FACTORS INFLUENCING ACHIEVEMENT OF TOTAL ENTERAL NUTRITIONAL SUPPORT IN SEVERE TRAUMATIC BRAIN INJURY AT THE KENYATTA NATIONAL HOSPITAL.

A DISSERTATION SUBMITTED IN PART FULFILMENT FOR THE MASTER OF MEDICINE IN NEUROSURGERY DEGREE, UNIVERSITY OF NAIROBI

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DECLARATION

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

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DEDICATION

This work is dedicated to my husband Paul and my daughter Sifa whose love, perseverance and encouragement has made this work possible.
To my loving parents Aggrey and The Late Margaret who raised me to believe in the validity of my dreams.
ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my husband Paul for his patience, encouragement and perseverance throughout the entire journey.

My sincere appreciation goes to my supervisor Professor N.M Mwang’ombe for his guidance throughout the period of study.

Thanks to all staff in the ICU facilities and nutritionist within Kenyatta National Hospital for their support during data collection and patient management.
# TABLE OF CONTENTS

DECLARATION ........................................................................................................... ii
SUPERVISOR ............................................................................................................ iii
DECLARATION OF ORIGINALITY FORM ........................................................... iv
DEDICATION ............................................................................................................ v
ACKNOWLEDGEMENT ........................................................................................... vi
TABLE OF CONTENTS ........................................................................................... vii
LIST OF TABLES .................................................................................................... ix
LIST OF FIGURES .................................................................................................. x
LIST OF ABBREVIATIONS ...................................................................................... xi
SUMMARY ............................................................................................................... xii
INTRODUCTION ..................................................................................................... 1
LITERATURE REVIEW ............................................................................................ 2
JUSTIFICATION OF STUDY .................................................................................. 7
PROBLEM STATEMENT ......................................................................................... 7
OBJECTIVES .......................................................................................................... 8
MAIN OBJECTIVE .................................................................................................. 8
SPECIFIC OBJECTIVES ......................................................................................... 8
MATERIALS AND METHODOLOGY ................................................................. 9
STUDY AREA .......................................................................................................... 9
STUDY POPULATION ............................................................................................ 9
STUDY DESIGN ..................................................................................................... 9
SUBJECTS ............................................................................................................... 9
STUDY OUTLINE ................................................................................................. 10
Care of patients ...................................................................................................... 10
Medication ............................................................................................................. 10
LIST OF TABLES

Table 1: time of onset and time of achievement of total enteral nutritional support in severe tbi patients at the Kenyatta National Hospital ................................................................. 16

Table 2: gcs score, marshall score and age distribution in relation to time of achievement of ten support. .................................................................................................................. 17

Table 3: characteristics of patients with gastric intolerance ................................................................ 18

Table 4: gastric intolerance versus achievement of tens ........................................................................ 19

Table 5: blood glucose versus achievement of tens ................................................................................ 19

Table 6: glasgow coma score versus achievement of tens ...................................................................... 20

Table 7: CT scan findings versus achievement of tens ......................................................................... 21
LIST OF FIGURES

Figure 1: distribution of patients according to gender .......................................................... 15
Figure 2: age distribution ........................................................................................................ 16
Figure 3: gastric intolerance versus achievement of tens .......................................................... 19
Figure 4: blood glucose versus achievement of tens ................................................................. 20
Figure 5: Glasgow coma score versus achievement of tens ..................................................... 21
Figure 6: CT scan findings versus achievement of tens ............................................................ 22
LIST OF ABBREVIATIONS

USA: United States of America
TBI: traumatic Brain Injury
GCS: Glasgow Coma Score
TPN: total Parenteral Nutrition
EN: enteral nutrition
SEN: standard enteral nutrition
PICU: paediatric Intensive Care Unit
ICU: intensive Care Unit
MUAC: Mid upper Arm circumference
MAMC: mid arm muscle circumference
TSF: triceps skin fold
ICP: Intracranial Pressure
KNH: Kenyatta National Hospital
GOS: Glasgow Outcome Score
CVA: Cerebrovascular Accident
SD: standard deviation
IQR: interquartile range
TEN: total enteral nutrition
TBI: traumatic brain injury
CT scan: computer tomography scan
ASPIN: American Association of Parenteral and Enteral Nutrition.
SUMMARY
This study was designed to describe the socio-demographic characteristics of patients with severe head injury at the Kenyatta National Hospital, time taken to achieve total enteral nutritional (TEN) support and factors that influence the achievement of TEN support in these patients. This is a prospective analysis of all patients with severe head injury, who qualified for TEN support, admitted at the KNH between December 2013 and March 2014. Data on socio-demographic characteristics, CT scan findings, initiation of feeds, blood glucose levels, gastric intolerance symptoms and duration taken to achieve TEN was collected using a questionnaire administered to the patients who met the inclusion criteria. The data collected was entered and analyzed using Statistical Package for Social Sciences (SPSS) for Windows® version 21.0
A total of 43 patients managed at the Kenyatta National hospital with severe head injury qualified to be included in the study. More than eighty three percent of the patients (83.7%) were males and sixteen percent (16.3%) were females, Male: Female ratio 6:1. Most of the patients (over 80%) were below the age of 40 years. All the patients were fed via enteral route, with the initiation of enteral feeding initiated within 48 hours of trauma in 83.7% of the patients. TEN supports was achieved within 4 days in 97.6% with majority (67.4%) between 48 and 96 hours. None of the patients with gastric intolerance achieved TEN support within 48hours whilst amongst those without gastric intolerance 32.5% achieved TEN support within 48 hours.
83 % of the patients with abnormal blood sugar levels on day 1 achieved TEN support after 48 hours a whilst 63% with normal blood sugar levels on day 1 achieved TEN support within 48 hours.

25% of patients with low GCS score (4-6) achieved TEN support within 48 hours compared to 34.7% of the patients with high GCS score (7-8) who achieved TEN support within 48 hours. Patients with Marshall type III and IV lesions took more than 48 hours to achieve TEN support (73.7% and 63.2% respectively)
Patients with gastric intolerance, deranged blood glucose levels, abnormal CT scan findings and low GCS scores took longer to achieve TEN support although this was not found to be statistically significant.
INTRODUCTION

Worldwide severe head injury is a leading cause of mortality and permanent disability. In USA 1.4 million cases are reported each year with 50,000 deaths and 235,000 are admitted yearly. The ages mostly affected are <5 years, 15-24 years and >70 years with a mortality rate of up to 30% yearly.\(^{(1)}\)

Masson et al in his study on epidemiology of severe brain injury found an incidence of 17.3 per 100,000 population.\(^{(27)}\)

In Kenya, severe traumatic brain injury accounts for 10.3% of all brain injuries seen at the Kenyatta National Hospital and 14.3% of all adults admitted at the Critical Care Unit.\(^{(28)}\) It’s associated with morbidity of 13.9% and mortality of 1% in children while in adults the mortality is up to 56.2%.

Individuals sustaining traumatic brain injury are at great risk of developing nutrition related complications due to primary and secondary injury cascade that ensues hence its importance in the recovery of the head injured patient.

Provision of optimal nutritional support to head injury patients is complex due to alteration in metabolism.

Brain injury has been shown to stimulate stress hormones and cytokine release which increase cardiac output, metabolic rate and oxygen consumption hence increasing caloric requirements. The degree of hypermetabolism is proportional to severity of head injury hence the need for adequate nutrition support for patients with severe head injury.

Increase in stress hormones contribute to catabolism which leads to increased weight loss, muscle wasting and gluconeogenesis.

Hypercatabolism seen in head injury is associated with impaired wound healing, hyperglycemia, increased infections and multiple organ failure.

Resting energy expenditure of head injured patients is estimated at around 40-200% above normal requirements. Sedation, paralyzing and use of barbiturates reduce the energy expenditure hence giving 140% of the estimated energy expenditure is advised.\(^{(29)}\)

Lack of adequate nutrition in patients with severe head injury results in 15% estimated weight loss per week.\(^{(3)}\)

To prevent excessive muscle wasting due to protein breakdown, adequate nutrition is required to balance the increased energy expenditure caused by the head injury. There is data that nutritional support can prevent the loss of immune competence and decrease morbidity, mortality and length of hospital stay associated with head injury.\(^{(4)}\)
Enteral nutrition is recommended to patients who are not expected to be taking full oral diet within 3 days \(^{(23)}\). American Association of Parenteral and Enteral Nutrition (ASPEN) recommend early enteral nutrition that is within 48 hours as it stalls catabolism allowing the body to recover \(^{(14)}\). In his study on prognostic significance of timing of total enteral feeding in traumatic brain injury patients Sivashanmugam et al found unfavorable outcome was associated with achievement of total enteral feeding > 3 days and even worse if achieved > 7 days after injury\(^{(11)}\).

Adequate delivery of enteral feeds is influenced by severity of injury, impaired swallowing and gastrointestinal functionality. These factors impair early achievement of total enteral nutritional support hence having an impact on the recovery of the patient.

**LITERATURE REVIEW**

Provision of adequate nutrition support for patients with severe TBI has been a clinical challenge for decades. The primary and secondary injuries create a unique metabolic derangement along with accompanying issues such as optimal timing and route of administering of the nutrients. Emphasizing the priority of early nutrition support within a multi-disciplinary team may be the critical key for successful provision and tolerance of nutrition support in the severe TBI population. Various studies have been done on nutritional support and severe traumatic brain injury.

Route of feed administration is still a contentious issue with various studies giving contradicting information. The American Association of Parenteral and Enteral Nutrition recommend use of enteral route. This is also supported by the European Society of Parenteral and Enteral Nutrition. \(^{(14, 23)}\)

Yung Chiang in his study on early enteral nutrition and clinical outcomes of severe TBI patients found an 89% survival in patients on EN compared to non enteral. Xiang Wang in his meta analysis found parenteral nutrition being better than enteral nutrition in reducing mortality and positively affecting outcome. \(^{(8, 17)}\)

Borzotta et al found that both routes of administration were equally effective in meeting their nutrition goals and infection rates were at similar levels in both routes. The only difference noted was the increase in hospital costs. \(^{(18)}\)

Gramlich et al in their Meta analysis comparing parenteral versus enteral route found that enteral route had a significant decline in infectious complications as compared to parenteral
but there was no difference in mortality rate noted. Parenteral nutrition was also associated with hyperglycemia.⁽²¹⁾ American association of Parenteral and Enteral Nutrition (ASPEN) recommends early enteral feeding (within 48 hours) as this slows protein breakdown and utilization of fat reserves, mitigates the innate inflammatory response, improves immunity, causes a decline in ICU infections and may improve neurological outcome. This was supported by the European Society of Parenteral and Enteral Nutrition⁽¹⁴,²³⁾ Brain Trauma foundation recommends initiation of feeds within 72 hours of injury.⁽¹⁾ Duration taken to achieve total enteral nutrition support varies. Aaron Cook et al in their review on nutrition consideration in traumatic brain injury recommends feeding to goal within 2-3 days as it slows protein and fat breakdown, enhances immunity, reduce ICU infections and improves neurological outcome at 3 months. They also noted that delay in initiation of nutrition leads to malnutrition and weight loss which increases ICU length of stay and impairs ambulation hence exposing patient to immobility complications including pressure sores.⁽²²⁾ This is in contrast to level II guidelines from brain trauma foundation indicating injured patients should achieve total caloric replacement by day 7 bringing confusion as to when is the ideal time to achieve total caloric replacement⁽¹,¹⁴⁾ Norton et al in their study on intolerance to feeding in the brain injury patient noted full caloric replacement occurred in a mean duration of 11.5 days with only 30.4% having achieved this goal within 7 days.⁽³⁷⁾ Hartl et al in their study on effects of early nutrition on deaths due to severe traumatic brain injury found out that 61% patients were fed between day 1-3 and this was associated with declining mortality rate compared to those who did not feed within days (6.3-7.6%).similar findings are seen in the study by Cote et al in their retrospective study on nutritional support in severe traumatic brain injury where they found 88.1% were fed within 3 days⁽¹²,¹³⁾ Early initiation of nutrition therapy was associated with achievement of nutritional goals in caloric measures by day 7 as shown by Malakouti et al in their retrospective review on nutrition support and deficiencies in children with severe TBI and reduction in the length of stay in ICU, patient improvement and early discharge from hospital hence reducing morbidity and hospital costs as shown by Taha et al in their retrospective study on effect of early nutritional support in children with severe TBI.⁽⁹,¹⁰⁾ There is need to engage a nutritionist to ensure adequate amount of kilocalories, proteins and mineral ions are given.⁽¹⁰⁾ Sivashanmugan et al in their study on prognostic significance of timing of total enteral feeding in TBI noted increased mortality in patients with severe head injury who were not
fed within days. This was supported by Hartl et al while Xiang Wang in his Meta analysis on studies done on nutrition support for patients sustaining TBI recommended early feeding as it was associated with reducing mortality among patients with traumatic brain injury. (13,17,11)

To aid in quick recovery of patients with severe traumatic brain injury, adequate nutrition is required post injury to counteract hypermetabolism. Ghajar et al in his review of nutritional considerations in clinical treatment; the perspective of a neurosurgeon, found out that feeding initiated within 5 days had an independent effect of reducing mortality(15)

Increasing amount of nutrition supplements was associated with reducing mortality as shown in Hartl et al study that found 6.3% and 7.6% mortality in patients fed >

25kcal/Kg within 5 and 7 days respectively. This was in comparison to the high 2 week mortality observed in patients who were not fed within days(13)

Nutrition considerations in TBI published by ASPEN states that underfeeding these patients have deleterious effects including impaired wound healing and immunity affecting recovery of the patient.(14)

Timing of administration of feeds is noted to have an impact on outcome of these patients. Sivashanmugam et al in their study on prognostic significance of the timing of total enteral feeding in traumatic brain injury found 80% fed earlier than 3 days had favorable outcome compared to 43% of those fed >3 days. There was a decline in nutritional status in correlation to delay in achieving total enteral feeding with a decline in MAC, MAMC and serum albumin. Roberts et al in her retrospective study found a reduction in length of stay in ICU in those fed within 3 days than those fed > 3 days (26)

To achieve full benefits of nutrition support in patients with severe TBI, the body’s energy requirements ought to be met. European Society of Parenteral and Enteral Nutrition recommend 25-30kcal/kg desirable weight/ day with proteins ranging from 1.5-2g/kg desirable weight/day. (29)

Enteral feeding has its challenges related to deglutition, severity of head injury and gastrointestinal tract functionality. Mackay et al in their study on factors affecting oral feeding with severe TBI found that GCS 3 -5, ventilation time > 15 days, CT scan showing midline shift, brainstem involvement, brain pathology requiring surgery were associated with impaired swallowing, aspiration, delay in initiation and achievement of total enteral nutritional support. (31)
McClave et al in their study on enteral tube feeding in ICU: factors impeding adequate delivery found that most patients were being underfed achieving an average of 51.6% of their nutritional goals due to inadequate feeds prescription by the physicians and inappropriate cessation of feeds when intolerance was suspected. Residual volume of > 200mls was seen in 2.8% yet 83.7% of patients’ feeds were stopped. ASPEN recommends gastric residual volume be assessed every 4hours and avoiding stopping infusion of feeds if residual volumes are < 500mls with no other signs of gastric intolerance.

Canadian clinical practice guidelines for nutrition support in mechanically ventilated, critically ill adult patients recommended EN to be started within 24-48 hours, patients nursed in a semi recumbent position, use of a feeding plan that accommodates higher levels of residual volumes and lessening failure of enteral feeding by head elevation.

Gastric intestinal complications reduce nutrient intake putting the patient at risk of under nutrition. This was shown in a study done by Montejo et al on enteral nutrition related gastrointestinal complications in critically ill patients: a multicenter observation which found 62.8% of the patients had one or two complications which included 39% high gastric volumes, constipation 15.7%, diarrhea 14.7%, abdominal distension 13.2%, vomiting 12.2%and 5.5% regurgitation. These complications seem to have an impact on length of stay in ICU and increased patients mortality.

Cote et al found gastric intolerance in 49.5% patients impeding adequate nutrition. This was commonly seen in patients who were young, had raised ICP and those who did not use prokinetics. Naomi Cahill found gaps in her observational study on nutrition therapy in critical setting which included delay in initiating enteral feeding averaging at 46.5hours, failure to use motility agents as seen only 58.7% used them and small bowel feeding in patients with high gastric volumes seen in 14.7% patients.

The study by Linda Ott on altered gastric emptying in the head injured patient in relation to feeding intolerance noted patients with rapid or normal gastric emptying tolerated full caloric replacement significantly earlier than those with delayed gastric emptying. (8.5 days vs 13.7 days)

Impaired glucose control in critically ill has been shown to be associated with enteral intolerance. Hyperglycemia is known to impair gastric emptying and enhance gastroparesis. ASPEN recommends maintaining blood glucose levels between 110 and 150mg/dl when administering nutrition.

Glasgow coma score is used to evaluate neurological status of patients with severe head injury and aids in noting improvement of these patients during their care. Byron et al found in
his study on effect of nutritional support on outcome from severe head injury a mean four point increase in GCS in patients on TPN and a three point increase in those on EN while Rapp et al in his study on favorable effect of early parenteral feeding on survival in head injured patients found no difference in those on TPN and EN\(^6,7\)

Nutrition assessment of severe head injury patients in intensive care unit is challenging. Body weight changes in ICU reflect fluid shifts hence not a good measure. Anthropometric measures like tricep skin fold thickness and mid arm muscle circumference have been noted to be of value to the overall clinical plan. Ravasco et al in their review article on critical approach to nutritional assessment in critically ill

Patients found mid arm circumference (MAC) simple, easy to use in prognostication of these patients\(^{24}\). This was also supported by Christman et al in their review paper that outlined that triceps skin fold estimates fat stores while mid arm muscle circumference estimates lean body mass hence adequate in nutritional evaluation of the critically ill.\(^{25}\). Total proteins depict nutrition status while serum albumin is a marker of visceral protein anabolism and an accurate tool in assessing sepsis and infection hence an excellent biochemical markers in nutrition assessment\(^{20,11}\)
JUSTIFICATION OF STUDY
Severe head injury is a major cause of disability, death and economic cost. It accounts for 10.3% of all head injuries seen at KNH. It’s associated with hypermetabolism increasing energy expenditure hence the need for adequate nutrition support. This study will determine time of initiation and achievement of total enteral nutrition and identify factors that influence the achievement of total enteral nutritional support in patients with severe. The results of this study will help in improving patient management.

PROBLEM STATEMENT
The factors that influence the achievement of total nutrition support in severe head injury among our patients is unknown yet nutrition is a key component in meeting the demands of hypermetabolism among these patients. There is need to identify and document to improve in patient management.
OBJECTIVES

MAIN OBJECTIVE
The main objective was to identify factors that determine the achievement of total enteral nutritional support in patients with severe traumatic brain injury at the Kenyatta National Hospital.

SPECIFIC OBJECTIVES
The specific objectives were

1. To determine average duration of time taken to achieve total enteral nutritional support.
2. To correlate gastric intolerance with achievement of total nutritional support in patients with severe TBI.
3. To correlate blood glucose levels with achievement of total enteral nutritional support with severe TBI.
4. To correlate post-resuscitation CT scan findings, and hence degree of severity of TBI, with the achievement of total enteral nutritional support.
MATERIALS AND METHODOLOGY

STUDY AREA
The study was conducted at the Kenyatta National Hospital (KNH) the main teaching hospital for University of Nairobi at the following units
- Neurosurgical unit ward 4c and its intensive care unit.
- Main Intensive Care Unit.
- Emergency ward in the accident and emergency department.
- Acute room at the accident and emergency department.

STUDY POPULATION
This composed of all patients who met the inclusion criteria and were considered to have severe head injury with a Glasgow coma score of 4-8. A total of 43 patients were included.

STUDY DESIGN
A four month prospective study was conducted between December 2013 to March 2014.

SUBJECTS
The patients admitted with severe head injury were aged between 3 and 60 years and were followed up till they achieved total enteral nutrition.
STUDY OUTLINE

Care of patients
Standardized care was offered to all patients who were admitted into the study. They were mechanically ventilated and nursed with head elevated 30-45 degrees to aid in control of ICP but also prevent reflux of feed. Fluids and electrolytes were monitored with decision regarding surgical decompression being based on computer Tomography scans and tailored to the individual patient’s findings.

Medication
Patients were started on mannitol 0.5g/kg to reduce intracranial pressure, ceftriaxone 50mg/kg in case of open wounds or post surgery and phenytoin loaded with 15-20mg/kg(in case of presence of seizures) then maintained at 5mg/kg for seizure prophylaxis.

Feeding
Enteral feeding was initiated either via nasogatric tube or orogastric tube while observing patient’s tolerance. Patients were given fresubin fibre original, a commercial feed available at the hospital. Fresubin 1 litre contains 1000 kcal and 38g protein, 138g carbohydrates, 34g Fat, 20g, and 840mls of water.

Target energy requirements were calculated at 25kcal/kg /day at a rate of 140% to accommodate hypercatabolism seen in severe TBI.

Total kilocalories required per day was calculated and divided by 24hours to determine maximum feeds to be given hourly to achieve the energy requirements.

Due to difficulty in measuring weight in adults, ideal weight was calculated using the Robinson formula as follows.

Men: ideal body weight (in kilograms) = 52kg + 1.9kg for each inch over 5 feet.
Women: ideal body weight (in kilograms) = 49kg +1.7kg for each inch over 5 feet

Date of initiation of nutrition support and duration taken to achieve total enteral nutrition was documented.

Total enteral feeding was considered achieved when the patients received at least 25kcal/kg body weight per day and 1.5g/kg body weight of protein.
Assessing tolerance or intolerance of feeds

Gastric intolerance was assessed clinically by checking gastric residual volume every four hours post feeding by suctioning stomach contents with a 50cc syringe and amount measured. Evaluation also included checking for presence of bowel sounds, adequate opening of normal bowels every 24 hours, vomiting, abdominal distension and diarrhea. Blood glucose levels was measured every 24 hours and correlated with tolerance or intolerance of the patients to the administered feeds.

CT scan findings

Post-resuscitation CT scan of the brain was done in the accident and emergency department of the Kenyatta National Hospital on admission of the patient to identify the severity of TBI. This information was correlated with the time taken to achieve total enteral nutritional support. CT scan findings were classified using the Marshall CT classification as shown below

MARSHALL CT CLASSIFICATION OF SEVERE TBI

<table>
<thead>
<tr>
<th>Diffuse Injury Grade</th>
<th>CT appearance</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Normal CT scan</td>
<td>10%</td>
</tr>
<tr>
<td>II</td>
<td>Cisterns present. Shift &lt;5mm</td>
<td>14%</td>
</tr>
<tr>
<td>III</td>
<td>Cisterns compressed/absent. Shift &lt; 5mm</td>
<td>34%</td>
</tr>
<tr>
<td>IV</td>
<td>Shift &gt; 5mm</td>
<td>56%</td>
</tr>
</tbody>
</table>


Study end point

The end of study per patient was defined as the point the patient achieved total enteral nutrition.

Comparison was done on timing taken to achieve total enteral nutrition and the CT scan findings, observed random blood sugar levels and patients with gastric intolerance vis a vis the patients without.
**INCLUSION CRITERIA**
Patients aged 3-60 years with severe traumatic brain injury with GCS 4-8 admitted within 24 hours of injury.
Patients whose relatives gave informed consent.
Patients with computer tomography scan of the brain taken at admission

**EXCLUSION CRITERIA**
Patients with a GCS <4 or > 8 at admission.
Patients with previous neurological disorders and associated deficits e.g CVA patients with hemiparesis.
Patients with associated co morbid illnesses e.g renal disease, diabetes mellitus,
Patient at risk of non occlusive bowel disease

**SAMPLE SIZE**
All patients with severe head injury admitted at the Kenyatta National Hospital from December 2013 to March 2014 who met the inclusion criteria formed the sample size for this study. Using masson et al who found 17.3 patients per 100,000 had severe head injury\(^{(27)}\)

\[
Z^2 \times (p) \times (1-p) \\
\frac{\sqrt{c}}{c^2}
\]

Where:

\[ Z = Z \text{ value (1.96 for 95% confidence level)} \]
\[ p = 0.0173 \]
\[ c = \text{confidence interval, 0.05} \]

sample size is 26 round off to 30
ETHICAL CONSIDERATIONS

-Permission to carry out the study was obtained from the Kenyatta National Hospital Ethical and Research Committee

-Informed consent was given by the next of kin

-The usual care and evaluation of procedures was followed.

-Those that decline to give consent were not discriminated.

-Confidentiality with each client was maintained.

-There was no harm for patients who participated in this study.
DATA COLLECTION

The principal investigator reviewed all patients who were admitted with severe head injury. The bio data, hospital number, date and time of admission, Glasgow coma score, route and timing of administration of feeds, time of initiating feeds, blood glucose levels, CT scan findings, timing taken to achieve total enteral nutrition were entered in the questionnaire

DATA ANALYSIS

Analysis was done in consultation with a statistician using the statistical package for social Sciences (SPSS) version 21.

All variables were summarized and presented as proportions for categorical data and mean with standard deviation for blood glucose levels. Associations were done between achievement of TEN and other categorical variables using Chi square test or Fisher’s exact test where appropriate. Mean blood glucose levels were compared between two groups using student’s t test. All statistical tests were significant at a p value of 0.05.

STUDY LIMITATIONS

1. Being a hospital based study the results cannot be generalized to population
2. Death of the patients prior to achievement of total enteral nutrition from their injuries.
RESULTS

A total of 43 patients managed at the Kenyatta National hospital with severe head injury who met the inclusion criteria were included in the study. 83.7% of the patients were male while 16.2% were female. 55.8% were patients aged between 21-35 years with those aged between 31-35 years being the most at 25.6%. The commonest cause of injury was road traffic accident at 41.8% with majority of the patients being pedestrians (72.2%). All the patients were fed via enteral route with initiation of feeds being done within 48 hours in 83.7%. Total enteral nutrition was achieved in 48-96 hours in 67.4% of the patients. Individuals with gastric intolerance all achieved TEN >48 hours later as compared to those without gastric intolerance where 32.5% achieved within 48 hours while 67.5% achieved > 48 hours later. 83% of the individuals with abnormal blood sugar level on day 1 achieved TEN > 48 hours later compared to 63% with normal blood sugar on day 1. 25% of patients with lower GCS (4-6) achieved TEN within 48 hours compared to 34.7% among patients with higher GCS (7-8). Majority of the patients had diffuse injury III and evacuated mass lesion and most took >48 hours to achieve TEN (73.7% and 63.2% respectively).

SOCIO-DEMOGRAPHIC CHARACTERISTICS

Figure 1: distribution of patients according to gender

Distribution according to gender was determined among the 43 patients with severe head injury. Most of the patients were male 37 representing 83.7% while female were 6 representing 16.3%. The male: female ratio was 6:1.
The distribution of patients with severe head injury according to age is as shown above. Majority of the patients were aged between 21 and 35 years representing 55.8%. The commonest age bracket was 31-35 years representing 25.6%, followed by 21-25 years at 18.6% and 26-30 years at 11.6%. 11-15 years, 50-55 years and 56-60 years were least represented at 2.3% per age bracket.

**Table 1: time of onset and time of achievement of total enteral nutritional support in severe tbi patients at the Kenyatta National Hospital**

<table>
<thead>
<tr>
<th>TIME (HRS)</th>
<th>START TIME OF TEN SUPPORT</th>
<th>ACHIEVEMENT OF TEN SUPPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 24</td>
<td>24-48</td>
</tr>
<tr>
<td>NO OF PATIENTS</td>
<td>9</td>
<td>27</td>
</tr>
<tr>
<td>%</td>
<td>20.9</td>
<td>62.8</td>
</tr>
</tbody>
</table>

Initiation of TEN support was only possible within 24 hours in 20% of the patients. In majority of the patients (63%) TEN support was possible between 24-48 hours and only in a small proportion (16%) was this possible after 48 hours. Full TEN support was achieved in nearly 70% of the patients (67.4%) within 96 hours.
Table 2: gcs score, marshall score and age distribution in relation to time of achievement of ten support.

The difference between the numbers of patients who achieved TEN support within 48 hours

<table>
<thead>
<tr>
<th>Time of Achievement of TEN support</th>
<th>GCS Score</th>
<th>Marshall Score</th>
<th>Age Distribution (Yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;48 hrs (n=13)</td>
<td>3-4 5-6 7-8</td>
<td>1 2 3 4</td>
<td>&lt;30 30-40 &gt;40</td>
</tr>
<tr>
<td></td>
<td>0 5 8</td>
<td>1 0 5 7</td>
<td>4 6 3</td>
</tr>
<tr>
<td>48-96 hrs (n=29)</td>
<td>3-4 5-6 7-8</td>
<td>1 2 3 4</td>
<td>&lt;30 30-40 &gt;40</td>
</tr>
<tr>
<td></td>
<td>4 10 15</td>
<td>3 1 14 11</td>
<td>4 6 3</td>
</tr>
<tr>
<td>&gt;96 hrs (n=1)</td>
<td>3-4 5-6 7-8</td>
<td>1 2 3 4</td>
<td>&lt;30 30-40 &gt;40</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1 1</td>
<td>1 1</td>
</tr>
</tbody>
</table>

(n=13) and those who achieved TEN support between 48 and 96 hours (n=29) was statistically significant: within 48 hours, 30.2% (95% CI 17.2-46.1%) while between 48 and 96 hours, 64.7% (95% CI 51.5-80.9%). There was a significantly higher number of patients who achieved TEN within 48 to 96 hours compared to those who achieved earlier than 48 hours.

However there was no correlation between the time of achievement of TEN support (<48hrs and 48-96 hrs) and the admission GCS score and Marshall score:

There was a negative correlation between TEN and GCS, pearson correlation coefficient, r=-0.148 (95% CI -0.459 – 0.163), p=0.343. This means a higher GCS score was not associated to a lower duration taken to achieve TEN.

There was also a negative correlation between TEN and the Marshall score findings with a pearson correlation coefficient: r=-0.026 (95% CI -0.146 to 0.094), p=0.664. 13 patients achieved TEN support within 48 hours and 29 between 48-96 hours. Nearly 100% of the patients achieved TEN support within 96 hours.
Table 3: characteristics of patients with gastric intolerance

<table>
<thead>
<tr>
<th>Variables</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age categories</strong></td>
<td></td>
</tr>
<tr>
<td>6-10</td>
<td>1 (33.3)</td>
</tr>
<tr>
<td>16-20</td>
<td>1 (33.3)</td>
</tr>
<tr>
<td>21-25</td>
<td>1 (33.3)</td>
</tr>
<tr>
<td><strong>GSC</strong></td>
<td></td>
</tr>
<tr>
<td>4-6</td>
<td>1 (33.3)</td>
</tr>
<tr>
<td>7-8</td>
<td>2 (66.7)</td>
</tr>
<tr>
<td><strong>Radiological Findings</strong></td>
<td></td>
</tr>
<tr>
<td>Diffuse injury 2</td>
<td>1 (33.3)</td>
</tr>
<tr>
<td>Diffuse injury 3</td>
<td>1 (33.3)</td>
</tr>
<tr>
<td>Evacuated mass lesion</td>
<td>1 (33.3)</td>
</tr>
<tr>
<td><strong>Blood glucose levels</strong></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>1 (33.3)</td>
</tr>
<tr>
<td>Abnormal</td>
<td>2 (66.7)</td>
</tr>
</tbody>
</table>

3 patients had gastric intolerance spread across 3 age categories from 6-25 years with each having different radiological findings. However 66.7% of them had abnormal sugar which likely predisposed them to further delay in achievement of TEN.
None of the three patients who presented with gastric intolerance symptoms which include diarrhea and vomiting achieved TEN within 48 hours in comparison to 32.5% of patients who didn’t have gastric intolerance. This however was not statistically significant (p= 0.542)

### Table 5: blood glucose versus achievement of tens

<table>
<thead>
<tr>
<th>Variable</th>
<th>Within 48 hours</th>
<th>≥48 hours</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1 blood glucose, mean (SD)</td>
<td>6.6 (2.2)</td>
<td>8.4 (3.8)</td>
<td>0.131</td>
</tr>
<tr>
<td>Blood glucose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal</td>
<td>3 (18.8)</td>
<td>13 (81.3)</td>
<td>0.307</td>
</tr>
<tr>
<td>Normal</td>
<td>10 (37.0)</td>
<td>17 (63.0)</td>
<td></td>
</tr>
</tbody>
</table>
Patients who achieved TEN within 48 hours had a lower mean blood glucose on day 1 (6.6 mmol/dl) than those who achieved after 48 hours (8.4 mmol/dl). Fewer patients (18.8%) with abnormal blood glucose (>8.3 mmols) achieved TEN within 48 hours compared to 37% of those who had normal blood glucose levels. This trend was seen though the association was not statistically significant (p=0.307).

Table 6: Glasgow coma score versus achievement of tens

<table>
<thead>
<tr>
<th>Variable</th>
<th>Within 48 hours</th>
<th>≥48 hours</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-6</td>
<td>5 (25.0)</td>
<td>15 (75.0)</td>
<td>0.486</td>
</tr>
<tr>
<td>7-8</td>
<td>8 (34.8)</td>
<td>15 (65.2)</td>
<td></td>
</tr>
</tbody>
</table>
25% of patients with Glasgow coma score of 4-6 achieved TEN within 48 hours compared with 34.8% of patients with a GCS OF 7-8. A trend is seen however this was not statistically significant (p=0.486)

Table 7: CT scan findings versus achievement of tens

<table>
<thead>
<tr>
<th>Variable</th>
<th>Diffuse injury 1</th>
<th>Diffuse injury 2</th>
<th>Diffuse injury 3</th>
<th>Evacuated mass lesion</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement of TEN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within 48 hours</td>
<td>1 (25)</td>
<td>0 (0.0)</td>
<td>5 (26.3)</td>
<td>7 (36.8)</td>
<td>0.728</td>
</tr>
<tr>
<td>≥48 hours</td>
<td>3 (75)</td>
<td>1 (100)</td>
<td>14 (73.7)</td>
<td>12 (63.2)</td>
<td></td>
</tr>
</tbody>
</table>
more patients with diffuse injury III and evacuated mass lesion took longer (> 48 hours) to achieve TEN,(73.7% and 63.2% respectively) compared to those who achieved within 48 hours, (26.3% and 36.8% respectively). However this was not statistically significant. P=0.728.
DISCUSSION

Brain injury has been shown to stimulate stress hormones and cytokine release which increase cardiac output, metabolic rate and oxygen consumption hence increasing caloric requirements. The degree of hyper metabolism is proportional to severity of head injury hence the need for adequate nutrition support for patients with severe head injury.

Increase in stress hormones contribute to catabolism which leads to increased weight loss, muscle wasting and gluconeogenesis.

Delayed caloric replacement is associated with increased morbidity and mortality probably due to effects of under nutrition. There is need to identify factors influencing total caloric replacement in severe head injury to be able to address them and their attendant complications.

Early enteral feeding is advocated for as it slows protein breakdown and fat reserves and mitigates innate inflammation.\(^{(14)}\)

All the patients in our study were fed via the enteral route as recommended by ASPEN. 83.7% of the study patients were fed within 48 hours with only 16.3% being fed > 48 hours later. This compared well with Cook et al who advocated for early enteral nutrition (within 48 hours) and brain trauma foundation guidelines (within 72 hours post injury).

Hartl and malakouti in their studies also noted early initiation in 61% and 82% patients respectively was an independent factor affecting mortality.\(^{(13,9)}\)

Up to 97.6% of our study patients achieved total enteral nutrition support within 4 days with majority at 67.4% achieving within 48-96 hours, 30.2% within 48 hours and 2.3% > 4 days. This was in keeping with Cook et al recommendations of feeding to goal within 2-3 days.

Majority of the other studies showed longer duration of time taken to achieve TEN. Sivashanmugam who reported only 12.6% achieving TEN within 3 days, 57.4% within 4-7 days and 32.6% > 7 days. Norton et al found only 30.4% achieved within 7 days with a mean duration from injury to giving full strength, full rate enteral feeding being 11.5 days.\(^{(11)}\)

Hartl noted 62% never achieved 25 kcal/kg/day within 7 days while Kirby et al showed a total caloric intake within a mean of 6.8 days\(^{(13)}\) brain trauma foundation level II guidelines advocate for full attainment caloric replacement by day 7 post injury\(^{(1)}\)
This study shows early achievement of TEN within 4 days in the Kenyan black population encouraging judicious feeding among patients with severe head injury as this may probably have an impact on the patients’ outcome.

7% of the patients in this study experienced gastric intolerance having developed vomiting and diarrhea and none of these attained TEN support within 48 hours compared to 32.5% without gastric intolerance who achieved within 48 hours.

Cote et al found gastric intolerance to be the most common factor associated with unsuccessful nutrition in 49.5%. Brenno Belazi et al also noted a significant number of patients with severe head injury could not tolerate feeds within the first two weeks. (12, 29)

The Eastern Association for the Surgery of Trauma in their review on timing of nutrition support noted enteral feeding being a challenge in severe head injury. Only

1/3 of the patients achieved feeds tolerance within 7 days and this was due to high gastric volumes and gastroparesis. (39)

Ott et al in their study on altered gastric emptying in head injured patient and relationship to feeding intolerance noted patients with rapid or normal gastric emptying tolerated full caloric replacement significantly earlier than those with delayed gastric emptying. (8.5 days vs 13.7 days p = 0.001) (38)

This clearly shows gastric intolerance has a significant role in achieving TEN hence this should be judiciously observed and mitigated to improve feeds tolerance.

Severity of head injury as depicted by CT scan findings affects achievement of total caloric replacement. In this study Marshall type III and IV lesions were the commonest CT scan findings at 44.2% each and being the most severe, it was noted these patients took longer to achieve TEN (> 48 hours) at 73.7% and 63.2% respectively. Similar observations have been made by Mackay et al in patients with abnormal CT scans findings (midline shift, brainstem injury or intracranial bleeds) who had significantly long intervals between initiation of TEN and achievement of total TEN support. (31)

Low Glasgow coma score has been show to influence achievement of full caloric replacement in patients with severe head injuries. Mackay et al noted individuals with more severe brain injury had a significant increased percentage of abnormal swallowing and took double the time from initiation to achievement of TEN (GCS 3-5 took 26.5 +/- 32.4 days while those with GCS 6-8 took 10.3+/- 6 days). (31)

Norton et al also found a significant association between low GCS score and number of days taken to achieve TEN. (37)
In this study, 75% of the individuals with low GCS (4-6) took longer to achieve TEN (> 48 hours) compared with 65.2% with GCS 7-8, however this difference was not statistically significant (p=0.486).

Fewer patients with abnormal blood glucose levels (18.8%) achieved TEN within 48 hours in comparison to 37% with normal blood glucose levels. This correlates with ASPEN recommendations that impaired glucose rate are associated with enteral intolerance by impairing gastric emptying and promoting gastroparesis hence take longer to achieve TEN\(^{29}\).
CONCLUSION

1. Early initiation of enteral feeding within 48 hours was documented within 83.7% of the patients.

2. Achievement of total enteral nutrition support was shown within 4 days in 97.6% encouraging timely feeding in patients with severe head injury.

3. Gastric intolerance, abnormal glucose levels, severe CT scan findings and low Glasgow Coma Score was associated with delay in the achievement of total enteral nutritional support however this was not statistically significant.
RECOMMENDATIONS

1. Educate all clinicians on ensuring all severe head injury patients receive timely nutritional support as achievement of TEN is within 4 days and this may have an impact on infection complications, length of stay in ICU and outcome.

2. Documentation of signs and symptoms of gastric intolerance is of necessity to identify patients at risk. Reduction of feeds in the patients with gastric intolerance is a safer option to allow gut acclimatization of feeds while patient still receives feeds. Cessation of feeds is not encouraged and use of anti emetics to reduce vomiting and enhance tolerability is also recommended.

3. Patients with abnormal CT scan findings necessitating surgery should have it done immediately to reduce factors slowing achievement of TEN.

4. Maintaining blood glucose levels < 8.3mmol/l in patients with severe head injury to achieve faster TEN. Patients with higher blood sugar levels, change of feeds to diabetogenic feeds or administration of insulin to reduce glucose levels hence encouraging reaching full caloric replacement.

5. Adequate staffing of doctors, nurses and nutritionists in health facilities by the county governments to further enhance early recommendation and initiation of feeds in critically ill patients hence improving their overall outcome.
REFERENCES


15. Jamshid Ghajar et al, nutritional considerations in clinical treatment; the perspective of a neurosurgeon. Journal of nutrition, Trauma and the Brain


32. McClave, Stephen A. MD; Sexton, Leslie K. RPh; Spain, David A. MD; Adams Joyce L. BA; Owens, Nancy A. RD; Sullins, Mary Beth RD; Blandford, Barbara S. RD; Snider, Harvy L. MD. Enteral tube feeding in ICU. Factors impeding adequate delivery. Critical Care Medicine. July 1999 : 27; 7 1252-1256.


INTRODUCTION
I am conducting a study on factors affecting proper and adequate feeding in patients with severe brain injury at the Kenyatta National Hospital. The purpose of this study is to determine duration taken to achieve this and any associated impeding factors that slowed achieving this goal.

PROCEDURE.
The weight of the patient will be calculated and used to determine amount of food that is adequate for the patient. The amount of food will be increased gradually till the expected amount per patient is achieved without intolerance.

Blood glucose levels will be checked daily till end of study when the patient has achieved adequate nutrition.

Duration of time taken to achieve proper and adequate feeding will be recorded. This will be compared with the gastric intolerance signs (vomiting, diarrhea and bloating), computer tomography scan of the brain findings and blood glucose levels to see if these affect achievement of proper and adequate feeding.

BENEFITS OF PARTICIPATING IN THIS STUDY
The next of kin will be informed of the condition of the patient, any procedures being undertaken and the results will be interpreted to the next of kin.

RISKS OF PARTICIPATING IN THE STUDY
No risk whatsoever will be incurred by either the patient or the next of kin. The next of kin can decide to have their patient discontinued from the study and no consequences will be incurred as the patient will continue receiving primary care from the institution.
CONFIDENTIALITY.
All information collected from the next of kin or the patient’s file will be kept under lock and key in the Department of Surgery and will not be availed to the public unless consent is obtained from the patient or their next of kin.

NEXT OF KIN APPROVAL.
I ……………………………………………………………………. Being the next of kin to (patient’s initials)……………… do hereby give consent for my patient to participate in the above study. The procedure, benefits and risks have been explained to me by the principal investigator to the best of my knowledge and I have no concerns whatsoever.

NEXT OF KIN………………………………………………………….
DATE & SIGNATURE………………………………………………
INVESTIGATOR……………………………………………………..
DATE & SIGNATURE………………………………………………

PROBLEMS OR QUESTIONS:
If you ever have any questions or concerns about the study or about the use of the results you can contact the principal investigator, Dr Shitsama Sylvia V. by calling 0722-347814. If you have any questions on your rights as a research participant, you can contact the Kenyatta National Hospital Ethics and Research Committee (KNH- ESRC) by calling 2726300 Ext. 44355.
APPENDIX II: QUESTIONNAIRE

DATE: -----------------------

NAME INITIALS: ----------------------

AGE: 3-5 (--), 6-10 (--), 11-15 (--), 16-20 (--), 20-25 (--), 26-30 (--), 31-35 (--), 36-40 (--), 41-45 (--), 46-50 (--), 51-55 (--), 56-60 (--)

GENDER: M (----) F (----)

TYPE OF INJURY
- ROAD TRAFFIC ACCIDENT (---)
  - PASSENGER/DRIVER (---)
  - PEDESTRIAN (---)
- ASSAULT (---)
- FALL FROM HEIGHT (---)
- WORK INJURIES (---)
- ACCIDENTAL INJURIES (---)
- CHILD ABUSE (---)

NEUROLOGICAL EXAM
- GLASGOW COMA SCALE
  MOTOR (----) VERBAL (----) EYE OPENING (-----)
  TOTAL (----------)

-PUPIL SIZE AND REACTION TO LIGHT RIGHT LEFT
  SIZE (------) (------)
  LIGHT REACTION (------) (------)

-RADIOLOGICAL FINDINGS-
DIFFUSE INJURY I--------
DIFFUSE INJURY II--------
DIFFUSE INJURY III--------
DIFFUSE INJURY IV--------
IDEAL WEIGHT
-----------------------------------------------------------------------------------------------

HEIGHT IN INCHES
-----------------------------------------------------------------------------------------------

34
ROUTE OF FEEDING
- ENTERAL
- PARENTERAL

INITIATION OF NUTRITION SUPPORT

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>WITHIN 24 HOURS</td>
<td></td>
</tr>
<tr>
<td>24 – 48 HOURS</td>
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<td>&gt;48 HOURS</td>
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DAILY FEEDING CHART

<table>
<thead>
<tr>
<th>Energy Requirements per Day</th>
<th>Expected</th>
<th>Given</th>
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<tbody>
<tr>
<td>Day 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 3</td>
<td></td>
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ACHEIVING TOTAL ENTERAL NUTRITION

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>WITHIN 48 HOURS</td>
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</tr>
<tr>
<td>48-96 HOURS</td>
<td></td>
</tr>
<tr>
<td>&gt;96 HOURS</td>
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</table>

GASTRIC INTOLERANCE NOTED
YES ..............
NO ...............

SIGNS OF GASTRIC INTOLERANCE

<table>
<thead>
<tr>
<th>Symptom</th>
<th></th>
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<tbody>
<tr>
<td>GRV &gt; 500MLS</td>
<td></td>
</tr>
<tr>
<td>DIARRHEA/VOMITING</td>
<td></td>
</tr>
<tr>
<td>ABDOMINAL DISTENSION</td>
<td></td>
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<tr>
<td>BOWEL SOUNDS</td>
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</tbody>
</table>

PROKINETIC DRUGS ADMINISTERED
YES ..............
NO ...............
IF ADMINISTERED WHICH TYPES AND DOSING
........................................................................................................................................
........................................................................................................................................
DAILY BLOOD GLUCOSE LEVELS

<table>
<thead>
<tr>
<th></th>
<th>LEVELS MMOLS/L</th>
<th>INCREASE/DECREASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAY 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAY 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
KNH/UON-ERC APPROVAL LETTER

UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
(254-020) 2726000 Ext 44355

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 7263000 9
Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH/ERC/A/390             Link: www.uonbi.ac.ke/activities/KNHUoN

Dear Dr. Vigehe

RESEARCH PROPOSAL: FACTORS INFLUENCING ACHIEVEMENT OF TOTAL ENTERAL NUTRITIONAL SUPPORT IN SEVERE TRAUMATIC BRAIN INJURY AT THE KENYATTA NATIONAL HOSPITAL (P475/09/2013)

This is to inform you that the KNH/UoN-Ethics & Research Committee (KNH/UoN-ERC) has reviewed and approved your above proposal. The approval periods are 2nd December 2013 to 1st December 2014.

This approval is subject to compliance with the following requirements:

a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b) All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH/UoN ERC before implementation.
c) Death and life threatening problems and severe adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH/UoN ERC within 72 hours of notification.
d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH/UoN ERC within 72 hours.
e) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (Attach a comprehensive progress report to support the renewal).
f) Clearance for export of biological specimens must be obtained from KNH/UoN-Ethics & Research Committee for each batch of shipment.
g) Submission of an executive summary report within 90 days upon completion of the study

This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/or plagiarism.

For more details consult the KNH/UoN ERC website www.uonbi.ac.ke/activities/KNHUoN.

"Protect to Discover"
Yours sincerely

PROF. M. L. CHINDIA
SECRETARY, KNH/UoN-ERC

c.c.  Prof. A.N. Guantai, Chairperson, KNH/UoN-ERC
     The Deputy Director CS, KNH
     The Principal, College of Health Sciences, UoN
     The Dean, School of Medicine, UoN
     The Chairman, Dept. of Surgery, UoN
     AD/Health Information, KNH
Supervisor: Prof. N.J. Mwang’ombe, Thematic Unit of Neurosurgery, UoN

"Protect to Discover"