TITLE: CHALLENGES IN OPTIMAL NUTRITIONAL CARE IN CRITICALLY ILL CHILDREN IN PICU - A DEVELOPING WORLD PERSPECTIVE

Principal Investigator:
Dr Adnaan Mustafa
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Department of Paediatrics and Child Health

A research project is conducted to fulfil the requirements to complete the Fellowship in Paediatric Emergency and Critical Care, Department of Paediatrics and Child Health, Faculty of Health Sciences, University of Nairobi.

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STUDENT DECLARATION

This proposal is my original work and has been formulated to meet the requirements of the University's fellowship program in Paediatric Emergency and Critical Care. It has not been presented for award of a Fellowship degree in another institution.

Signature ..... **date**.....21/02/2022.....

Dr Adnaan Mustafa(MB CH B,Mmed Pediatrics)
Dept of child health and paediatrics
University of Nairobi.

Supervisors:

1. Dr Bhupi Reel

Paediatric Intensivist,

University of Nairobi - Department of Paediatrics

Tel: +254722555712

email: bhupireel@gmail.com

Sign _____

2. Dr Rashmi Kumar

Paediatric Intensivist,

University Of Nairobi - Department of Paediatrics

Tel: +254725764831

email: drrash_21@yahoo.com

Sign _____

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List of abbreviations and acronyms

ASPEN - American Society for Parenteral and Enteral Nutrition

EN – Enteral nutrition

ESPNIC - European Society of Pediatric and Neonatal Intensive Care

GRV – Gastric Residual Volume

KMH – Kijabe Mission Hospital

PECCCO – Paediatric Emergency and Critical Care Clinical Officer

PICU - Paediatric Intensive Care Unit

PN – Parenteral Nutrition

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ABSTRACT

In critically ill children, nutritional support remains a glaring challenge in resource-limited settings, which may be a contributor towards poor outcomes in the very sick children managed in the Paediatric Intensive Care Units (PICUs). To develop educational programs and hospital protocols towards optimal nutrition care of the very sick children, knowledge of the current trends, practices and significant challenges becomes the primary need. This study is aimed to review the current practices and challenges to optimal feeding in the ICUs.

We plan to conduct a retrospective study on the feeding patterns of children aged 0 months to 14 years admitted to the Paediatric Intensive Care Unit (PICU) within the first 7 days of admission, at the Kijabe Mission Hospital. Data will be collected using a pre-prepared checklist from the Health Management Information System. The aim is to identify the gaps and challenges towards optimal feeding, if any, and optimize the feeding practices to meet international standards. We will conduct a census for three months; therefore enrol all patients admitted at PICU, within the determined three-month time frame. As evidence of numbers of patients presenting to KMH who receive intensive care is limited, based on daily ward round estimations, we will enrol approximately 75 patients into the study. As mentioned, the exact number depends on the number of patients presenting, and meeting study inclusion criteria during the three months of study enrolment.

Frequencies of the baseline characteristics will be generated. For the primary analysis we will conduct a univariate logistic regression analysis where we will assess the association between each variable and outcome. Variables whose association with outcome will have a p-value less than 0.05 will be included in the multivariate analysis. All analyses will be done using SPSS software version 19.

The main risks are the breach of confidentiality of patient records during the proposed research and invasion of patient privacy. There are no physical risks involved. All data will be collected after approval from the KNH/UoN - ERC and the KMH administration.

CHAPTER ONE

INTRODUCTION

Care of the critically ill children has been a challenge in resource limited settings due to lack of optimum resources and high patient volumes[1]. Nutritional support in the critically ill children remains one of the striking challenges in care of children in the Paediatric Intensive Care Unit (PICU). This is attributed by the severity of illness and co-morbid conditions of children admitted to PICU, feed interruptions due to various daily procedures and lack of proper monitoring protocols. Failure to accurately estimate or measure energy expenditure during critical illness may result in unintended underfeeding or overfeeding. Indirect calorimetry is the gold standard for energy expenditure assessment and helps guide energy prescription, but is impractical in high income countries and not available in the low and middle income countries.Protein catabolism and nitrogen loss are characteristic features of the metabolic stress response to critical illness, resulting in net negative protein balance and loss of lean body mass. Nutritional support itself cannot reverse or prevent metabolic stress response, but may help offset the catabolic losses, particularly protein losses, during this state. Failure to provide optimal calories and protein during the acute phase of critical illness may exaggerate existing nutritional deficiencies and further exacerbate underlying nutritional status.

Prevalence of malnutrition in sub saharan Africa is high and furthermore, according to Gachau et al 2018, 9.8% of all children admitted in a Kenyan hospital had a diagnosis of severe acute malnutrition[2]. A study done by Fernanda de Souza et al (2012), showed that 45% children admitted to PICU were malnourished which was associated with increased length of mechanical ventilation [3].

Studies have shown that malnutrition (including obesity) is associated with worse clinical outcomes, which includes: prolonged mechanical ventilation, longer PICU and inpatient stay, higher risk of hospital-acquired infection and increased mortality[4]. It also leads to cardiovascular disease such as cardiomyopathy, heart failure and cardiac arrhythmias which can further worsen the critical illness. Electrocardiograms done in children with severe acute malnutrition, significant changes were noted in the p wave, QRS complex and the T wave. These changes were reversed with malnutrition protocol therapy[14]. Malnutrition can affect the structure and function of the gastrointestinal tract. There is a decrease in absorptive surface area because of decreased cell proliferation, migration and maturation within the crypt villous

unit. This dysfunction including the loss of the gut barrier contribute to the morbidity and mortality of critical illness.

A phenomenon which is rapid and intense in malnourished critically ill children, is muscle wasting[5]. It has been shown that in children being managed for a critical illness, increased morbidity (weakness, delayed recovery, prolonged mechanical ventilation and infections) and increased mortality are associated with malnourishment and macronutrient deficiency. However, re-feeding syndrome, due to overfeeding in the acute phase, has also shown to pose harm to critically ill children. During the course of the critical illness, the metabolic and endocrine response evolves. Therefore, the nutritional support should be adjusted during the different phases of paediatric critical illness.

It is recommended by the American Society for Parenteral and Enteral Nutrition (ASPEN) that children admitted in the PICU be assessed nutritionally within 48 hours. Furthermore, as the risk of nutritional deterioration in these children is high which in turn affects clinical outcomes, it is suggested that re-evaluation of the nutrition status of patients be carried out at least weekly during the hospital stay.

CHAPTER TWO

LITERATURE REVIEW

2.1 Epidemiology

A nutritional survey done on children with critical illness in a PICU in China, 50% were malnourished at admission. Enteral nutrition was provided in 56%, 5.6% received parenteral nutrition and 6.4% mixed (enteral and parenteral). Feeding interruptions happened 1.9 times in each patient and 27.2% had interruptions more than three times[6].

In Kenya, the prevalence of severe acute malnutrition in hospitalized children (1-59 months) in thirteen hospitals was 9.8%, while the median case fatality rate was 10.1%[2], while in Siaya, Kenya, the prevalence of severe wasting in admitted children was 14.2%[16].

2.2 Barriers to Enteral Feeding

An online survey involving healthcare professionals working in PICU perceived: 1)holding of feeds prior to a procedure, 2) poor coverage of the nutrition department during weekends and night shifts, and 3) insufficient education and training on optimum nutritional support of patients as barriers to enteral nutrition[7].

2.3 Enteral Feeding in Children on Vasoactive Agents

Looking at the safety of providing enteral feeds in children on vasoactive medications, there was no difference in the outcomes of the gastrointestinal tract and a mortality trends were lower in the children who did receive enteral feeds. A retrospective study conducted in a developed country in which 339 critically ill children were included, those children who were on vasoactive agents and provided early enteral feeds had no adverse gastrointestinal outcomes compared to those who were not on enteral nutrition[8]. Thus the European Society of Paediatric and Neonatal Intensive Care (ESPNIC) guidelines state that early enteral nutrition is recommended in paediatric patients who are stable on vasoactive agents[11].

2.4 Feeding Routes

Feeding routes in critically ill children include nasogastric, orogastric, trans-pyloric or nasoduodenal. Furthermore, either continuous or intermittent delivery methods can be used to administer enteral nutrition. Although the optimal route for an individual patient depends on a

number of factors, the evidence does not clearly support one route over another in all clinical situations[9].

2.5 Gastric Residual Volume

GRV is defined as the aspiration of the entire stomach contents, with a view to assess feeding tolerance, both in terms of assessing the volume and often the colour of the aspirate. Aspirating gastric fluid before feeding via the gastric route is a common practice. A survey done in twenty four PICU's, showed that, ninety five percent measured GRV to initiate and guide enteral gastric feeding[12]. A randomized study done in two paediatric critical care units demonstrated that in those children in which GRV as not monitored, feeding targets were reached earlier and no increase in gastrointestinal complication rates were found[13].

2.6 Parenteral Nutrition

In regards to parenteral nutrition, a multicentre, randomized, controlled trial on comparing early and late parenteral nutrition in critically ill children was conducted and showed higher rates of infection in early parenteral nutrition, while in those children who received late parenteral nutrition, both length of mechanical ventilation and hospitalization were decreased[10].

Studies have shown that delaying parenteral nutrition to up to one week can be considered in children and neonates receiving critical care, independent of their nutritional status, while providing micronutrients[11].

2.7 Nutrition in Post – Operative Children

Perioperative nutritional care for neonates, infants and younger children differ greatly from those seen in older children and adults. About 18% to 40% of paediatric surgical patients have malnutrition. Abdominal surgery is the most stressful factor leading to the reorganization of metabolic processes, redox homeostasis and immune changes. Postoperative nutrition should be started early, using enteral nutrition (EN) or a combination of PN and EN until the gastrointestinal tract fully recovers. Postoperative PN should be restricted to infants who will not tolerate short period of starvation, older children who will probably not start enteral nutrition for at least 5 to 7 days. In well-nourished adolescents, this period of time should increase to 7 to 10 days[16].

2.8 Enteral Nutrition versus Clinical Severity

Clinical severity as measured by several scores including paediatric risk of mortality score has no effect on feeding intolerance. However, those with higher scores were initiated enteral nutrition later, longer period of achieving maximum energy delivery as compared to those with lower scores[17].

2.5 Conceptual framework

Independent Variables		**Dependent variables**
Age Sex Weight Cardiac disease Employment type Race Referral from other facility Nutrition type Reason for Admission	→	Malnutrition status Severity of Illness Surgery involving gastrointestinal tract

2.6 JUSTIFICATION

Nutrition plays a big role in the care of critically ill children. There is paucity of data on delivery of nutrition in children with critical illness, especially in PICU in Sub Saharan Africa, including in Kenya. This study can help in formulating protocols for nutritional management in PICU thus improving outcomes.

Projected innovations from this study include the following:

1. To inform development of nutritional educational programs and treatment guidelines for pre-hospital, hospital care in critically ill children.
2. To develop and implement a locally maintained high quality database for continuous nutritional surveillance and outcomes monitoring
3. To advocate for improved resources needed in the care of critically ill children in Kenya.

OBJECTIVES

Main Objective:

To review the provision of nutritional care to the critically ill children in Kijabe Mission Hospital, a level six hospital in Kenya

Specific Objective

1. To determine the prevalence of malnutrition in children admitted in Paediatric Intensive care unit
2. To determine the proportion of children on enteral feeds in PICU within the first 48 hours of admission
3. To identify risk factors associated with inadequate provision of nutritional support

CHAPTER THREE

3.1 METHODOLOGY

3.1.1 Study Design

This is a quantitative retrospective study to evaluate the provision of nutritional support to critically ill children at Kijabe Mission Hospital

3.1.2 Study Site

Paediatric Intensive Care Unit at Kijabe Mission Hospital is an eight bed capacity unit, with three beds providing critical care and mechanical ventilation, while five beds providing as a high dependency unit. It is located on the ground floor of Kijabe Mission Hospital. KMH is a level six mission hospital located in Kiambu County. It receives patients from all over the country and beyond.

The KMH PICU admits an average of 20 patients per month, which includes both medical cases and post- operative cases. KMH serves patients of all ethnic backgrounds.

All patients records are electronically recorded in the HMIS from the time of admission till discharge. Patient records in the HMIS includes: doctors notes, vital signs chart, nutrition chart, treatment sheet, nursing cardex, input-output chart among others.

Approval from the KMH research committee is required to carry out the research. One of the requirement is to have an internal supervisor of which is met in this proposal. A username and password is provided to retrieve the information.

3.1.3 Study Population

Children aged between 0 months to 14 years admitted to PICU

3.1.4 Inclusion Criteria

All Children aged between 0 months to 14 years admitted to PICU

3.1.5 Exclusion Criteria

Readmission within 3 months

Patients with surgery involving the gastrointestinal tract

Children with chronic gut disease

3.1.6 Sample Size and Study Period

A census of all patients admitted to PICU over a period of 3 months will be collected

3.1.7 Sample Collection

Data will be collected by the principal investigator and a research assistant; paediatric emergency and critical care clinical officer

Demographic data including age and gender will be collected.

Clinical information such as diagnoses at admission, whether requiring mechanical ventilation and ionotropic support will be gathered.

Nutritional assessment like weight, height and mid upper arm circumference will be recorded.

Data for nutritional prescriptions, time of initiation, type and mode of feeding, interval and adequacy of feeds will be recorded from the doctor's ward round notes, nursing records and nutritionist records. Other than the questionnaire, this study does not involve any procedures.

All data will be captured from the Health Management Information System at KMH and the Paediatric Emergency and Critical Care redcap database. HMIS has been in place since October 2019. All patient records starting from the casualty till discharge are recorded in the system. This information includes doctor's notes, patient vitals, nursing notes, nutritionist notes, treatment prescriptions, lab results among others.

All data will be filled in a pre-prepared data collection form and transferred to a password protected excel file.

All data intended to be collected is available on the HMIS.

3.2 ETHICAL CONSIDERATION

- Approval of this study from the ERC – KNH and KMH
- Patient data will remain confidential and stored in a password protected file known only to the principal investigator

3.3 STATISTICAL ANALYSIS

Categorical variables e.g. sex, race and employment type will be summarised in terms frequencies and proportions using tables and bar charts. Continuous variables like age, height and weight will be summarized in terms of means and standard deviations. The continuous variables will also be presented in histograms.

For bivariate analysis, Chi square test will be used to assess the association between two categorical variables e.g. the type of employment of the parent and the malnutrition status. The Chi square statistic will be evaluated using p-value. A p-value less than 0.05 indicate a significant association between employment type and malnutrition status.

Multivariate analysis will be done using a binary logistic regression. This is because malnutrition status is a binary outcome i.e. yes or no. The risk factors will be treated as independent variables and the results for each predictor will be interpreted using p-values, odds ratios and confidence intervals.

3.4 Study Strength and Limitations

This will be one of the first studies looking at nutrition in critically ill children in Sub-Saharan Africa. It will provide data to those making guidelines for nutrition in PICU in our setting.

Limitations include a fixed time period dependant . However, the results from this study can provide information on the trends on nutrition delivery and outcomes.

Most measures of feeding intolerance are non-specific like vomiting and loose stool. These sometimes overlap with the illness the child presented with like acute diarrhoeal illness. This is however not in all cases. This will overcome by trying to look at the time of vomiting in comparison with the feeding time.

This study can serve as pilot data for future study of nutritional and feeding challanges in PICU in the developing world.

Chapter 4: Results

This study involved 51 participants and all of them responded. The youngest participant was 4 days old while the oldest was 10 years old. The median age was 1.1 years with an interquartile range of 1.6 years.

The mean weight of the participants was 9.8 kilograms; the median weight was 7.8 with an interquartile range of 7.9.

Among the participants, 15.7 % (n = 8) were below 1 month old, 68.6 % (n = 35) were between 1 month to 5 years and 15.7 % (n = 8) were above 5 years. 58.8% (n = 30) of the participants were females while 41.2% (n = 21) were males.

In terms of nutritional status, 69.6 (n = 32) had normal nutritional status, 10.9% (n = 5) had moderate malnutrition while 19.5% (n = 9) had severe malnutrition. 98% (n = 50) of the respondents were black while 2% (n = 1) were white.

Table 1: Demographic and clinical characteristics

Variable	**Frequency** N=51	**Percentage**
Children's characteristics		
Age **(median = 1.1 years, IQR = 1.6 years)**		
Age categories < 1 month	8	15.7
1-60 months	35	68.6
>60 months	8	15.7
Sex: Female	30	58.8
Male	21	41.2
Weight (**median = 7.8 kgs, IQR = 7.9**)		
Nutritional status: Normal	32	69.6
Moderate malnutrition	5	10.9
Severe malnutrition	9	19.5
Race: Black	50	98.0
White	1	2.0
Feeding characteristics		

Feeds: Both	46	90.2
Enteral	3	5.9
Intravenous fluids	2	3.9
Nutritional assessment: No	30	61.2
Yes	19	38.8
Adequate feeding: No	8	16.7
Yes	43	84.3
Adequate calories: No	5	10.0
Yes	38	76.0
Ventilation support		
Intubated: No	45	88.2
Yes	6	11.8

Broad objective: To review the provision of nutritional care to the critically ill children in Kijabe Mission Hospital, a level six hospital in Kenya

In terms of feeding, no patient was on total parenteral or partial parenteral nutrition. 90.2% (n = 46) of the participants were on intravenous fluids and enteral feeds, 5.9 % (n = 3) were on enteral feeds while 3.9% (n = 2) were on intravenous fluids only.

On feeding adequacy, 84.3% (n = 43) were adequately prescribed feeds while 16.7% (n = 8) were not prescribed adequate feeds. 76.0% (n = 38) were given adequate calories while 10.0% (n = 5) were not. 38.8% (n = 19) were assessed by the nutritionist while 61.2% (n = 30) were not assessed by the nutritionist. On respiratory support, 11.8% (n = 6) were intubated while 88.2% (n = 45) were not intubated.

Nutritional status of the children

Form the pie chart below, majority of the participating children 69% had normal nutritional status followed by those with severe malnutrition at 20% and those with moderate malnutrition were 11%.

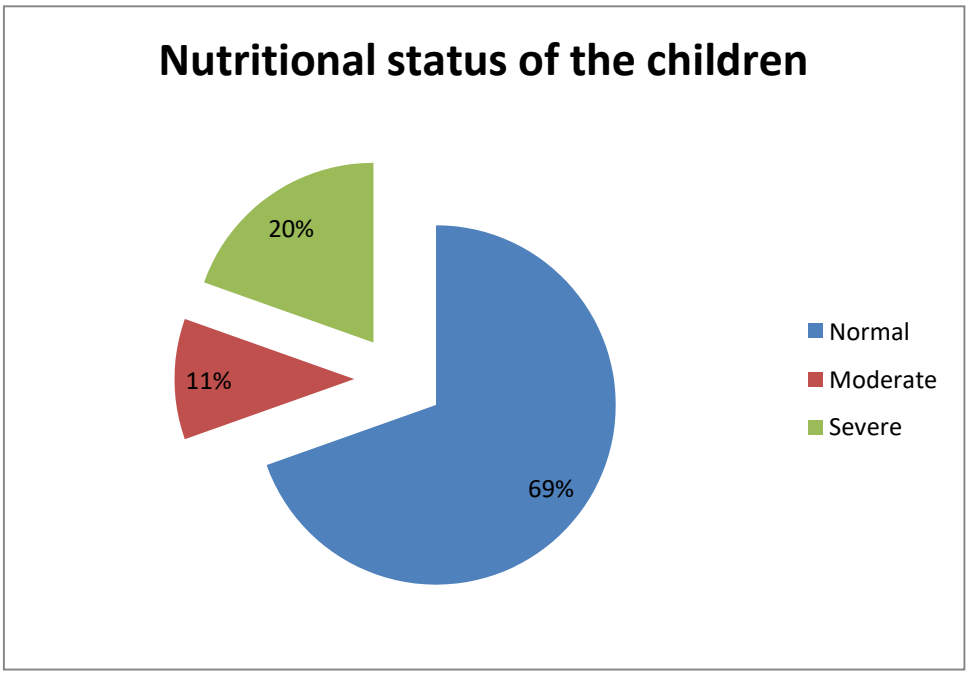

Figure 1: Nutritional status of the children

Objective 1: To determine the prevalence of malnutrition in children admitted in Paediatric Intensive care unit

In terms of malnutrition, 30% of the children had malnutrition while 70% did not. The proportion of those with malnutrition with 95% confidence interval was 0.3 (0.18, 0.46).

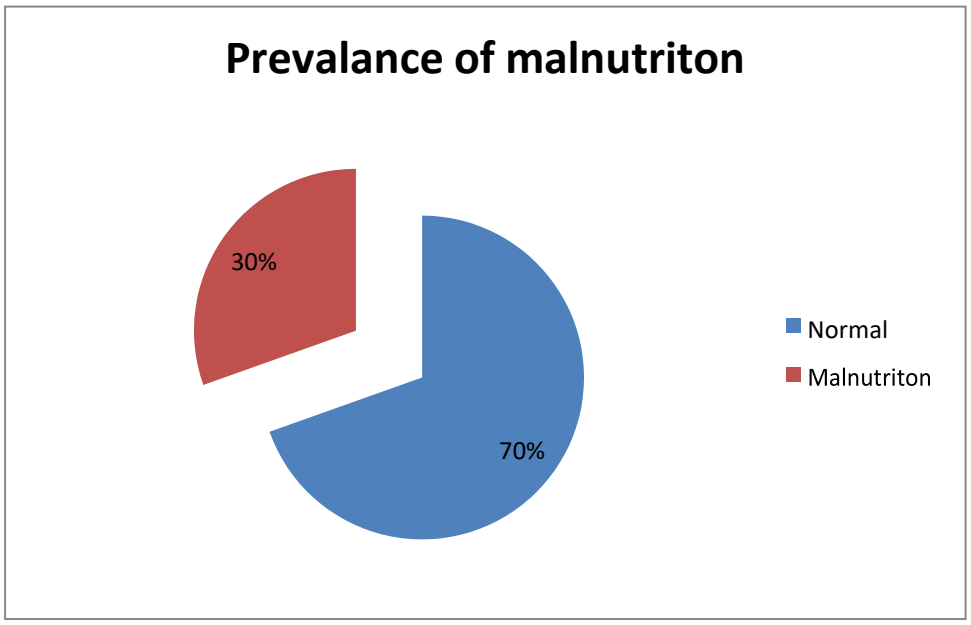

Figure 2: Prevalence of malnutrition

Objective 2: To determine the proportion of children on enteral feeds in PICU within the first 48 hours of admission

Enteral feeds can either be oral or via nasogastric tube. In this study children were either on oral feeds, intravenous fluids or feeds via the nasogastric tube.

The bar chart below illustrates the proportion of children on enteral feeds within the first 48 hours of admission

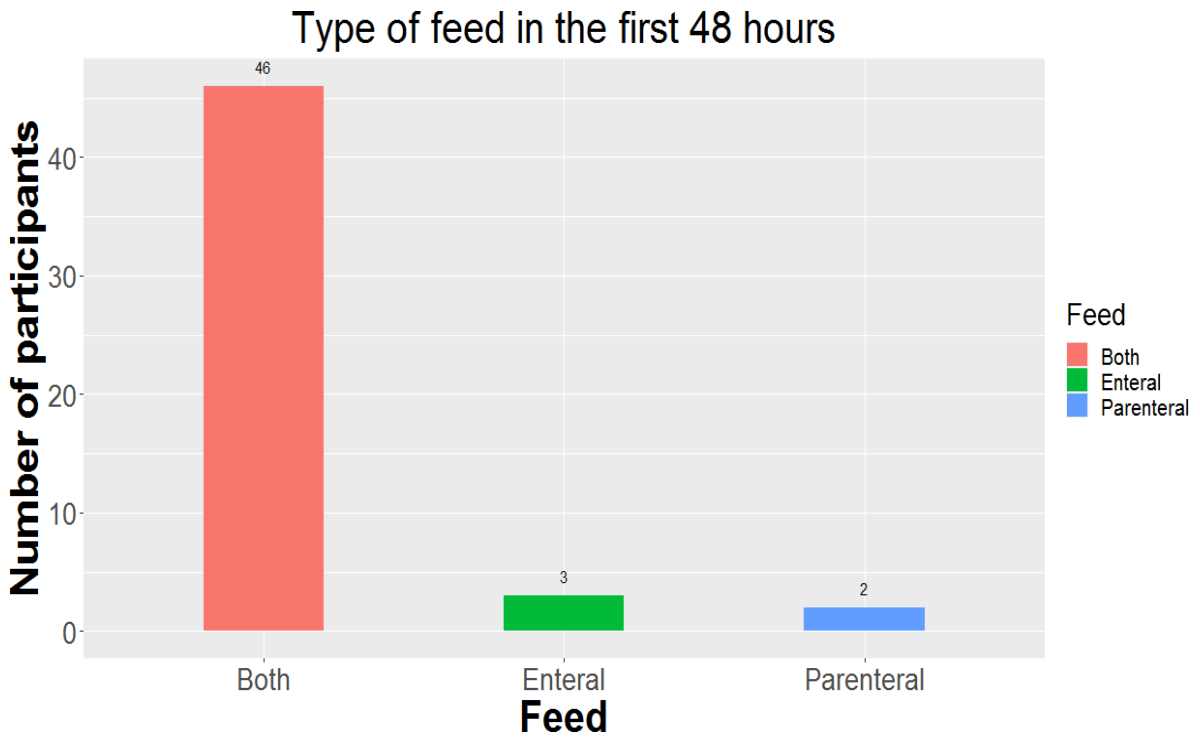

Figure 3: Distribution of type of feed

From the bar chart above, it is clear that 46 of the participants were on both on oral feeding and intravenous fluids, 3 were on enteral feeds only while 2 of the participants were on intravenous fluids only.

To simplify the above information in a pie chart; it is clear from the pie chart below that 90% of the participants were put on enteral feeds and intravenous fluids within 48 hours of admission while 4% were on intravenous fluids only. 6% of the participants were entirely on enteral feeds.

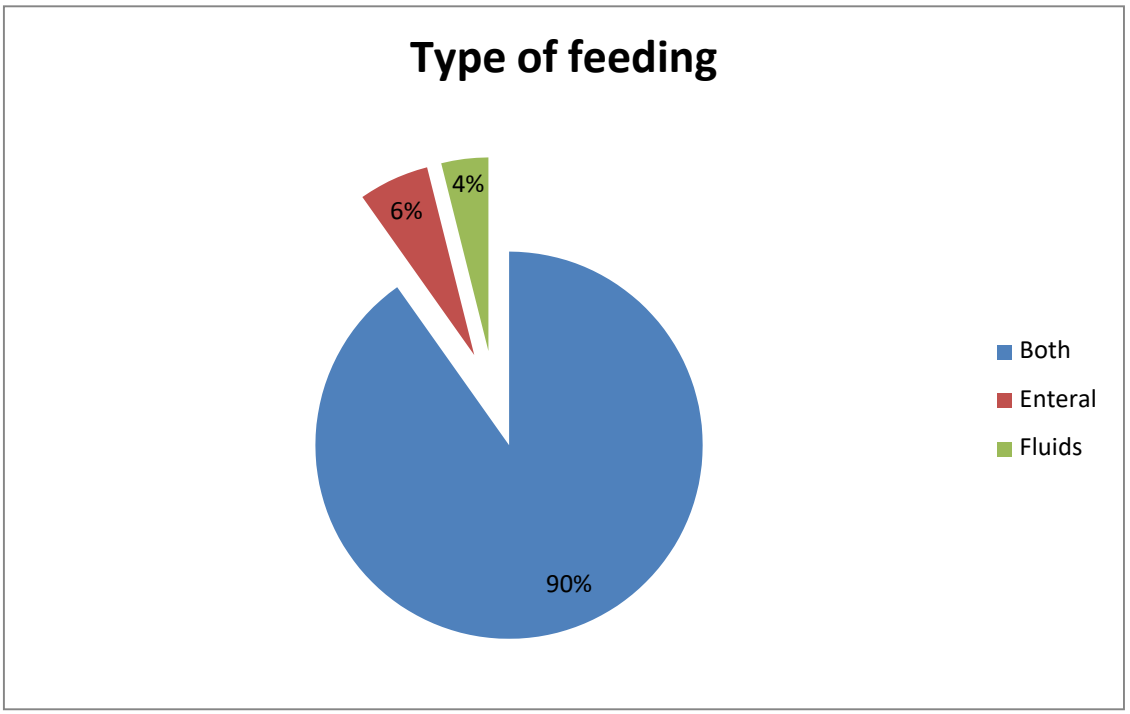

Figure 4: Type of feed distribution in proportions

Inotropic support and type of feeding

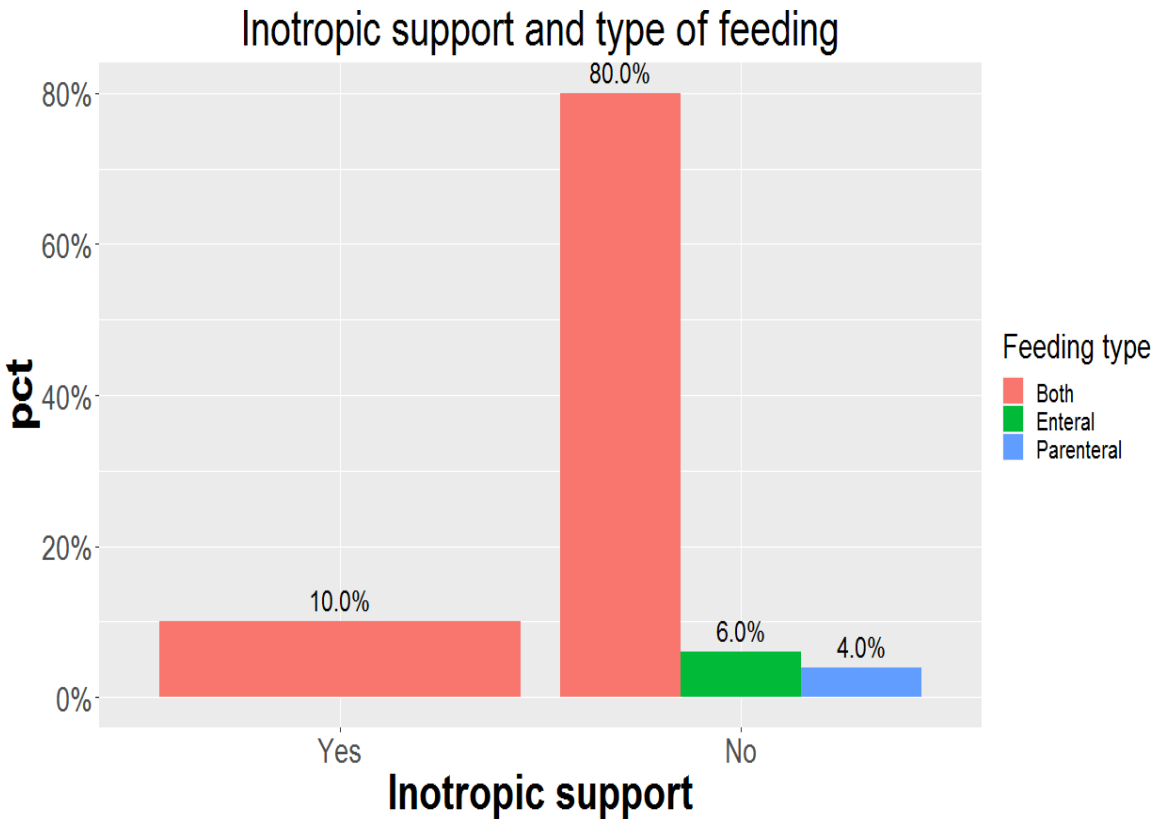

Figure 5: Bar chart showing inotropic support and mode of feeding

From the bar chart above, all the children on inotropic support were on mixed feeding i.e. both intravenous fluid and enteral feeding which was 10.0% of all the participants. 90.0% of the participants were not on inotropic support. 80.0% of all the participants were on both oral and intravenous fluids, this 80.0% were not on inotropic support. 6.0% were on enteral feeds while 4.0% were on intravenous fluids.

Objective 3: To identify risk factors associated with inadequate provision of nutritional support

Age categories and feeding adequacy

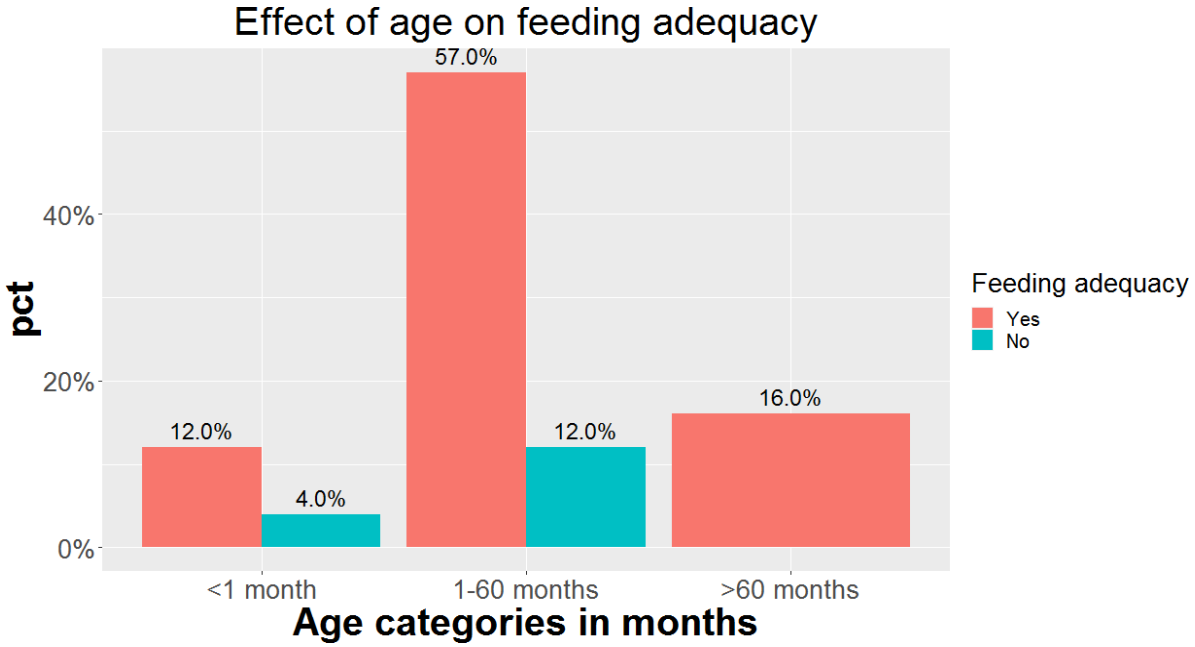

Figure 6: Effect of age categories on feeding adequacy

It appears from the bar chart below that 12.0% of the participants who were adequately fed were below 1 month while 4.0% of the same category was not well fed.

57.0 % of the participants who were adequately fed were between 1-60 months while 12.0% of those not adequately fed were in the same category. All the participants aged above 60 months were adequately fed which amounted to 16.0%.

Referral and feeding adequacy

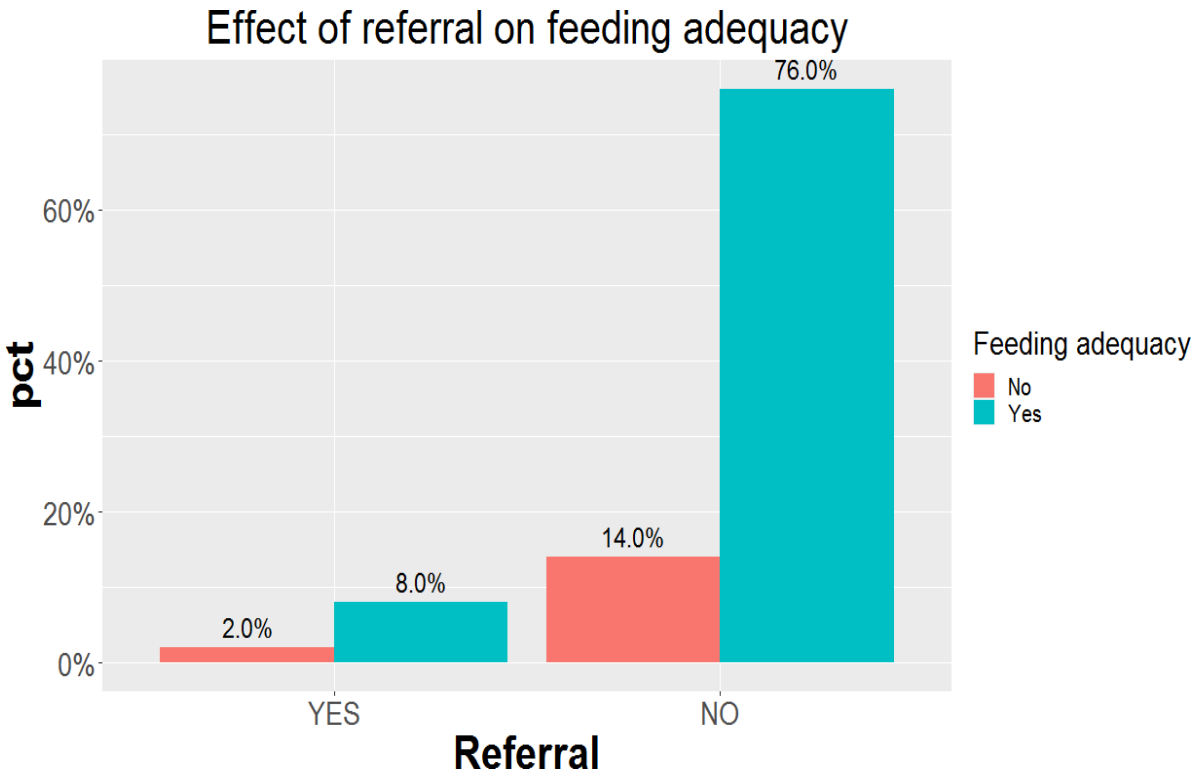

Figure 7: Bar chart showing how referral affected feeding adequacy

The above chart shows that 76.0% of those who were not referred were adequately fed while 14.0% of those in the same category were not adequately fed. 8.0% of those that were referred were adequately fed while 2.0% were not.

Nutritional status and feeding adequacy

On nutritional status, 59.0% of those who were adequately fed were those in the normal category while 11.0% of those who were not well fed were also in the normal category. 11.0% of those who were adequately were those with moderate malnutrition. All the children with moderate malnutrition were adequately fed. 13.0% of the children that were adequately fed were those with severe malnutrition while 7.0% were those in severe malnutrition category that were not well fed.

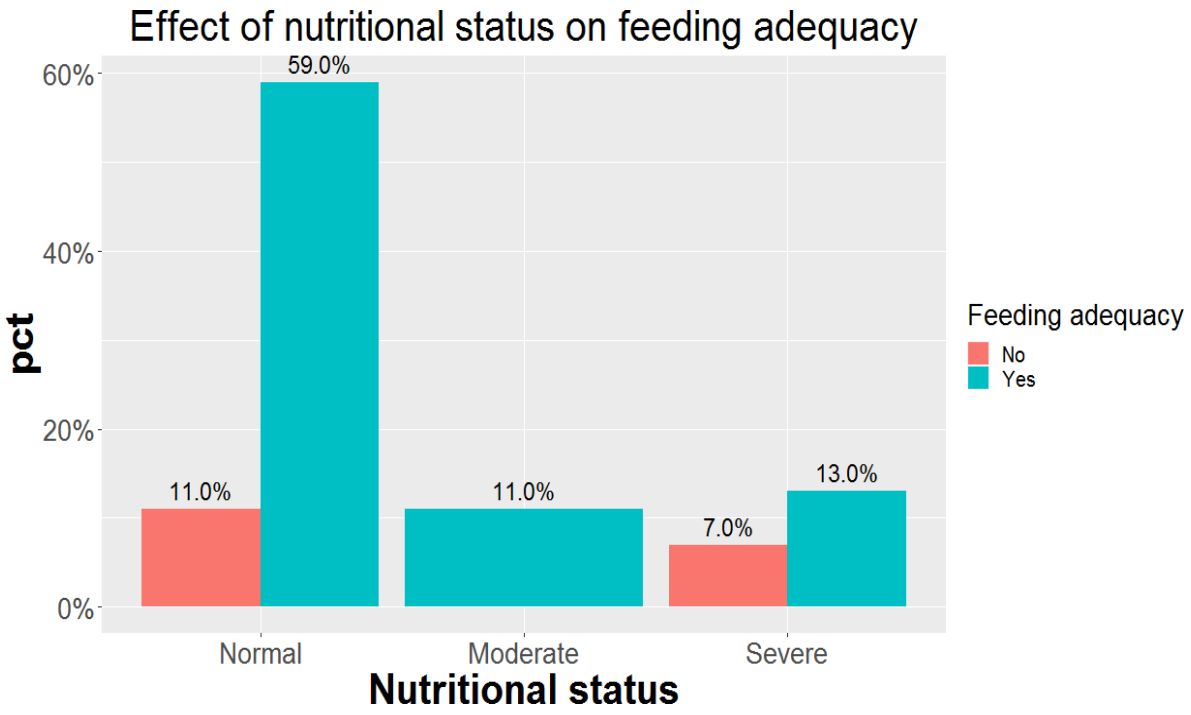

Figure 8: Effect of nutritional status on feeding adequacy

Type of feed and feeding adequacy

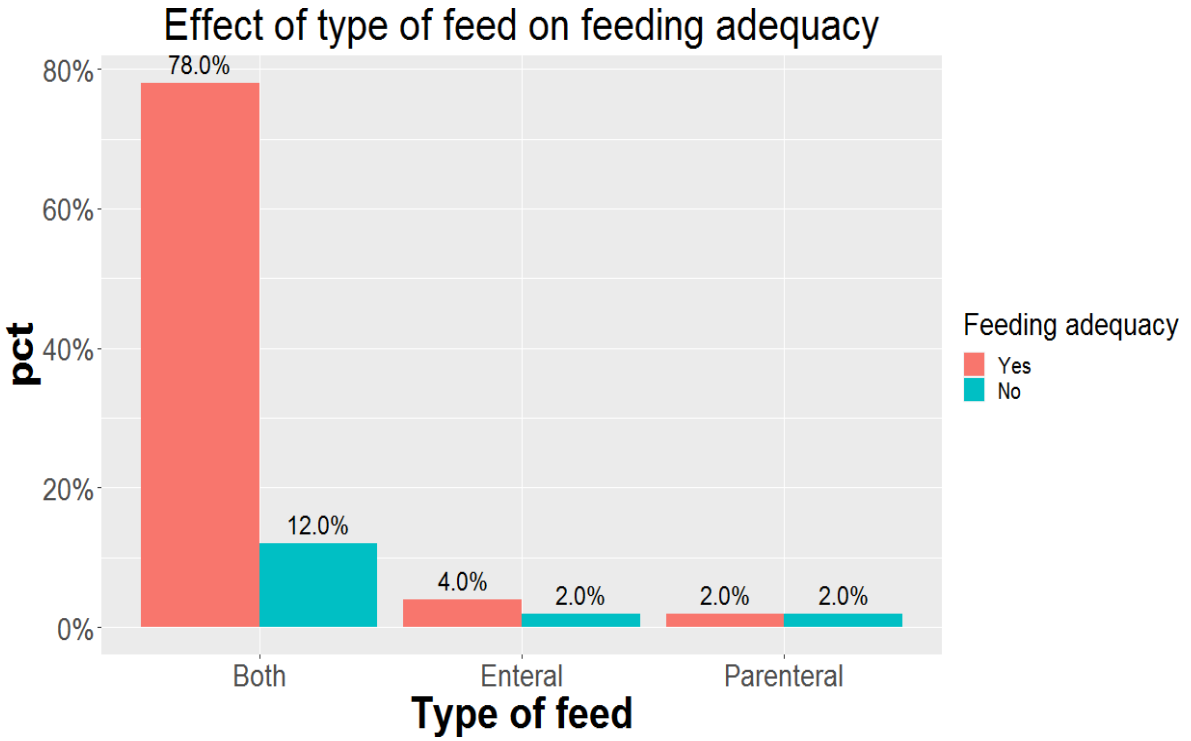

Figure 9: Effect of type of feed on the adequacy of feeding

From the above bar graph, 78.0% of the adequately fed children were those on both intravenous fluids and enteral feeds while 12.0% of the children who were inadequately fed were in the same category.

Table 2: Univariable analysis

Risk factors associated with inadequate feeding				
Variable	**Adequate feeding N = 51**		**Crude OR (95% CI)**	**P-value**
	Yes	No		
Age categories < 1 month	6	2		0.44
1 – 60 months	29	6	0.62 (0.10, 3.85)	
>60 months	8	0	NA	
Type of feed: Both	40	6		0.51
Enteral	2	1	3.33 (0.26, 42.65)	
Parenteral	1	1	6.66 (0.37, 121.35)	
Referral: No	38	7		1.00
Yes	4	1	1.36 (0.13, 14.02)	
Abdominal distension: No	33	4		0.08
Yes	8	4	4.13 (0.84, 20.16)	
Loose stools : No	37	7		1.00
Yes	9	1	0.51 (0.06, 4.69)	

From the univariable analysis table above, the p-values indicate that all the variables examined were not statistically significant in their association with feeding adequacy. However we can use the odds ratios to determine the effect of each variable on feeding adequacy.

Interpretation of odds ratios

Age

A child who is between 1-60 months is 38% less likely to be prescribed inadequate feeds compared to the one who is less than 1 month.

Type of feeds

A child who was put on enteral feeds only was 3.33 times more likely to receive inadequate feeds compared to a child who was on both enteral and intravenous fluids. Equally a child who was on intravenous fluids only was 6.66 times more likely to receive inadequate feeds compared to child who was both on enteral and intravenous fluids.

Referral status

A child who had been referred from another hospital was 36% more likely to receive inadequate feeds compared to a child who had not been referred.

Abdominal distension

A child who had abdominal distension was 4.13 times more likely to receive inadequate feeds compared to a child without abdominal distension.

Loose stools

A child who had loose stools was 49% less likely to receive inadequate feeds compared to a child who did not have loose stools.

Multivariable analysis

Under multivariate analysis, a logistic regression model was fitted where the most influential variables were selected. The variables that were considered to have the most impact on feeding adequacy were intravenous fluids administration, oral feeds and age.

Table 3: Multivariable analysis

Risk factors associated with inadequate feeding				
Variable	**Adequate feeding N = 51**		**Adjusted OR (95% CI)**	**P-value**
	Yes	No		
Age categories: < 1 month	6	2		
1-60 months	29	6	0.66 (0.10, 6.13)	0.68
>60 months	8	0	NA	1.00
Type of feed: Both	40	6		
Enteral	2	1	2.91 (0.12, 37.15)	0.42
Parenteral fluids	1	1	4.72 (0.16, 13.63)	0.31

The p-values in the multivariable table above are more than 0.05 at 95% confidence level hence indicating that the associations between independent variable and the dependent variable are not statistically significant.

Interpretation of odds ratios

Age

Holding the type of feed constant, a child who is 1-60 months old is 44% less likely to receive inadequate feeds compared to a child who is less that 1 month old.

Type of feed

Holding age constant, a child who is on enteral feeds only is 2.91 times more likely to be prescribed inadequate feeds compared to a child who is both on enteral and intravenous fluids. Equally, a child who is on intravenous fluids only is 4.72 times more likely to receive inadequate feeds compared to a child who is on enteral and intravenous fluids.

CHAPTER FIVE

DISCUSSION

A third of our children were malnourished**.** This is in keeping with most other paediatric intensive care units where the prevalence of malnutrition is between 18- 60% as per a survey done in China by Jingjing Li et al.

However most low income countries have prevalence rates of more than 50%, a study done in Kenyatta National Hospital showed that 60% of critically ill children had some form of malnutrition

This difference could probably because of the location of the hospital and most malnourished children could be referred to KNH

Majority of the children received both enteral feeds and IVF on admission upto 48 hours

This is in line with ASPEN guidelines which opines that critically ill children with haemodynamic stability can be fed enterally within the first 24 hours.

A study done in Australia showed children on NIV (5-25%) rarely received enteral feeds in the 1st 24 hours.

Majority of our children in PICU received adequate volumes and calories

Probably due to daily consultant rounds and frequent reviews by nutritionist – 2/3 of the children were reviewed by a nutritionist.

This is in keeping with the ASPEN guidelines which states that the critically ill children to be reviewed by a nutritionist within the first 48 hours then by the 7^{th} day.

Most children who dint achieve adequate calories in the 1st 48 were severely malnourished. This practice was done to avoid re-feeding syndrome. KMH protocol is to start with 60/40 (enteral/IVF) and to progress feeds as the clinical and lab features improve.

All children on inotropes received enteral feeds and this was as per the ESPNIC guidelines

Apurva et al found that enteral feeding in patients receiving vasoactiveagents is associated with no difference in GI outcomes and a tendency towards lower mortality.

References

1. Elisabeth Riviello et al. Critical care in resource-poor settings: Lessons learned & future directions.February 2011, Critical Care Medicine 39(4):860
2. Susan Gachau et al. Prevalence, outcome and quality of care among children hospitalized with severe acute malnutrition in Kenyan hospitals: A multi-site observational study. 2018 https://doi.org/10.1371/journal.pone.0197607
3. Fernanda De Souza et al. Malnutrition as an independent predictor of clinical outcome in critically ill children Nutrition Volume 28, Issue 3, March 2012, Pages 267-270
4. Lori J Bechard et al. Nutrition status based on Body Mass Index is associated with morbidity and mortality in mechanically ventilated critically ill children in the PICU. Crit Care Med. 2016 Aug; 44(8): 1530–1537.
5. Fredrick Valla et al. Thigh ultrasound monitoring identifies decreases inquadriceps femoris thickness as a frequent observation in critically ill children. Pediatr Crit Care Med. 2017 Aug;18(8):e339-e347.
6. Jingjing Li et al. Nutritional survey in critically ill children: a single center study in China. Transl Pediatr. 2020 Jun; 9(3): 221–230.
7. Lyvonne Tume et al. Barriers to delivery of enteral nutrition in paediatric intensive care: A World Survey
8. Apurva Panchal et al. Safety of enteral feedings in critically ill children receiving vasoactive agents. JPEN J Parenter Enteral Nutr 2016 Feb;40(2):236-41
9. Wendalyn King et al. Enteral Nutrition and cardiovascular medications in the pediatric intensive care unit. JPEN J Parenter Enteral Nutr Sep-Oct 2004;28(5):334-8
10. Tom Fivez et al. Early versus Late Parenteral Nutrition in Critically Ill Children. N Engl J Med 2016; 374:1111-1122
11. Lyvonne Tume et al. Nutritional support for children during critical illness: European Society of Paediatric and Neonatal Intensive Care (ESPNIC) metabolism, endocrine and nutrition section position statement and clinical recommendations. Intensive Care Med 2020 Mar;46(3):411-425.
12. LN Tume et al. Gastric residual volume measurement in UK paediatric intensive care units: a survey of practice. Pediatr Crit Care Med. 2019 Aug; 20(8): 707–713.

13. Nurten Ozen et al. Evaluation of the effect on patient parameters of not monitoring gastric residual volume in intensive care patients on mechanical ventilator receiving enteral feeding: A randomized clinical trial. Journal of Critical Care, Volume 33, June 2016, pgs 137-144.
14. Neeraj Kumar et al. To identify myocardial changes in severely malnourished children: A prospective Observational Study. Front Pediatr, 2015;3:57
15. Cecilia Abinya. Prevalence of Malnutrition and Related Factors among Children aged 6-60 months admitted at Siaya district hospital. erepository.uonbi.ac.ke
16. Hasina K et al. Perioperative Nutrition in Pediatric Surgical Patients. Journal of Paediatric Surgeons of Bangladesh (2014) Vol. 5 (2): 64-67
17. Cesar Sanchez et al. Clinical severity scores do not predict tolerance to enteral nutrition in critically ill children. British Journal of Nutrition , Volume 102 , Issue 2 , 28 July 2009 , pp. 191 - 194

Appendix 1.

Serial No. _____

SUBJECT DEMOGRAPHIC DATA

1. Age/ DOB: _____ ____Months _____ Days _____Years

2.Sex: Male_____ Female _____

3. Height: _____cm

4. Weight: _____ kg weight for length_____SD BMI _____

5. malnutrition score (MUAC)? _____cm

6. Race: Black _____ White _____ Other _____

b. Did the patient transfer from another hospital emergency department? Yes _____ No _____

c. Did the patient transfer from another hospital ward/ICU? Yes _____ No _____

d. Was the patient transferred from within the hospital ? Yes_____No _____

e. How many days since admission to KMH?_____days

13. Primary guardian's type of employment:

Full Time _____ Part Time _____ Unemployed _____

14. Primary Diagnosis _____

15 a. Vital signs

Heart rate (beats per min): _____

Blood pressure: Systolic_____Diastolic_____or Mean _____

Temperature: °F_____or °C _____

Capillary refill time: _____sec

Respiratory rate: breaths per minute _____

Pulse oximetry :_____%

b. Glasgow coma scale *(preferred over Blantyre coma scale)* Total: _____

c. Type of respiratory support

Room air_____ Oxygen support only (no positive pressure) _____

Nasal cannula _____ Simple facemask _____

Fraction of inspired oxygen _____ Non-rebreather _____

Bag-valve mask (assumed $FiO_2 = 1.0$) _____

Was the patient intubated? Yes _____ No _____

d. Cardiovascular

Hypotensive Yes_____ No _____

Inotrope or vasopressor used? Yes_____ No _____

If so, which one(s): _____

e. Disposition

Home_____Ward_____ICU_____Rehabilitation_____Morgue_____

Operating room _____

Another intermediate or lower care hospital

LABORATORY/RADIOLOGIC/NEUROLOGIC TESTING

1. Oxygen delivery and electrolytes

a. Blood gas analysis performed: Yes _____ No _____

i. Type: Arterial _____ Venous _____ Capillary_____

ii. Results: pH: _____ PaCO2: _____ PaO2: _____

Base excess: _____ or deficit: _____ HCO3

b. Lactate: _____

i. Measured on hospital day # _____

c. Sodium: _____

i. Measured on hospital day # _____

2. Hematology

a. Hemoglobin_____

i. Measured on hospital day # _____

b. Hematocrit _____

i. Measured on hospital day # _____

c. INR: _____

i. Measured on hospital day # _____

d. WBC _____

i. Measured on hospital day # _____

3. Organ dysfunction

a. ALT

i. Measured on hospital day # _____

b. Creatinine

i. Measured on hospital day # _____

4. Nutrition (indicate hospital day when initiated)

a. Intravenous fluids (not feeds) available: Yes_____ No _____

Started on hospital day: _____ Duration (no. of days); Full _____
Part _____

b. Total parenteral nutrition (i.v.) given: Yes_____ No _____

Started on hospital day:_____Duration (days):_____Rate: _____

c. Partial Parenteral Nutrition given Yes_____No_____rate _____

d. Tube feeds given: Yes _____ No _____ Tube tupe _____

Started on hospital day:_____ rate: ml/kg/day _____

e. Oral feeds given: Yes_____ No _____

Started on hospital day: _____

f. Nutritional assessment done within 48 hours of admission? Yes_____No _____

g. Type of IV fluids .....

h. Type of oral feeds ----------

i. Type of NG feeds ----------

j. Presence of:

1. GRV Yes_____No_____Volume_____Freq per day _____

2. Abdominal distension Yes_____ No _____

3. Loose stools Yes _____ No_____ No. of episodes in 24 hrs _____

4. Vomiting Yes _____ No _____ No. of episodes in 24hrs _____

k. amount of feeds/fluids prescribed % of required _____

l. Adequate calories prescribed. Yes _____ No _____ % of required _____

m. Were oral/ ngt feeds stopped. Yes_____ No _____

If Yes, Reason for stopping? Vomitting _____ Loose Stools _____ Aspirates _____

Procedure_____ Risk of aspiration _____ Surgery _____ Radiology _____

How long did the child remain NPO_____hrs _____days

n. did the child get refeeding syndrome? Yes_____ No _____

CHRONIC AND CONCURRENT MEDICAL PROBLEMS

1. Gastrointestinal disease

History of GIT surgery? Yes_____No _____

Chronic GIT disease: Malabsorption syndrome (Yes/No).

Inborn error of metabolism (Yes/No)

Celiac disease (Yes/No)

Inflamatory bowel disease (Yes/No)

Short bowel syndrome (Yes/No)

Others _____

2. Chronic pulmonary disease: Yes_____ No _____

If yes, check all applicable: Asthma_____ Broncho-pulmonary dysplasia _____

Other: _____

3. Cardiac disease

a. Congenital heart disease: Yes_____ No _____

If yes, what kind: _____

If yes, has the child underwent corrective surgery: Yes_____ No _____

If so, type of surgery: _____

b. Acquired heart disease: Yes_____ No _____

If yes, diagnosis: _____

c. Neuromuscular disease Yes_____ No _____

Static encephalopathy _____ Spinal cord trauma _____

Seizure disorder _____ Other _____

5. Oncologic disease Yes_____ No _____

If yes, in remission: Yes_____ No _____

Type: _____

6. Infectious diseases

a. Chronic disease: Yes_____ No _____

If yes, specify: _____

b. History of previous cerebral malaria: Yes_____ No _____

c. History of previous tuberculosis: Yes_____ No _____

If yes, currently on treatment: _____

7. Other chronic diseases: _____

Appendix 2

Data analysis plan

Univariate analysis

Demographics

Table1: Mean and standard deviation of child's weight

Number of respondents	Mean	Standard deviation
n		

Table2: Mean and standard deviation of the weight

Number of respondents	Mean	Standard deviation
n		

Table3: Sex of the child

Sex	Frequency	Proportion
Male		
Female		

Table4: Child's race

Nationality	Frequency	Proportion
Kenyan		
Non Kenyan		

Table5: The patient is a transfer form another hospital

Transfer from another hospital	Frequency	Proportion
Yes		
No		

Table6: Parents employment type

Employment type	Frequency	Proportion
Unemployed		
Part-time		
Full-time		

Table7: Congenital cardiac diseases

Cardiac Disease	Frequency	Proportion
Yes		
No		

Bivariate analysis

These tests assess the relationship between two variables. The tests can be interpreted using p-values or odds ratios.

1. **Chi square analysis**

Chis square analysis is used in situations where categorical variable frequencies are presented in contingency tables. The resulting Chi square statistic is evaluated using P-value.

A good example of a contingency table can be created using responses from the primary guardian employment type and malnutrition status.

Employment type	**Malnutrition**	
	Yes	**No**
Unemployed	xx	xx
Part-time	xx	xx
Full-time	xx	xx

The equation below estimates a Chi square value that is evaluated using a p-value at significance level 0.05.

$$X^2 = \sum \frac{(Oij - Eij)^2}{Eij}$$

O is the observed value in cell ij while E is the calculated expected value in cell ij.

A p-value less than 0.05 indicate association between employment type and malnutrition.

Multivariate analysis

1. Binary logistic regression

Multivariate analysis considers multiple independent variables and their impact on the dependent/outcome variable. A regression model is fitted with for the outcome variable whereby it is modelled as a function of the independent variables. A full model contains all the independent variables where those that are not significant are removed and the model refitted again.

For this study, the outcome variable which is malnutrition is binary i.e. yes or no. the independent variables can either be binary or continuous.

The general equation for this model with the chosen independent variables is shown below

$$\ln(\boldsymbol{malnutrition}) = Q_0 + Q_1\boldsymbol{Age} + Q_2\boldsymbol{Weight} + Q_3\boldsymbol{employment\ type} + Q_4\boldsymbol{Race} + Q_5\boldsymbol{cardiac\ disease} + Q_5\boldsymbol{sex}$$

β_0 . Is the nutritional status of the child in the absence of risk factors. Also known as the intercept in case the data is plotted.

$\beta_1 to\ \beta_5$. Refers to the impact of the risk factors on malnutrition

The results of this model are interpreted using p-values, odds ratios and confidence intervals for the significance of each predictor.

KIJABE HOSPITAL INSTITUTIONAL ETHICS AND RESEARCH REVIEW COMMITTEE
PO Box 20 Kijabe 00220, Kenya
Tel: 0709728200/637
E-mail:researchcoord@kijabehospital.org
Website: www.kijabehospital.org

Reference : KH/IERC/0021/2021
Formal Approval Number: KH/ IERC/02718/0114/2021

Dear Adnaan Mustafa,

RE: CHALLENGES IN OPTIMAL NUTRITIONAL CARE IN CRITICALLY ILL CHILDREN IN PICU - A DEVELOPING WORLD PERSPECTIVE.

The Institutional Ethics and Research review Committee having carefully reviewed your above title proposal grants you approval to conduct this study at Kijabe Hospital as of 16TH December 2021.

The draft of any manuscript resulting from the study should be submitted to the IERC for review before it is submitted for publication.

As exempt studies, annual reviews will not be required and no expiration date will be listed in this approval letter.

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 KH IERC 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 KH IERC immediately.

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 KH IERC immediately.
e. For studies lasting more than one year an annual report must be submitted for ongoing approval to be valid.
f. 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).
g. Clearance for export of biological specimen or any form of data must be obtained from KH IERC, NACOSTI and Ministry of Health for each batch of shipment /export.
h. Submission of an executive summary report within 90 days upon completion of the study. This information will form part of the database that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.
Please do not hesitate to contact the AIC Kijabe Hospital IERC Coordinator (researchcoord@kijabehospital.org) for any clarification or query.
We wish you all the best in the study.
Thank you,
Yours Sincerely,

Peter Halestrap
BMBCh, MRCGP, DCH, DRCOG,MA (OXON)

Chair, AIC Kijabe Hospital IERC.