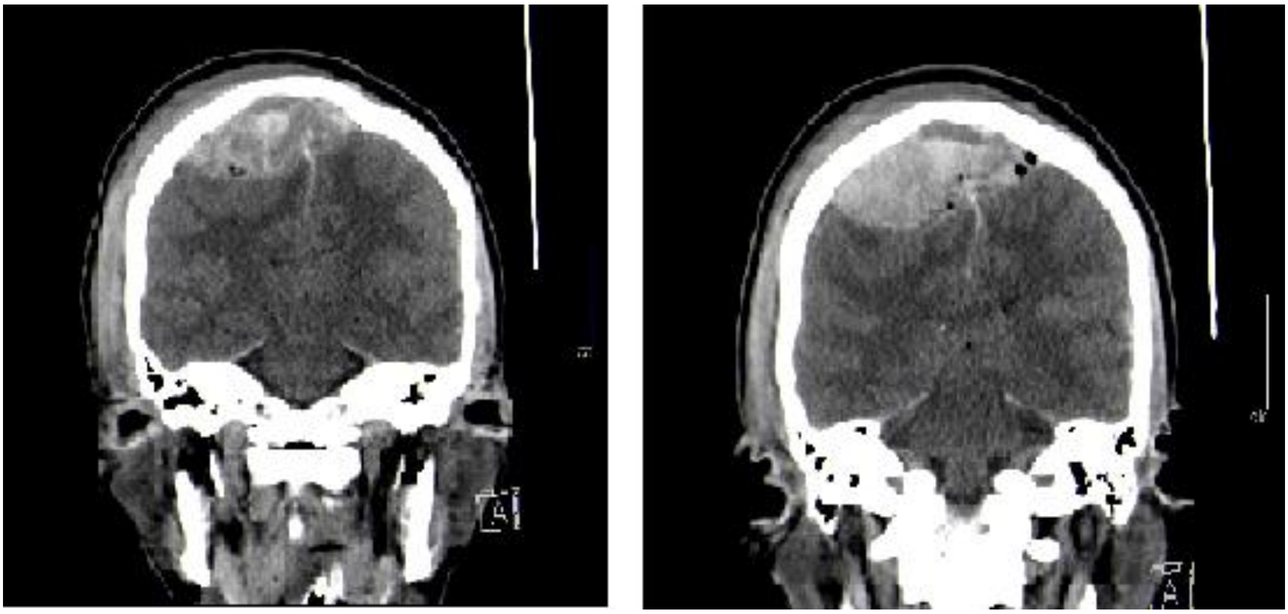
Figures 1 to 8 demonstrate the CT findings in patients with various GCS at presentation and mechanisms of injury.

Figure 1 shows the presence of an intraparenchymal haemorrhagic contusion in the left frontal lobe, intra ventricular haemorrhage in the occipital horns of the lateral ventricles bilaterally as well as subarachnoid haemorrhage and the presence of blood along the posterior inter hemispheric fissure in a patient who presented with a GCS of 4 and a history of assault as a mechanism of injury. Neurosurgical intervention was performed.



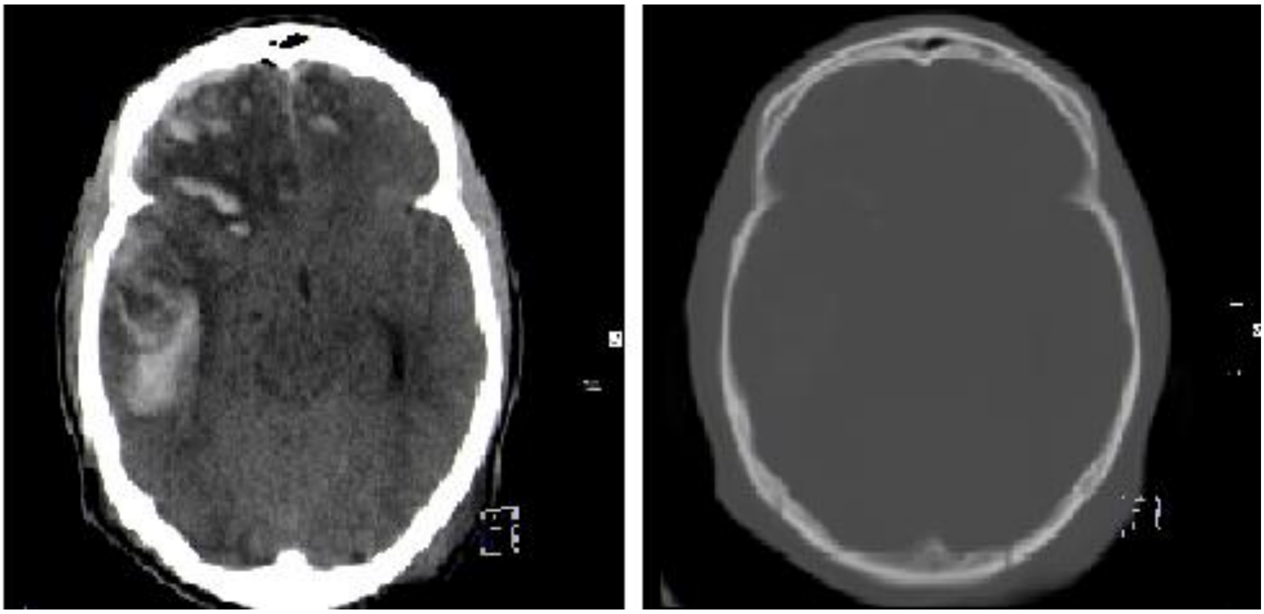
a b

Figure 2: Patient with a history of assault as mechanism of injury and was intubated with a GCS of 6. Figure 2a shows a large extradural haemorrhage with overlying subgaleal haematoma. The low density within the extradural haemorrhage suggests active bleeding. Raised intracranial pressure was noted on additional images in this study. Figure 2b shows left posterior cerebral territory infarct due to uncal herniation. Neurosurgical intervention was performed.



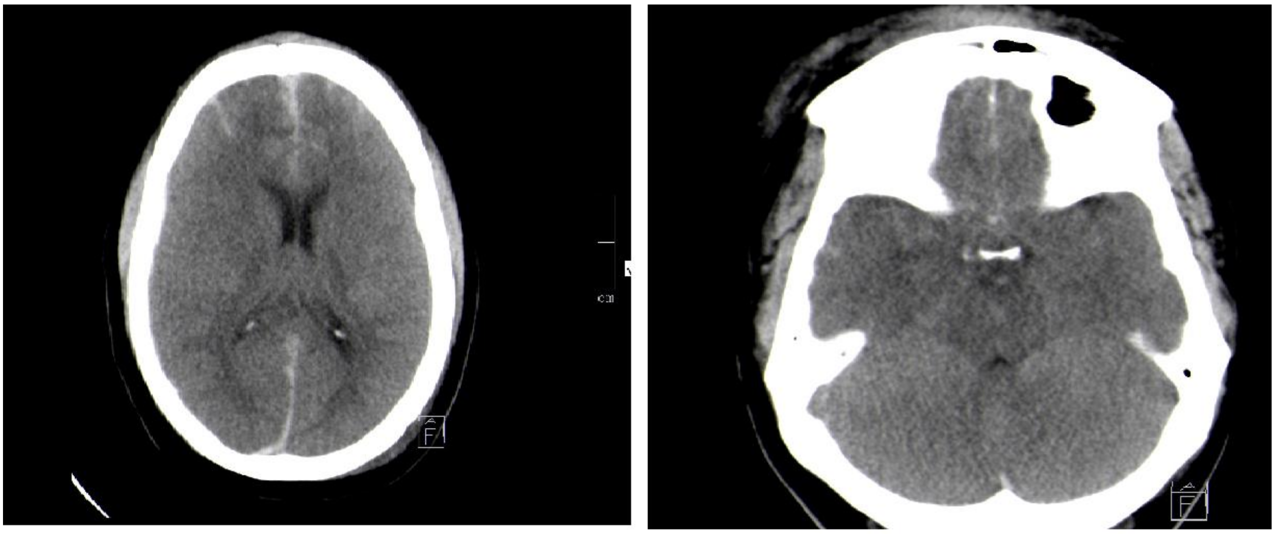
a b

Figure 3 shows a large extradural haemorrhage with low densities noted within suggesting active haemorrhage in the high parietal region. There is a large subgaleal haematoma noted in the high parietal region and the right temporal region. Pneumocranim is demonstrated. This patient presented with a GCS of 6 and motor vehicle accident as a mechanism of injury. This patient had neurosurgical intervention.



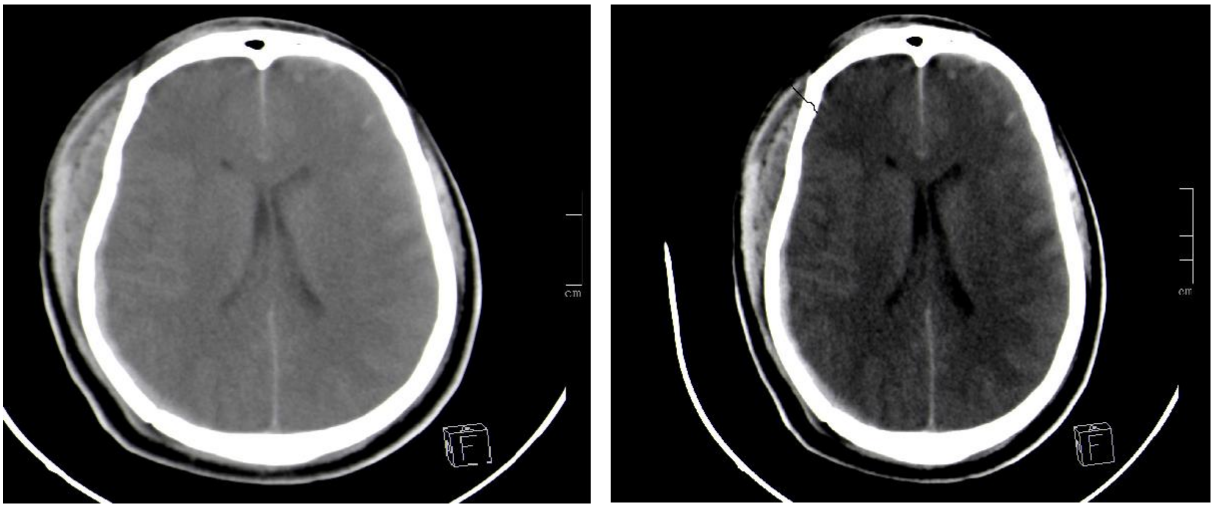
a b

Fig 4a shows multiple intraparenchymal haemorrhagic contusions in the frontal lobes bilaterally as well as subarachnoid haemorrhage in the right frontal lobe. There is a small subdural haemorrhage in the right frontal lobe. There was associated raised intracranial pressure noted on additional images in this study. Figure 4b shows a linear fracture in the left occipital bone. Features are in keeping with a coup-contrecoup injury. These findings were demonstrated in a patient with a history of pedestrian vehicle accident as a mechanism of injury and presenting with a GCS of 6 and intubated. This patient required neurosurgical intervention.



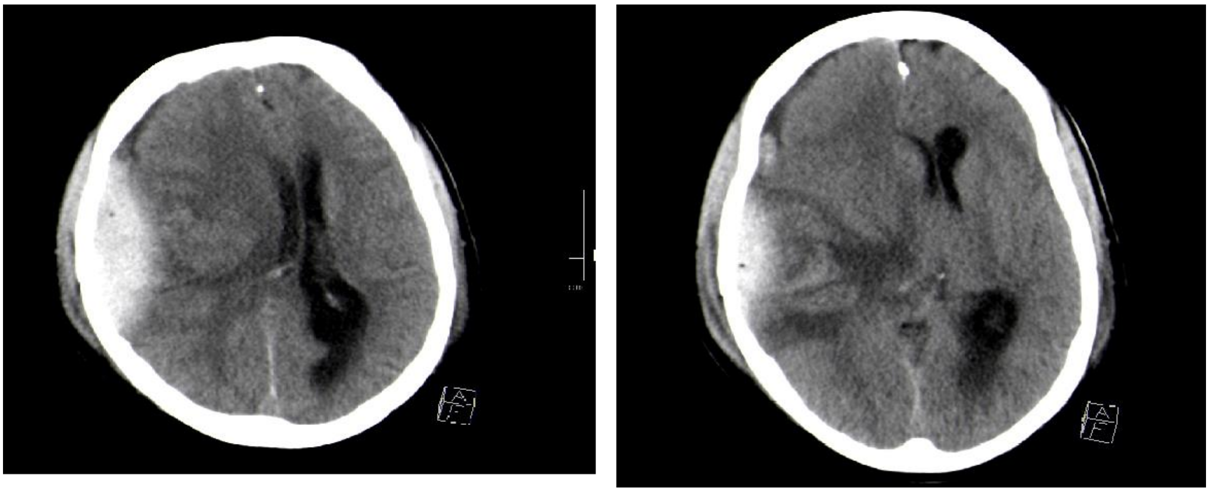
a b

Fig 5a shows subarachnoid haemorrhage in the right frontal lobe and blood along the anterior and posterior interhemispheric fissures. Raised intracranial pressure was demonstrated on the additional images for this study. Figure 5b demonstrates subarachnoid haemorrhage in the right temporal lobe and effacement of the basal cisterns. These features were demonstrated in a patient with a fall as a mechanism of injury and a presenting GCS of 7. There was neurosurgical intervention.



a b

Figure 6 shows a patient with a presenting GCS of 15 and fall as a mechanism of injury. Figure 6a shows subarachnoid haemorrhage in the left frontal lobe. Intraparenchymal haemorrhagic contusions in the left frontal lobe. Blood is noted in the anterior and posterior interhemispheric fissures. Figure 6a and 6b show a subdural haemorrhage in the right parietal and occipital regions with overlying subgaleal haematoma. Note the linear fracture in the right parietal bone. This patient required neurosurgical intervention.



a b

Figure 7a and 7b demonstrate a large extradural haematoma in the right parietal region. The low density areas within the haemorrhage suggest active bleeding. There is associated midline shift to the left with subfalcine herniation. Raised intracranial pressure was noted on subsequent images in this study. These findings were found in a patient with a GCS of 14 and a mechanism of injury of fall. This patient required neurosurgical intervention.

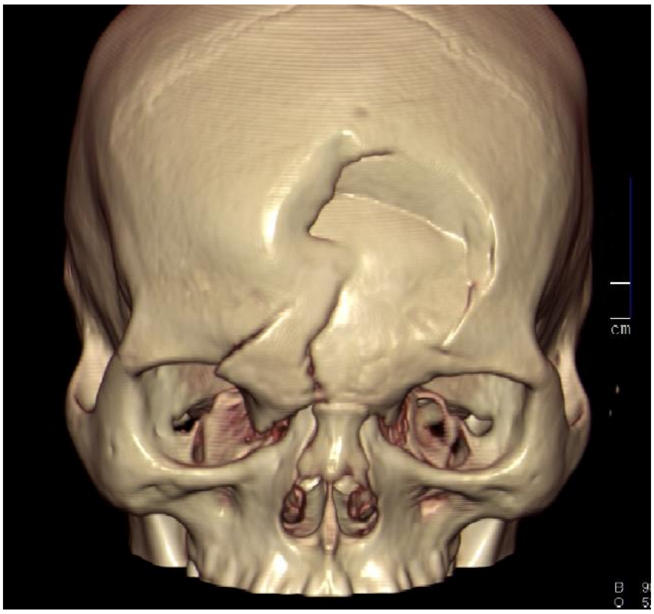


Figure 8 demonstrates extensive depressed comminuted depressed skull fractures in the frontal bone in a patient with a presenting GCS of 14 and history of pedestrian vehicle accident as a mechanism of injury.

# COMPETING INTEREST

The author declares that she has no financial or non-financial competing interests which may have inappropriately influenced her in writing this article.


# ACKNOWLEDGEMENTS

The author would like to thank the following individuals for their assistance:

| Name | Department | Contribution |
| --- | --- | --- |
| Dr J. Maharajh (Senior specialist) | Radiology – King Edward Hospital Durban | Supervisor |
| Dr A Sewnarain | Department of health | Assisted with logistics |
| Dr W Nombula | Radiology- RK Khan hospital Durban | Assisted with logistics |
| Ms Fikile Nkwanyana (Statistician) | UKZN | Assisted with statistics |
| Mr Boikhutso Tlou (Statistician) | UKZN | Assisted with statistics |
| My lovely parents Radhika and Preethlall Sewnarain | | Psychosocial support |

# REFERENCES


1. M. Naseri MD ATM, A.R. Moghaddas MD. Correlation of CT scan findings with the level of consciousness in acute head trauma. Iranian Journal of Radiology. 2005 June 2005;(125-129)2:5.

2. Saboori M, Ahmadi J, Farajzadegan Z. Indications for brain CT scan in patients with minor head injury. Clinical neurology and neurosurgery. 2007 Jun;109(5):399-405. PubMed PMID: 17350162.

3. World Head Injury Awareness Day : 20 March 2010 20 March 2010. Available from: http://www.kznhealth.gov.za/headinjury.htm.

4. Rossi FlMlA. Correlation between the Glasgow Coma Scale and computed Tomography imaging findings in patients with traumatic brain injury. Radiologia Brasileira. 2011;44:7.(35-41)

5. Kisat M, Zafar SN, Latif A, Villegas CV, Efron DT, Stevens KA, et al. Predictors of positive head CT scan and neurosurgical procedures after minor head trauma. The Journal of surgical research. 2012 Mar;173(1):31-7. PubMed PMID: 21872271.

6. Siasios J, Foutzitzi S, Deftereos S, Karanikas M, Birbilis T. The traumatic brain injury: diagnosis and management at emergency department by general surgeon. A retrospective critical analysis on the use of the CT head scan. Turkish neurosurgery. 2011;21(4):613-7. PubMed PMID: 22194124.

7. Vilke GM, Chan TC, Guss DA. Use of a complete neurological examination to screen for significant intracranial abnormalities in minor head injury. The American journal of emergency medicine. 2000 Mar;18(2):159-63. PubMed PMID: 10750921.

8. Kung WM, Tsai SH, Chiu WT, Hung KS, Wang SP, Lin JW, et al. Correlation between Glasgow coma score components and survival in patients with traumatic brain injury. Injury. 2011 Sep;42(9):940-4. PubMed PMID: 21067749.

9. Abdul Latip LS, Ahmad Alias NA, Ariff AR, Shuaib IL, Abdullah J, Naing NN. CT scan in minor head injury: a guide for rural doctors. Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia. 2004 Nov;11(8):835-9. PubMed PMID: 15519858.

10. Wardlaw JM, Easton VJ, Statham P. Which CT features help predict outcome after head injury? Journal of neurology, neurosurgery, and psychiatry. 2002 Feb;72(2):188-92; discussion 51. PubMed PMID: 11796768. Pubmed Central PMCID: 1737755.

11. Kido DK, Cox C, Hamill RW, Rothenberg BM, Woolf PD. Traumatic brain injuries: predictive usefulness of CT. Radiology. 1992 Mar;182(3):777-81. PubMed PMID: 1535893.

12. NAIDOO, Dinesh. Traumatic brain injury: The South African landscape. South African Medical Journal, [S.l.], v. 103, n. 9, p. 613-614, aug. 2013.

13. Alexander T., Fuller G., Hargovan P., Clarke D. L., Muckart D. J., Thomson S. R.. An audit of the quality of care of traumatic brain injury at a busy regional hospital in South Africa. S. Afr. j. surg. [Internet]. 2009 Nov [cited 2017 July 03] ; 47( 4 ): 120-126.

14. Nayebaghayee H, Afsharian T. Correlation between Glasgow Coma Scale and brain computed tomography-scan findings in head trauma patients. Asian J Neurosurg 2016;11:46-9.

# APPENDIX 1

1. Research proposal submitted to Ethics

2. Appendices which accompanied the BREC application

3. Approval letters: BREC, IALCH, DOH and BREC recertification.

## 1. Research proposal submitted to Ethics

**Title:** What is the association between the Glasgow Coma Scale score, mechanism of injury and computed tomography findings in neurosurgically relevant head injury patients.

**Principle Investigator**: Dr. Kavishka Sewnarain

**Proposed Degree**: M.Med

**Department:** Diagnostic Radiology

**Institution**: Nelson Mandela School of medicine. University Of Kwa- Zulu Natal

**Supervisor**: Dr. J Maharajh

**Year**: 2013

**Title:** What is the association between the Glasgow Coma Scale (GCS) score, mechanism of injury and computed tomography (CT) findings in neurosurgically relevant head injury patients

## AIM:

-To compare patients GCS at presentation, mechanism of injury and CT findings in neurosurgically relevant head injury patients.

- To assist clinicians on initial contact to determine the severity of head injury, this is especially important in rural areas to determine the severity and urgency for which patients should be transferred to regional and tertiary hospitals.

## OBJECTIVES:

- To record GCS at presentation
- To record the mechanism of injury
- To follow up the CT findings of these head injury patients.
- To determine the patterns of CT findings at various GCS ranges, i.e.; GCS3-6; 6-9; 9-12; 12-15.
- To determine the patterns of CT findings in patients with various mechanisms of injuries

## Background

Head injury occurs very commonly in a developing country with a high crime rate, like South Africa. An estimate of 89 000 cases of new traumatic brain injuries are reported annually in South Africa. (1) The first assessment often made during the examination of such a patient is the GCS. Very often patients present to clinics and institutions without radiological facilities and the GCS is the basis on which patients are transferred to centres with CT scanners.

Naser et al showed that motor vehicle accidents were the leading cause of head trauma in Iran(2). Another study done in Malaysia, a developing country showed that 43,5% of patients involved in non-motor vehicle accidents needed neurosurgical intervention in comparison to 12,7% who were involved in motor vehicle accidents (MVA) (3). The study in Malaysia also looked at CT findings in patients with GCS of 13, 14, 15 and it was noted that 74% of patients with GCS of 13 and 14 had significant CT findings and 29,5% of patients with GCS of 15 had significant CT findings There have been cases of patients with a GCS of 15 not only having significant CT findings but additionally needing neurosurgical procedures(4) It was additionally found that older age, male gender, African American origin and fall as a mechanism of injury were all predictors of positive CT findings(4)

There are however no studies that provide, patterns of CT findings at the various GCS levels and finding the association between mechanism of trauma and CT findings. Most studies done are on patients with GCS of 13, 14, and 15. In addition there are no South African studies on GCS and mechanism of injury as a predictor of CT findings in head injury patients. This study aims to provide a pattern of expected CT findings at various GCS levels, and the association between the mechanism of trauma and the severity of head injury expected on CT in neurosurgically relevant head injury patients. This will assist in transferring patients to relevant centres and using adequate imaging modalities based on GCS and mechanism of injury.

1. World Head Injury Awareness Day : 20 March 2010 20 March 2010. Available from: http://www.kznhealth.gov.za/headinjury.htm.

2. M. Naseri MD ATM, A.R. Moghaddas MD. Correlation of CT scan findings with the level of consciousness in acute head trauma. Iranian Journal of Radiology. 2005 June 2005;(125-129)2:5.

3. Abdul Latip LS, Ahmad Alias NA, Ariff AR, Shuaib IL, Abdullah J, Naing NN. CT scan in minor head injury: a guide for rural doctors. Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia. 2004 Nov;11(8):835-9. PubMed PMID: 15519858.

4. Kisat M, Zafar SN, Latif A, Villegas CV, Efron DT, Stevens KA, et al. Predictors of positive head CT scan and neurosurgical procedures after minor head trauma. The Journal of surgical research. 2012 Mar;173(1):31-7. PubMed PMID: 21872271.

## LITERATURE REVIEW, MMED

The leading cause of death among those aged between 1-24 years is trauma related (1) Head injury caused by trauma is a leading cause of disability in the world. The incidence of traumatic brain injury (TBI) in South Africa is estimated to be 1, 5 to 3, 5 times that of the estimated global rate. In South Africa about 89 000 traumatic brain injuries are reported annually. TBI is more common in males than females (2)

The commonest cause of head injury is MVA (1-3), bicycle or vehicle pedestrian accident, falls and violence (2, 3) respectively.

CT scans are utilized in the evaluation of intracranial structures non-invasively and is the imaging of choice for diagnosis, evaluation and determination of prognosis in patients with acute head trauma (1). Many hospitals and clinics where patients present do not have CT scanners available and medical staff assess patients clinically and based on this assessment patients are either sent to centres that have CT facilities or are managed conservatively.

The GCS is currently the most widely used method for assessing consciousness and is used to classify TBI into mild, moderate and severe (4). GCS scores ranging from 13-15 are regarded as mild, 9-12 moderate and 3-8 severe (3) By determining the patients level of consciousness on arrival and CT findings, the patients current condition can be evaluated, appropriate intervention planned and prognostic outcome predicted(1).

Most patients presenting to hospitals have minor head injury (2, 4). In the United States approximately 80% of patients with head trauma have minor head injury (5). Patients with a GCS of 15 are said to have minor head injury and those with a GCS of 13 and 14 are said to have mild head injury (2).

There is much controversy regarding whether patients with GCS 15 and minor head injury require CT imaging (5). Less than 10% of patients with minor head injury have positive CT findings and less than 1% require neurosurgical intervention (2, 5, 6).

Some authors debate the financial cost of doing CT imaging in these patients. However the cost of a CT scan is less than the cost of admission for neurological observation in these patients(6) In a study done by M Saboori et al, 93,2% of patients with a GCS of 15 had normal CT scans and of the 6,8% with abnormal results, 4 of the 46 patients needed surgical intervention, the non-surgical injuries included localised subarachnoid haemorrhage (SAH) 2mm, small contusion 5mm, subdural haematoma 3mm and isolated pneumocephalus (2).

In patients with a GCS of 15, another study by Kisat et al, 29, 2% of patients had positive CT findings and 4, 2% underwent a neurosurgical procedure. Of these 2, 5% had a therapeutic procedure whilst 1, 7%had a diagnostic procedure (5).

Despite the positive findings in patient with GCS of 15 being relatively low, the presence of positive findings and need for neurosurgical intervention remains an area of concern. Significant brain injury and need for CT scan cannot be excluded in patients with minor head injury despite GCS 15 and normal complete neurological examination at presentation(7).

Older age male patients with a history of fall are considered risk factors for positive CT findings in patients with GCS 15 (5). Those with history of fall had a higher likelihood of positive CT findings than those with history of MVA in patients with a GCS of 15.(5)

It was noted that the presence of skull fractures or intracranial haemorrhage was accompanied with lower GCS in patients (8). The presence of skull fractures regardless of GCS will place patients into high risk groups (9) However, patients with GCS of 13-14 are recommended to have CT done even without evidence of skull fracture if there are abnormal central nervous system (CNS) examination and presence of cranio facial injuries(9)

In minor head injury patients, non MVA including pedestrian injury, fall from height, falling object and assault are significantly associated with the need for neurosurgical intervention and should be categorised as high risk minor trauma and therefore require urgent CT when stable(9)

The finding of midline shift on CT scan, regardless of the underlying lesions and the presence of mixed lesions are accompanied with lower GCS scores(1). The idea behind patients with mixed lesions and midline shift regardless of the background lesion having a lower GCS is that, it may be due to major energy transmission, diffuse brain damage and compression of brainstem structures.(1)

The presence of intraventricular haemorrhage in patients was associated with the finding of lower levels of consciousness being obtained with an average GCS of 10,33 noted in these patients(1)

According to a study done by Morgado FL et al, the incidence of mild TBI was 82, 4%, moderate TBI 2, 0% and severe TBI 15, 6%. In patients with mild TBI, subgaleal hematomas were seen in 66, 6% of cases and cranio facial fractures in 28, 5%. In moderate TBI the most common finding was of subgaleal haematoma (100%). Bone fracture, subarachnoid haemorrhage, area of cerebral contusion with haemorrhagic suffusion and diffuse cerebral oedema were seen in approximately 50% of cases. In severe TBI he noted an increase in all of the CT findings, with a 100% rate of abnormalities, the most common being SAH in 62, 5%, craniofacial fractures in 62, 5%, basilar fractures in 37, 5%. An association of 3 or more findings were seen in 68, 7% of patients. Half of the patients with diffuse cerebral oedema had severe TBI.(4)

Patients with TBI and low GCS scores have more severe CNS injuries with more devastating effects and present with a tendency for haemodynamic instability(4). A need for intubation was noted in all patients with severe TBI.

In another study by Siasios J et al, all patients with GCS < 13-14 required neurosurgical intervention. (6)

Patients with subdural haemorrhage (SDH) or SAH or midline shift and an abnormal third ventricle had significantly lower GCS and were more severely injured.(10). Extradural haemorrhage (EDH) presence was not associated with the GCS total or severity of injury on admission. The most common localisation of intracerebral haemorrhage (ICH) and contusions, EDH and SDH were in the frontal, temporal and parietal parts respectively(1)

Subdural haematomas are associated with a worse GCS score and prognosis. Intracranial hematomas have been associated more frequently than diffuse brain injury with neurological deterioration. The lesion size is very important , and increasing lesion size may compress and distort vital structures in the diencephalon and upper brainstem(11)

A lower GCS and certain CT findings including SAH, midline shift > 3mm and mass lesions are poor prognostic factors after closed head injury(1).

The presence of CT scanners in every major hospital and neurosurgical units is very important. It was noted that in some parts of Europe up to 33% of severe traumatic brain injured patients do not reach a hospital with a neurosurgical unit and there is therefore a 26% increase in mortality

South Africa has a high crime rate and the mechanism of injury here is often different than that seen in first world countries. There is not much work regarding the various mechanisms of injury in South Africa and the associated CT findings. A study which combines GCS and the mechanism of injury in patients and attempts to correlate this with CT findings will benefit in categorising TBI patients into high and low risk and assist clinicians on initial contact to determine the severity of head injury. This is especially important in rural areas to determine the severity and urgency for which patients should be transferred to regional and tertiary hospitals

1. M. Naseri MD ATM, A.R. Moghaddas MD. Correlation of CT scan findings with the level of consciousness in acute head trauma. Iranian Journal of Radiology. 2005 June 2005;(125-129)2:5.

2. Saboori M, Ahmadi J, Farajzadegan Z. Indications for brain CT scan in patients with minor head injury. Clinical neurology and neurosurgery. 2007 Jun;109(5):399-405. PubMed PMID: 17350162.

3. World Head Injury Awareness Day : 20 March 2010 20 March 2010. Available from: http://www.kznhealth.gov.za/headinjury.htm.

4. Rossi FlMlA. Correlation between the Glasgow Coma Scale and computed Tomography imaging findings in patients with traumatic brain injury. Radiologia Brasileira. 2011;(35-41)44:7.

5. Kisat M, Zafar SN, Latif A, Villegas CV, Efron DT, Stevens KA, et al. Predictors of positive head CT scan and neurosurgical procedures after minor head trauma. The Journal of surgical research. 2012 Mar;173(1):31-7. PubMed PMID: 21872271.

6. Siasios J, Foutzitzi S, Deftereos S, Karanikas M, Birbilis T. The traumatic brain injury: diagnosis and management at emergency department by general surgeon. A retrospective critical analysis on the use of the CT head scan. Turkish neurosurgery. 2011;21(4):613-7. PubMed PMID: 22194124.

7. Vilke GM, Chan TC, Guss DA. Use of a complete neurological examination to screen for significant intracranial abnormalities in minor head injury. The American journal of emergency medicine. 2000 Mar;18(2):159-63. PubMed PMID: 10750921.

8. Kung WM, Tsai SH, Chiu WT, Hung KS, Wang SP, Lin JW, et al. Correlation between Glasgow coma score components and survival in patients with traumatic brain injury. Injury. 2011 Sep;42(9):940-4. PubMed PMID: 21067749.

9. Abdul Latip LS, Ahmad Alias NA, Ariff AR, Shuaib IL, Abdullah J, Naing NN. CT scan in minor head injury: a guide for rural doctors. Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia. 2004 Nov;11(8):835-9. PubMed PMID: 15519858.

10. Wardlaw JM, Easton VJ, Statham P. Which CT features help predict outcome after head injury? Journal of neurology, neurosurgery, and psychiatry. 2002 Feb;72(2):188-92; discussion 51. PubMed PMID: 11796768. Pubmed Central PMCID: 1737755.

11. Kido DK, Cox C, Hamill RW, Rothenberg BM, Woolf PD. Traumatic brain injuries: predictive usefulness of CT. Radiology. 1992 Mar;182(3):777-81. PubMed PMID: 1535893.

**Study Design**

**Study Population**

The study is a retrospective chart review at Inkosi Albert Luthuli Central Hospital (IALCH). As discussed with the statistician Boikhutso Tlou, a randomised review of 100 charts of the patients from January 2011 until December 2011 will be done

**Sampling Strategy**

A randomised chart review will be done of 100 patients who have had CT scans for closed head injury in the period from January 2011 to December 2011

***Statistical planning (variables/ confounders)***

**Sample size**

The sample size is calculated as 100 patients scanned for head injury in 2011

**Inclusion Criteria**

3. Patients in the age group 18 to 65
4. Closed head injury patients

**Exclusion Criteria**

3. Open head injury
4. Other medical causes that could account for the decrease in level of GCS

**Data collection methods and tools**

Inkosi Albert Luthuli Central Hospital has an online record of all the CT scans done for head injury patients in 2011. The patients are assigned patient numbers to identify them, I will use there patient numbers to access their clinical history in addition to their CT scans to obtain the required information

**Data analysis techniques**

The patient numbers of all the patients that have had CT scans for closed head injury in 2011 will be obtained from the online AME database present at Inkosi Albert Luthuli Central Hospital. These patient numbers will be saved on Microsoft excel in a password protected computer. The patient numbers will be used to obtain their CT findings and mechanism of injury on the online database available. These will be saved with their patient numbers on EXCEL on a private password protected computer and will thereafter be deleted

**Statistical analysis**

Research data will primarily be analyzed within a quantitative framework making use of univariate and multivariate analysis. Data will be entered into SPSS version 21 (Statistical Packages for the Social Sciences) .A p value $<0.05$ will be considered as statistically significant.  Data analysis will initiate with a check of the data for outliers, missing data, and normality through skewness and kurtotis values that could affect relations between variables. A descriptive statistical analysis of the data (means, standard deviations, ranges, frequencies and percentages, etc.) will initially be conducted prior to conducting inferential and multivariate analyses. Non parametric statistical methods like the Kruskall Wallis and the Mann Whitney test will be conducted for the association between GCS and mechanism of injury with CT findings in neurosurgically relevant head injury patients

## Study location

Data is to be collected from Inkosi Albert Luthuli Central hospital. This is a quaternary hospital that receives referrals from Kwa Zulu Natal and part of the Eastern Cape

## Study Period

The data collected is from 01 January 2011 to 31 December 2011

## TIME SCHEDULE

| Task | Duration | Time period |
| --- | --- | --- |
| Writing protocol | 11 weeks | 29 August 2013- 14 November 2013 |
| Apply to postgraduate and ethics committees | 2 weeks | 14 November 2013- 28 November |
| Data Collection | 2 months | 28 November to 28 January2014 |
| Data Analysis | 2 months | 28 January to 28 March 2014 |
| Writing the thesis or publication | 2 months | 28 March to 28 May 2014 |
| Submission for examination or to the journal | 6weeks | 28 May to 09 July 2014 |

**Limitations of the study**

Due to Inkosi Albert Luthuli Central Hospital being a referral center for other hospitals, majority of the patients are referred due to the high suspicion of intra cranial injury. Therefore the number of normal CT scans in this study will be lower than expected at other centers

**Ethical consideration**

Due to this study being a retrospective chart review, the patients are not required to undergo any further investigations for the purpose of the study. Patients will additionally not be required to answer any questionnaires.

The patient’s privacy is ensured as the cases are not saved with the patients details attached to it. Furthermore the cases are saved on a password protected computer

## 2. Appendices which accompanied the BREC application

***Abbreviations***

| | |
|---|---|
| GCS | Glasgow Coma Scale |
| CT | computed tomography |
| MVA | motor vehicle accidents |
| TBI | traumatic brain injury |
| SAH | subarachnoid haemorrhage |
| CNS | central nervous system |
| SDH | subdural haemorrhage |
| EDH | Extradural haemorrhage |
| ICH | intracerebral haemorrhage |
| IALCH | Inkosi Albert Luthuli Central Hospital |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

***Glasgow coma scale***

| RESPONSE | SCORE |
|---|---|
| **<u>EYE OPENING</u>** | |
| Opens eyes spontaneously | 4 |
| Opens eyes to verbal command | 3 |
| Opens eyes to pain | 2 |
| Does not open eyes to any stimulation | 1 |
| | |
| **MOTOR RESPONSE** | |
| Follows commands | 6 |
| Localises painful stimuli | 5 |
| Flexion or withdrawal to pain | 4 |
| Abnormal flexion in response to pain | 3 |
| Extension in response to pain | 2 |
| No response to stimuli | 1 |
| | |
| **<u>VERBAL RESPONSE</u>** | |
| Orientated to time place and person | 5 |
| Confused | 4 |
| Inappropriate response | 3 |
| Incomprehensible speech | 2 |
| No response | 1 |

## 3. Approval letters: BREC, IALCH, DOH and BREC recertification.

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

17 March 2014

Dr Kavishka Sewnarain
12 Rahle Road
Scottburgh South
4180
Kav.trinity@gmail.com

Dear Dr Sewnarain

**PROTOCOL: What is the association between Glasgow Coma Scale (GCS) score, mechanism of injury and Computed Tomography (CT) findings in neurosurgically relevant head injury patients. REF: BE418/13**

**EXPEDITED APPLICATION**

A sub-committee of the Biomedical Research Ethics Committee has considered and noted your application received on 03 December 2013.

The study was provisionally approved pending appropriate responses to queries raised. Your responses received on 12 March 2014 to queries raised on 31 January 2014 have been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given full ethics approval and may begin as from 17 March 2014.

This approval is valid for one year from 17 March 2014. To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2004), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be RATIFIED by a full Committee at its next meeting taking place on 08 April 2014.

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely

Professor D.R Wassenaar
Chair: Biomedical Research Ethics Committee

**Professor D Wassenaar (Chair)**
**Biomedical Research Ethics Committee**
**Westville Campus, Govan Mbeki Building**
**Postal Address:** Private Bag X54001, Durban, 4000, South Africa
**Telephone:** +27 (0)31 260 2384 **Facsimile:** +27 (0)31 260 4609 **Email:** brec@ukzn.ac.za
**Website:** http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx

Founding Campuses: Edgewood | Howard College | Medical School | Pietermaritzburg | Westville

INSPIRING GREATNESS

health

Department:
Health
**PROVINCE OF KWAZULU-NATAL**

Inkosi Albert Luthuli Central Hospital
Ethekwini Health District
Office of the Medical Manager
Private Bag X 03, Mayville, 4058
800 Bellair Road, Mayville, 4058
Tel.: 031 240 1059,
Fax.: 031 240 1050
Email.:ursulanun@ialch.co.za
www.kznhealth.gov.za

26 February 2014

Dr K Sewnarain
Department of Radiology
IALCH

Dear Dr Sewnarain

**Re: Ref No: BE 5418/13: What is the association between Glasgow Coma Scale (GCS) score, mechanism of injury and Computed Tomography (CT) findings in neurosurgically relevant head injury patients.**

As per the policy of the Provincial Health Research Committee (PHRC), you are hereby granted permission to conduct the above mentioned research once all relevant documentation has been submitted to PHRC inclusive of Full Ethical Approval.

Kindly note the following.

1. The research should adhere to all policies, procedures, protocols and guidelines of the KwaZulu-Natal Department of Health.
2. Research will only commence once the PHRC has granted approval to the researcher.
3. The researcher must ensure that the Medical Manager is informed before the commencement of the research by means of the approval letter by the chairperson of the PHRC.
4. The Medical Manager expects to be provided feedback on the findings of the research.
5. Kindly submit your research to:

   The Secretariat
   Health Research & Knowledge Management
   330 Langaliballe Street, Pietermaritzburg, 3200
   Private Bag X9501, Pietermaritzburg , 3201
   Tel: 033395-3123, Fax 033394-3782
   Email: hrkm@kznhealth.gov.za

Yours faithfully

……………………..
**Dr A M Seedat**
**Acting Medical Manager**

uMnyango Wezempilo . Department van Gesondheid

*Fighting Disease, Fighting Poverty, Giving Hope*

health

Department:
Health
PROVINCE OF KWAZULU-NATAL

**Health Research & Knowledge Management sub-component**
10 – 103 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg
3200
Tel.: 033 – 3953189
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

**Reference** : **HRKM 48/14**
**Enquiries** : **Mr X Xaba**
**Tel** : 033 – 395 2805

Dear Dr K. Sewnarain

**Subject: Approval of a Research Proposal**

1. The research proposal titled **'What is the association between the Glasgow Coma Scale (GCS) score, mechanism of injury and computed tomography findings in neurosurgically relevant head injury patients'** was reviewed by the KwaZulu-Natal Department of Health.

   The proposal is hereby **approved** for research to be undertaken at Inkosi Albert Luthuli Central Hospital.

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mr X. Xaba on 033-395 2805.

Yours Sincerely

ELutge

**Dr E Lutge**
Chairperson, Health Research Committee
Date: 06/03/2014.

uMnyango Wezempilo . Departement van Gesondheid

*Fighting Disease, Fighting Poverty, Giving Hope*

UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

RESEARCH OFFICE
BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604769 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za
Website: http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx

10 March 2016

Dr Kavishka Sewnarain
12 Rahle Road
Scottburgh South
4180
Kav.trinity@gmail.com

Dear Dr Sewnarain

**PROTOCOL: What is the association between Glasgow Coma Scale (GCS) score, mechanism of injury and Computed Tomography (CT) findings in neurosurgically relevant head injury patients? BREC REF: BE418/13**

## RECERTIFICATION APPLICATION APPROVAL NOTICE

| | |
|---|---|
| Approved: | 17 March 2016 |
| Expiration of Ethical Approval: | 16 March 2017 |

I wish to advise you that your application for Recertification dated 04 February 2016 in relation to the above protocol has been noted and approved by a sub-committee of the Biomedical Research Ethics Committee (BREC) for another approval period. The start and end dates of this period are indicated above.

If any modifications or adverse events occur in the project before your next scheduled review, you must submit them to BREC for review. Except in emergency situations, no change to the protocol may be implemented until you have received written BREC approval for the change.

The approval will be ratified by a full Committee at a meeting to be held on **10 February 2015.**

Yours sincerely

[illegible]

Ms A Marimuthu
Senior Administrator: Biomedical Research Ethics

*********************************************************************