# AUDIT OF THE CURRENT STANDARD OF CARE FOR CHILDREN ADMITTED TO MBAGATHI DISTRICT HOSPITAL WITH SEVERE MALNUTRITION

**A DISSERTATION SUBMITTED IN PART FULFILLMENT FOR THE DEGREE OF MASTER OF MEDICINE IN PEDIATRICS AND CHILD HEALTH, UNIVERSITY OF NAIROBI.**

**DR ANN WANGECHI KAMUNYA**

## Declaration

This dissertation is my original work and has not been presented for the award of a degree in any other university.

Signed.....Date.....

Dr Ann Wangechi Kamunya

(MBChB) University of Nairobi.

This dissertation proposal has been presented with our full approval as supervisors

Signed.....Date.....

Professor Fred Were

Professor of Pediatrics and Child Health, Consultant Neonatologist

Senior Lecturer, Department of Pediatrics and Child Health, University of Nairobi.

Signed..... Date.....

Dr. Nyambura  Kariuki

Consultant Pediatrician, Hematologist

Senior Lecturer, Department of Pediatrics and Child Health, University of Nairobi.

Signed..... Date.....

Dr. Ahmed Laving

Consultant Pediatrician, Gastroenterologist

Senior Lecturer, Department of Pediatrics and Child Health, University of Nairobi.

## DEDICATION

This book is dedicated to my dear husband Thiong'o and our lovely children Muthoni and Wacira for their patience and support throughout the period of my post graduate programme.

**ACKNOWLEDGEMENTS**

I wish to express my sincere gratitude to:

1. My supervisors: Prof. Fred N. Were, Dr. Nyambura Kariuki and Dr. Ahmed Laving for their valuable input, guidance and support.

2. The childhood malnutrition study group residents:They include Dr Sophia Mwinyishee, Dr Phoebe Wamalwa, Dr Kimani Ngaruiya, Dr John Fondo and Dr.Respicious Bakalemwa. Together we were able to collect data 24 hours,7 days a week.

3. Mbagathi District Hospital management and staff especially Dr. A. Suleh, Dr .L. Mutai and Dr. B. Mutai for their cooperation and support which made this study a success.

4.PRIME-K MNCH linked award for funding this study.

5. All the children and caregivers who participated in this study.

**TABLE OF CONTENTS**

# ABBREVIATIONS

| | |
|---|---|
| ANOVA | Analysis of Variance |
| Cm | Centimeter |
| ETAT | Emergency triage assessment and treatment |
| G/dl | grams per deciliter |
| Gms | grams |
| H | Height |
| Hb | Hemoglobin |
| HIV | Human Immunodeficiency Virus |
| HSD | Half Strength Darrow's |
| IGA | Immunoglobulin A |
| IV | Intravenous |
| KDHS | Kenya Demographic and Health Survey |
| Kgs | kilograms |
| MUAC | Mid upper arm circumference |
| NCHS | National center for health statistics |
| NGT | Nasogastric Tube |
| RBS | Random blood sugar |
| ReSoMal | Rehydration Solution for Malnutrition |
| SAM | Severe acute malnutrition |
| SPSS | Statistical package for social studies |
| W | Weight |
| WHO | World Health Organization |

# ABSTRACT

**BACKGROUND:** Inappropriate case management of severe malnutrition is believed to be one of the main reasons why high case fatality rates (20–30%) persist worldwide. In 1999, the WHO developed guidelines for the management of severe malnutrition which have shown to reduce mortality rate of children .These guidelines have been adopted by the ministry of health in Kenya in the Basic Paediatric Protocols.

**OBJECTIVE:** The objective of this study was to evaluate the use of the World Health Organization guidelines for the treatment of children with severe acute malnutrition at Mbagathi District Hospital.

**METHODOLOGY**: A prospective audit of care given to 102 children aged 6-59 months admitted to Mbagathi District Hospital with severe malnutrition was carried out over a period of 4 months between June 2012 and September 2012. Consecutive sampling of study subjects was done until the desired sample size was achieved. Relevant information was extracted from medical records and entered in a structured data collection tool which allowed assessment of WHO steps 1-8 of management of severe acute malnutrition. Additional information was collected through daily observations in the ward and interviews with care givers and health workers.

**RESULTS**

A total of 102 children were recruited. The male: female ratio was 1:1 and the median age was 13 months. The majority (84.3%) of the children were aged below 24 months out of whom 47.5% were aged below 12 months. Overall, 77.5% of children had marasmus, 12.7% had kwashiorkor and 9.8% had marasmic kwashiorkor. The initial steps (steps 1, 2 and 3) of stabilization, which were essential for the survival of these children, were poorly implemented and inappropriately provided. The least implementation was in step I where none of the children were fed within one hour and there was a delay in initiating feeds with a median time of 12.3 hours from the time of admission. Less than half of the children were appropriately managed as per Step 3 (48.3%, 95%CI42.7-65.1) and step 8 (40.8%, 95%CI 33.7-47.8).There was modest implementation of Step 2 (78.6%, 69.1-86.1) and Step 6 (68.8%, (95%CI 60.4-78.2). The highest

implementation was in Step 4 (96.1%, (95%CI 90.3-98.9), Step 5 (92.2%, 95%CI 85.1-95.6) and step 7 (92%, (95%CI82.7-95.2).

Overall essential supplies were mostly available.

**CONCLUSIONS**

The management of children with severe malnutrition at Mbagathi District Hospital is inadequate and WHO guidelines are not adequately followed. Essential supplies needed for the management of these children are mostly available.

**RECOMMENDATIONS**

Continued training of health care workers in the use of the WHO guidelines and further studies to assess barriers to utilization of the WHO protocol which will help identify gaps which can be addressed.

# 1.0 CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW

Severe acute malnutrition is defined by a very low weight for height (below -3Z scores of the median WHO growth standards), by visible severe wasting or by the presence of nutritional edema. Decreasing child mortality and improving maternal health depend heavily on reducing malnutrition which is responsible, directly or indirectly, for 35% of deaths among children under five.[1]

Malnutrition in all its forms remains a major public health problem in the developing world and is an underlying factor in over 50% of the 10 million deaths among children under 5 years annually. Forty one percent of these preventable deaths occur in sub-Saharan Africa.[3]

In spite of important advances in prevention and treatment, malnutrition continues to be a worldwide problem. Internationally, 55 million children under the age of five are estimated to be wasted, of whom 19 million (35%) are severely wasted or severely malnourished. [6]

According to the 2008-2009 Kenya Demographic and Health Survey, 14 percent of Kenyan children are severely stunted and 2 percent are severely wasted. The target of MDG 4 for Kenya is to reduce mortality of children aged less than five years (under-five mortality) from the current 74/1,000 live births by 2/3 in 2015. The rates of under-five and infant mortality for the 15 year period preceding KDHS 2008-2009 were 74 and 52 per 1,000 live births respectively. This means that one in 14 children born in Kenya dies before reaching the fifth birthday while one in 19 dies before the first birthday.[2]

Children with severe acute malnutrition are more likely to fall sick and contribute to high mortality and morbidity. Although children are usually taken to a healthcare facility for acute illnesses including pneumonia or diarrhea, severe malnutrition is often an underlying causal factor, the importance of which is not well-recognized to warrant specific treatment. [4]

## PATHOPHYSIOLOGY OF MALNUTRITION

Malnutrition affects virtually every organ system. Dietary protein is needed to provide amino acids for synthesis of body proteins and other compounds that have various functional roles. Energy is essential for all biochemical and physiologic functions in the body. Furthermore, micronutrients are essential in many metabolic functions in the body as components and cofactors in enzymatic processes.

In addition to the impairment of physical growth and of cognitive and other physiologic functions, immune response changes occur early in the course of significant malnutrition in a child. These immune response changes correlate with poor outcomes. Loss of delayed hypersensitivity, fewer T lymphocytes, impaired lymphocyte response, impaired phagocytosis secondary to decreased complement and certain cytokines, and decreased secretory immunoglobulin A (IgA) are some changes that may occur. These immune changes predispose children to severe and chronic infections, most commonly, infectious diarrhea, which further compromises nutrition causing anorexia, decreased nutrient absorption, increased metabolic needs, and direct nutrient losses.

Other pathologic changes include fatty degeneration of the liver, atrophy of the small bowel, and decreased intravascular volume leading to secondary hyperaldosteronism. This causes sodium retention and loss of potassium through the kidneys leading to low total body potassium. Fatty degeneration of the heart causes subclinical or overt cardiac insufficiency and increases the risk of cardiac failure with iatrogenic sodium or fluid overload.

Severely malnourished children undergo physiological and metabolic changes to conserve energy and preserve essential processes including reductions in the functional capacity of organs and slowing of cellular activities. Coexisting infections add to the difficulty of maintaining metabolic control. Infections may be silent as normal immune responses are often suppressed. These profound changes put severely malnourished children at risk of death from hypoglycemia, hypothermia, electrolyte imbalance, heart failure and untreated infection. Thus, severely malnourished children are prioritized for immediate admission, and the initial stabilization phase

focuses on frequent feeding day and night, rehydrating with low-sodium fluids with close monitoring for signs of fluid overload, correcting electrolyte and micronutrient imbalances, and prescribing broad-spectrum antibiotics even when clinical signs are absent. The rehabilitation phase focuses on rebuilding wasted tissues, psychosocial stimulation and preparation for follow-up after discharge.

Schofield and Ashworth[8] demonstrated that mortality in children with severe malnutrition remained unchanged in the last 50 years (20% and 30%), with even higher rates (50% and 60%) in children with malnutrition edema (kwashiorkor), even taking into consideration the new knowledge about therapy for malnutrition. The authors hypothesized that these high mortality rates could be associated with misuse of diets high in protein, energy, and sodium and with low micronutrients; inadequate rehydration; improper antibiotic use; and administration of diuretics in children) [3,11,13]

Implementation of a standard treatment protocol based on the guidelines of the World Health Organization [1] is an essential first step for the facility-based management of severe acute malnutrition. It has been suggested that the mere presence of a standardized protocol increases discipline and attention to detail and results in fewer errors by health workers [7,8]. As long as severe malnutrition is prevalent, efforts to improve its treatment and outcome remain a priority.

In 1999 the World Health Organization (WHO) published a set of guidelines for the treatment of severe malnutrition in children.[1] The guidelines have been adopted by the Ministry of Health in Kenya and incorporated into their Basic Pediatric Protocols.[10] The rationale for following these 10 steps is based on studies that provide evidence that their use results in improvement of care and a decline in case fatality.[12 -18]

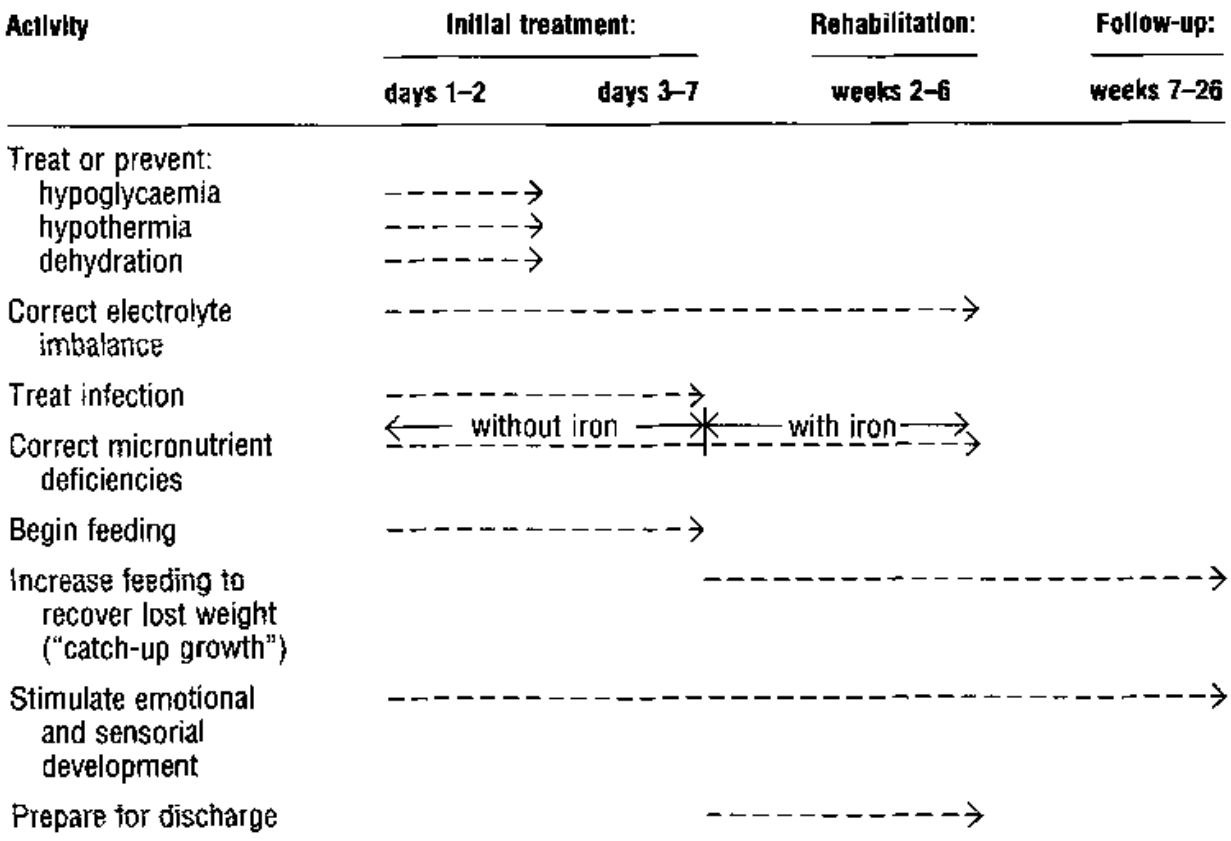
Management of the child with severe malnutrition is divided into three phases.
These are:

• **Initial treatment***:* life-threatening problems are identified and treated in a hospital or a residential care facility, specific deficiencies are corrected, metabolic abnormalities are reversed and feeding is begun.

• **Rehabilitation***:* intensive feeding is given to recover most of the lost weight, emotional and physical stimulation are increased, the mother or carer is trained to continue care at home, and preparations are made for discharge of the child.

• **Follow-up***:* after discharge, the child and the child's family are followed to prevent relapse and assure the continued physical, mental and emotional development of the child.

A typical time-frame for the management of a child with severe malnutrition is shown in the table below.



A study by Nzioki et al at Kenyatta National Hospital, the national referral hospital and a teaching hospital in Kenya showed that there is a challenge in the management of severe malnutrition with critical deficiencies in care being observed in a majority of steps. A case fatality of 38% was recorded.[9]

A study in Bangladesh reported a 17% mortality rate in children before the implementation of the WHO guidelines, and a 9% mortality rate after they were officially introduced [12]. A similar trend in South Africa revealed a reduction from 30% to 20% in the initial mortality rate, with a further reduction to 6% when WHO guidelines became more rigorously introduced. [13]

In a review of 140 studies on management of severe malnutrition in developing countries, Bhan et al, found evidence that careful assessment and appropriate treatment using WHO standardized protocols reduced morbidity and mortality from rates as high as 40-50% to some as low as 6%.[20]

## 2.0 STUDY JUSTIFICATION

In the last 50 years, significant progress has been made to improve the recovery of children with severe malnutrition.The government of Kenya through the ministry of health has adopted WHO guidelines on management of severe acute malnutrition which has shown to significantly lower mortality rates and improve treatment outcomes in the Basic pediatric protocols. The degree to which guidelines are implemented in the care of malnourished children in lower level public hospitals of (District/County Hospitals) where patients with acute malnourished are managed as inpatients is not known. A study done at a tertiary facility showed critical deficiencies in the management of children with severe malnutrition. It was important to systematically evaluate the care given to these children and to identify barriers gaps with the aim of using these findings to address any weaknesses that may exist and improve care.It was also important to determine whether availability of essential supplies needed for the management of these children was a limiting factor in the provision of quality care.

## 2.1 UTILITY OF THIS STUDY

This study documents the current practice in the management of acute malnutrition at Mbagathi District Hospital .It identifies weaknesses to successful utilization of WHO guideline based care and therefore informs on where improvements can be made.

# 3.0 OBJECTIVES

## 3.1 PRIMARY OBJECTIVE

To evaluate use of WHO recommended guidelines in the management of children aged 6-59 months admitted with severe malnutrition to Mbagathi District Hospital.

## 3.2 SECONDARY OBJECTIVES

1. To determine the proportion of children aged 6-59 months with severe malnutrition that receives appropriate treatment as per WHO guidelines at Mbagathi District Hospital

2. To assess the availability of essential supplies required for the management of children with severe malnutrition at Mbagathi District Hospital.

## 4.0 METHODOLOGY

### 4.1 Study Design

The study was a hospital-based prospective audit.

### 4.2 Study population

Children aged 6-59 months admitted with severe malnutrition

### 4.3 Study site

Mbagathi District Hospital is in Dagoretti Division, Nairobi County. It has a 38 bed pediatric ward. It has a monthly average admission of approximately 340 children aged less than 5 years. The catchment area is the whole of Nairobi especially the low social economic population of Nairobi. Most of the patients come from the neighboring Kibera slums.

Clinical care is provided by 2 Consultant Pediatricians, Medical Officers, Clinical Officers (diploma-level clinicians), nurses, and nutritionists. Sick children are first triaged, assessed and provided with immediate care in a walk-in pediatric casualty. Initial evaluation of the patients is done by clinical officers. (Diploma level clinicians) Medical Officers are responsible for the initial evaluation and management of patients on admission to the ward with a review of all admitted children by a consultant pediatrician during routine ward rounds.

Daily monitoring of patients and administration of drugs and fluids is done by nurses. Nutritionists are responsible for provision of feeds as prescribed by clinicians, alternate day weighing of the children, nutrition counseling and liaising with community based nutrition clinics where patients are followed up after discharge.

### 4.4 Sampling method

All patients who met the criteria were recruited consecutively until the desired sample size was achieved.

.

## 4.5 SAMPLE SIZE CALCULATION

Using Fischer's for calculating one sample size using precision around a proportion,

i.e. $N=d^2 (1-p)(P)/a^2$

Where: a2=0.1(the accepted precision around the mean)

p=the proportion of children receiving appropriate care .This is not known but it is assumed to be 50%

d=1.96(normal deviate corresponding to 95% confidence interval)

Thus $N=1.96^2x0.5x0.5/0.1x0.1=96$

The minimum number of patients was 96

## 4.6 PATIENTS SELECTION

Inclusion criteria

1. Children aged 6-59 months admitted with a diagnosis of severe malnutrition

2. Parent /guardian consent for the study

Exclusion criteria

1. Children whose care giver refused to give consent.

## 4.7 STUDY PROCEDURES

The principle investigator at first recruited two research assistants and trained them on the objectives and procedures of the study. They were trained on length, height, weight and MUAC measurements, data collection and entry of relevant information onto the data collection form. The research assistants captured any eligible patients admitted when the principle investigator was not available

Patient recruitment was carried out in the ward. The principal investigator together with the research assistants were stationed in the pediatric ward during the study period of four months. Enrollment of study subjects was carried out daily for 24 hours by the principal investigator with the help of the research assistants. All the patients admitted with a diagnosis of severe malnutrition had their nutritional status reassessed on the first day of admission into the ward.

The height/length, weight and MUAC of all patients admitted for inpatient management of severe malnutrition was measured according to the procedure outlined in appendix 6 [(21)] and the Z scores calculated as per NCHS/WHO reference values. (Appendix 9) The results were documented on the data collection form. The subjects were also assessed clinically for visible severe wasting and bilateral nutritional edema.

Weights were measured using the Secca infant weighing scale for the infants whose maximum weight is 20kg and the precision is up to 15 grams. For the older children, the digital weighing scale SYE-2005 A11 was used. The maximum weight is 150kg and a precision of up to 0.1 kg. The weighing scales were checked for accuracy on a daily basis. Heights were taken using a measuring board (Shorr Board$^{TM}$) which has a maximum height of 130 cm. A non-stretch MUAC tape was used to measure MUAC values. An informed consent was then sought from the caregiver of each of the eligible children and consecutive patients recruited until the desired sample size was achieved. Children who did not satisfy the eligibility criteria were not recruited. Relevant findings were documented on a structured data collection form. The study mainly focused on the utilization of steps1-8 of the WHO protocol in the management of severe malnutrition. The data collection form was designed such that it we were able to systematically assess the use of the first eight steps of WHO guidelines and capture any type of intervention given to the children at presentation at casualty and in the ward. Case records were reviewed

daily and on death or discharge and relevant information was abstracted and entered in a structured data collection form (Appendix 3).

Care givers of living children were interviewed on the third day in the ward .Information sought was on the initial management given to these children from the time of admission. Caregivers were also interviewed at the end of the first week or on discharge whichever was earlier using an open ended questionnaire (Appendix4).The information sought at this time was on the subsequent care the children were receiving e.g frequency and amounts of feeds, education sessions on nutrition given to them while in the ward and whether there was a plan for follow up of the children after discharge. A caregiver was the person who was taking care of the patient from the time of admission and throughout the period that they were in the ward. Any child who did not have a constant caregiver was excluded.

Consent was sought before being given the questionnaire to fill. The information from caregivers of each child allowed us to validate information from the medical records and observations.

Treatment records of the patients were also assessed and information about medication given, adjustment of feeds by clinicians and on monitoring of vital signs by the nurses was extracted.

All the ward based healthcare workers were also interviewed. Information was sought on their knowledge about the WHO guidelines, challenges faced during their management of these children and they filled a self administered inventory which explored availability and reliability of supplies and equipment. The latter asked staff to rate availability of items on a four point scale as: never available, rarely available, usually available or always available.(Appendix 5) Information collected was supplemented with information obtained through direct daily observations on the wards.

## 5.0 ETHICAL CONSIDERATIONS

1. Ethical approval was sought from the Kenyatta National Hospital Ethics Review and Research Committee and Mbagathi District Hospital management through the medical superintendent. Voluntary written informed consent was obtained from parents/guardians for recruitment into the study after giving them detailed information about the study.

3. Risks- No medical procedures were undertaken to the study participants in addition to the routine investigations in the ward and therefore there were no foreseeable risks to their health or wellbeing by participating in this study. Any necessary care was not withheld or delayed from those who chose to participate in the study. Useful information was passed on to the clinicians for the benefit of the patient.

.

4. Benefits-No monetary gain was obtained from participating in this study and only those willing were included.

5. Confidentiality- This was maintained at all times, the study participants was given study numbers and no identifying data was recorded. The information given was strictly for research purposes only, and was only available to the investigator.

6. Information sharing- The study findings was made available to the health workers taking care of the children at the hospital. The results inform on where improvements can be made and contribute to better management of children with severe malnutrition.

## 6.0 DATA MANAGEMENT

Clinical data was collected and recorded onto a pre formatted data collection tool. The data was then entered into a purpose designed MS Access database. Names and hospital inpatient numbers were not entered. Data was cross checked for completeness, accuracy and consistency. The analysis was done with SPPS version 19 software. Weight for height (WH) Z scores was calculated using EPINUT. Proportions were calculated with appropriate confidence intervals and medians with interquartile ranges derived appropriately to provide descriptive summaries of the data. Testing of associations between variables was done using Student's T tests, analysis of variance (ANOVA) for continuous variables and Chi square tests for comparing categorical data. Descriptive data is presented as frequency tables, bar graphs, pie charts and cross tabulations. Simple summaries of inventory findings, views on availability of supplies, staff and care giver perceptions were prepared.

## 8.0 RESULTS

For the period beginning 1st June to 30th September 2012, a total of 102 children aged between 5 and 59 months were recruited into the study. Out of these 51 were male (50%) and 51 (50%) were female giving a male: female ratio of 1:1.

Table 1 below summarizes the distribution of the three types of severe malnutrition according to gender.

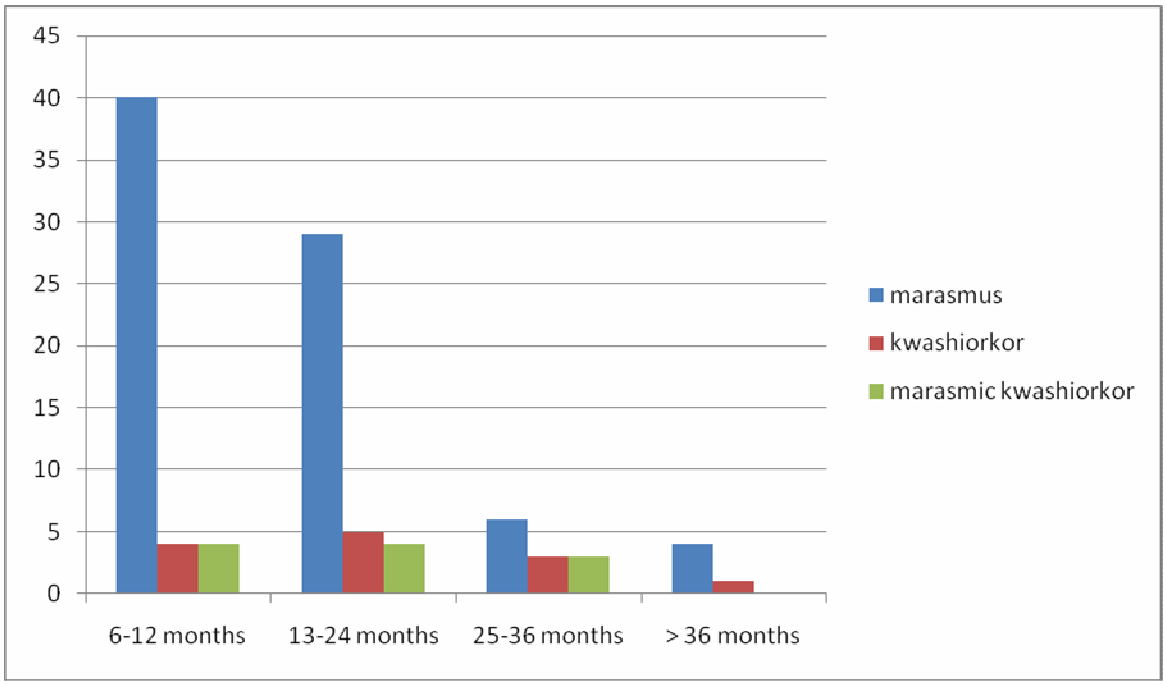
| Type of Malnutrition | Male | Female | Total (%) |
|---|---|---|---|
| | | | |
| Marasmus | 40 | 39 | 79 (77.5) |
| Kwashiorkor | **7** | 6 | 13 (12.7) |
| Marasmic kwashiorkor | 4 | 6 | 10 (9.8) |
| Total | 51 | 51 | 102 (100) |

Table 1: Distribution of Malnutrition according to gender (N=102)

Overall, majority of the children 79 (77.5%) had marasmus while 13 children (12.7%) had kwashiorkor and 10 (9.8%) had marasmic kwashiorkor.

On further analysis, there was no sex based differences in frequency between kwashiorkor and marasmus (OR 0.9, 95% CI 0.3-0.9, p value = 0.83) and between marasmic-kwashiorkor and marasmus (OR 1.5, 95% CI 0.4-5.9, p value = 0.526).

Figure 1: Age distribution by the type of malnutrition.




The median age for all the children was 13 months (IQR 9-18 months) with a range of 6 to 54 months.

The median age for the children with marasmus was 12 (IQR 9-18) months, marasmic kwashiorkor 17 (IQR 12-24) months and kwashiorkor 15 (IQR 9-24) months.

**WEIGHT FOR HEIGHT Z SCORES (n=102)**

At admission total of 80 (78.4%) had a WHZ score of -3SD and 22 (21.6%) had a WHZ score of -4SD. The table below summarizes the distribution of severity of malnutrition according to gender.

Table 2: Severity of malnutrition according to gender

| Z scores | Male | | Female | | Total | P value |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | Freq (%) | |
| -3SD to – 4SD | 41 | 80.4 | 39 | 76.5 | 80 (78.4) | 0.630 |
| < -4 SD | 10 | 19.6 | 12 | 23.5 | 22 (21.6) | |
| Total | 51 | 100 | 51 | 100 | 102 (100) | |

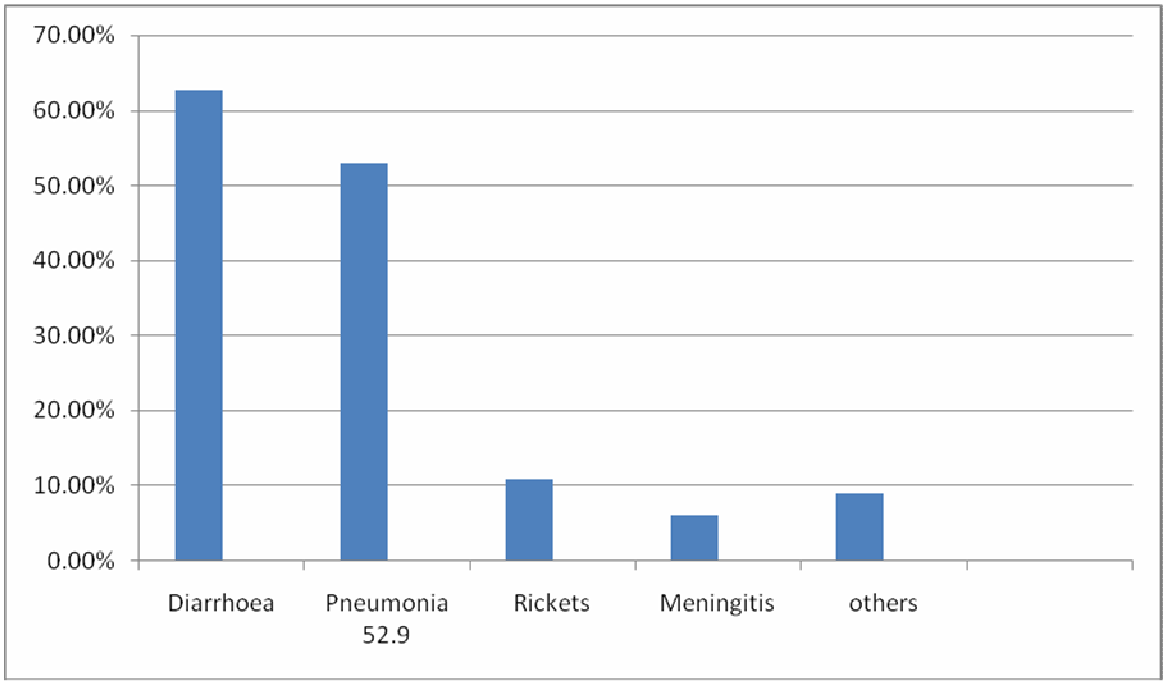
On further analysis, the difference of severe malnutrition (Z score-3 to-4) and very severe malnutrition (Z score <-4) between males and females was not statistically significant (p=0.63).

**CO- MORBIDITIES**

At admission, the most common co morbid clinical conditions in these patients were diarrhea 64 (62.7%), Pneumonia (52.9%),Rickets (10.8%) and meningitis (5.9%).Other conditions e. g otitis media and urinary tract infections comprised 8.8% while 5(4.9%) of all the patients had an underlying chronic disease. At admission 38 (37.3%) had one co-morbid condition, 56 (54.9%) had two co-morbid conditions while 8 (7.8%) had three co-morbid conditions.

The figure below illustrates the frequency of the various co morbidities at admission.

Figure 2:Co-morbidities at admission



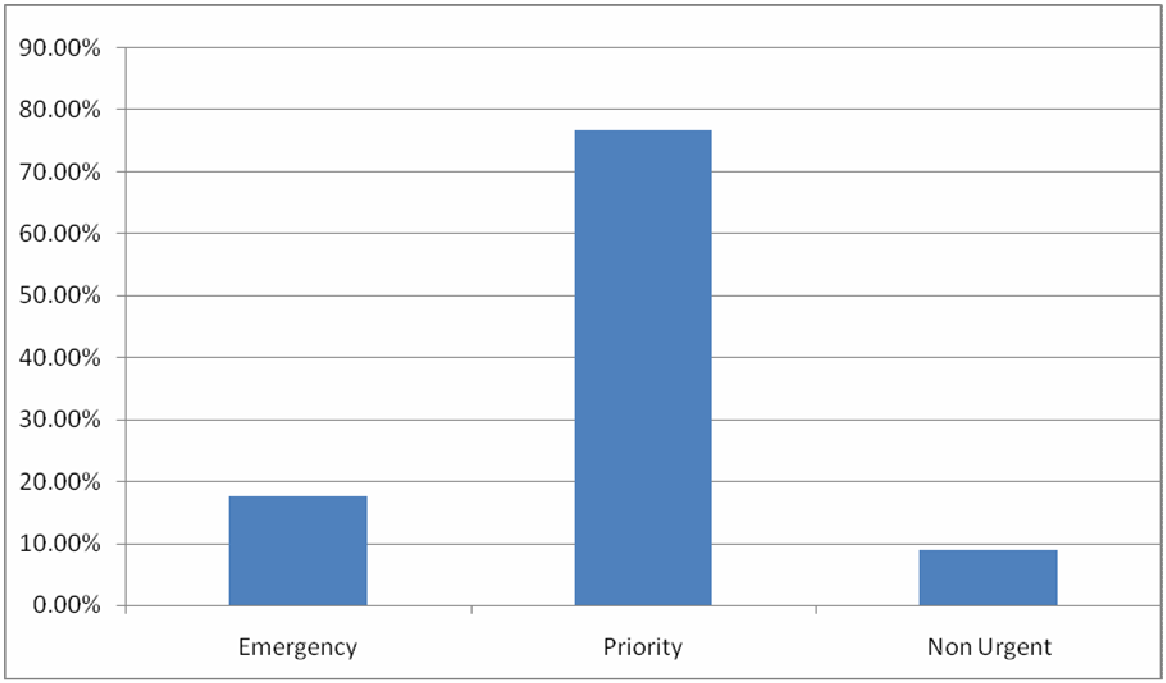

A total of 55 (53.9%) of children were tested for HIV, out of whom 4 (7.2%) were HIV positive while 14 (18.1%) were exposed to mother's HIV infection.

## AUDIT OF THE PROCESS OF CARE

### TRIAGING

All children with severe acute malnutrition should access immediate care. At the casualty department, 13.6% of children were triaged as emergency cases, 76.7% as priority while 8.8% were triaged as not urgent as illustrated in the figure below.

Figure 3: Triaging




Overall, 91.3% of the children were appropriately triaged either as priority or emergency. (95% CI 83.6 - 95.8).

**Table 3: Interventions in steps 1-3 in the management of severe malnutrition at MDH.**

| **Prevent and treat:** | Casualty | Ward |
|---|---|---|
| **Hypoglycemia (step 1) n=102** | | |
| Random blood sugar done | 17 (16.7%) | 4 (3.9%) |
| Treatment given (5mls/kg of 10% dextrose or Oral /NGT glucose or feeds within 30 minutes) | 2 (1.9%) | 0 |
| Waiting time from admission to first feed (mean) | - | 12.3 hours |
| **Hypothermia (step 2) n=102** | | |
| Temperature taken | 93 (90.3%) | 98 (96.0%) |
| Warmth provided | 45 (43.6%) | 81 (76.6%) |
| Mother instructed to keep child warm | 30 (29.1%) | 48 (46.6%) |
| Temp monitoring | 0 | 0 |
| **Correct management as per step 2** | **45 (44.1%)** | **81(79.4%)** |
| **Dehydration(step 3)** | | |
| Diarrhoea present | 62/102 (60.8%) | 64/102(62.7%) |
| Dehydration present | 53/62 (85.5%) | 58/64 (90.6%) |
| Hypovolaemic shock | 3/62 (4.8%) | 4/64 (6.3%) |
| ReSoMaL given for dehydration | 40/53 (75.5%) | 26/58 (44.8%) |
| Correct amount of ReSoMal prescribed | 39/40 (97.5%) | 26/26(100%) |
| Monitoring of ReSoMal | 11/53 (20.8%) | 26/58(30.8%) |
| IVF administered for shock | 3/3 (100%) | 4/4 75 (100%) |
| Correct amount of IV fluids for shock | 1/3 (33.3%) | 3/4 (75%) |
| Correct amount of IV Fluids in 1st hour | 1/3(33.3%) | 3/4 (75%) |
| Correct recording and monitoring of IV fluids | 1/3 (33.3%) | 2/4 (50%) |
| IVF administered for dehydration ( no shock) | 11/53 (20.8%) | 11/58 (18.9%) |
| **Correct management as per step 3** | **12/53(22.6%)** | **28/58(48.3%)** |
| Hb done | 56/102 (54.9%) | 70/102(68.6%) |
| Hb < 5g/dl | - | 5/102 (4.9%) |
| Transfused under IV furosemide | | 5/5 (100 %) |

**STEP 1: TREAT / PREVENT HYPOGLYCEMIA (n=102)**

A total of 17 (16.7%) had a random blood sugar done at casualty. Three children had a random blood sugar of less than 3mmol/l in casualty. Two of them had this corrected with the right volume of 10% dextrose. An additional 4 children had a random blood sugar done in the ward. None had a random blood sugar less than 3mmol/l. No feeding or presumptive treatment either orally or through nasogastric tube was documented for all the children either in casualty or in the ward. None of the children had their first feed within 30 minutes of presentation. Overall mean duration of first feed was 12.3 hours.

Therefore, only 2(1.9%), 95% CI 0.6 - 6.5) of the children received appropriate treatment as per WHO guidelines.

**STEP 2: TREAT / PREVENT HYPOTHERMIA (n=102)**

Out of a total of 102 children, axillary temperature at admission was documented in 93 (91.2%). None of these children had temperature below 35.O$^{o}$C hence none of the children was hypothermic. Out of the 93 children whose temperature was documented at casualty, total of 19 (20.8%) were noted to be febrile and caregivers were advised to keep then exposed. A total of 45(44.1%) children were kept warm in casualty and 81(79.4 %) were kept warm in the malnutrition room by providing them with a heater. The other 21(46.6%) children were nursed together with other non malnourished children. There were no heaters provided in these rooms. A total of 78 (76.7%) of all the caregivers were given instructions on how to keep their children warm through proper clothing and minimal washing and exposure

Overall, 45 (44.1%) of all children were appropriately managed for hypothermia at casualty (95% CI 34.3-54.3) and 81(79.4%) in the ward (95% CI 69.1-86.1).

## STEP 3: TREAT/PREVENT DEHYDRATION

A total of 62 children (60.7%) were documented to have diarrhea at casualty and 64 (62.7%) in the ward. Three children were diagnosed and treated for shock at casualty while an additional one child was managed for shock in the ward. Overall, three (75%) of the children with hypovolaemic shock were appropriately managed as per WHO guidelines. Inappropriate use of intravenous fluid for children who were not in shock was detected in a total of 11 (17.1%) of all the children who had diarrhea .At casualty, dehydration was documented in 53 (85.5%) of the children who had diarrhea while in the ward 58 (90.6%) children were diagnosed with dehydration, five more than was documented at casualty. ReSoMal was prescribed correctly for nearly all the children with dehydration both at casualty and in the ward. (97.5% and 100% respectively.) However it was difficult to determine whether the children received the correct amount because documentation was not done for all the children. Monitoring for changes in the pulse and respiratory rate as signs of over hydration was not done for any of the children.

Overall, 12(11.7%, 95% CI 9.6-24.3) and 28(27.4%, 95% CI 20.2-37.4) of the children were appropriately managed as per step 3 of the WHO guidelines at casualty and in the ward respectively.

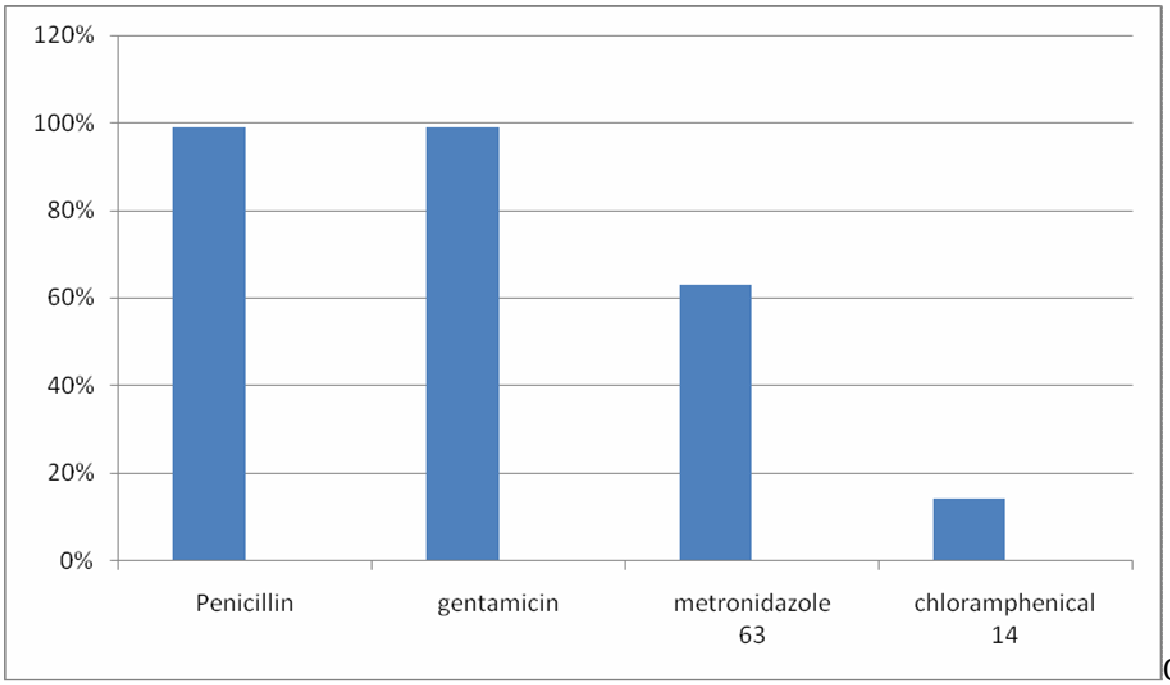
## STEP 4: CORRECT ELECTROLYTE IMBALANCE

A total of 98 were fed commercially prepared starter F75 that contains extra potassium and magnesium. A total of 4(3.9%) were given extra potassium. None of the children with edema were given furosemide. Therefore 96.1%, 95% CI 90.3-98.9) of the children were appropriately managed.

**STEP 5: TREAT INFECTIONS ROUTINELY**

A total of 99 (97.1%, 95% CI 91.6-98.4) children were treated with crystalline and 94 (92.2% ,95% CI 85.1-95.6) with gentamicin.Oral metronidazole was prescribed in 61.8% ,95% CI 51.6 - 71.2) of the children. Therefore prescription of oral metronidazole is significantly lower. A total of 26 (25.2%) were treated with mebendazole with 22 (84.6%) being given on admission.

Figure 4: Antibiotics




Overal l a total of 94 (92.2%), 95% CI 85.1-95.6) of all the children were treated with the correct combination of broad spectrum antibiotics. Chloramphenical was given in combination with crystalline penicillin in those patients suspected to have meningitis.

**STEP 6: CORRECT MICRONUTRIENT DEFICIENCIES (n=102)**

Vitamin A was given in 70 (68%) of all the children. There was no documentation of prior doses the children may have received. A total of 7 (6.8%) received folate while 13 (12.6%) were given multivitamins. F75 which contains adequate zinc was given to 98 (96.1%) of all the children.

Iron was given in only 4 (3.9%) of children. In all these children iron was given during rehabilitation phase.

Table 5: Micronutrients

| MICRONUTRIENT (%) | GIVEN | NOT GIVEN |
|---|---|---|
| Vitamin A | 70 (68.6%) | 32 (31.4%) |
| Correct dose of vitamin A | 69 (98.6%) | 1 (1.4%) |
| Multivitamins | 13 (12.6%) | 89 (87.4%) |
| Folic Acid | 7 (6.8%) | 95 (93.2%) |
| Zinc | 41 (39.8%) | 61 (60.2%) |
| Iron | 4 (3.9%) | 94 (96.1%) |

Overall 70 (68.8%) of all the children were given vitamin A and starter F75 which contains adequate micronutrients, hence they were adequately managed. ( 95% CI 60.4 -78.2).

**STEP 7: FEED CAUTIOUSLY ( n=102)**

F75 in the initial phase was prescribed in 98 (96.1%) of all the children. The rest of the children were fed on routine ward diet .A total of 11(10.8%) of all children were given additional feeds to F75.Daily monitoring of feeds was observed in 92 (90.2%) of children fed with F75 (table 6).

Children continued with breastfeeding where applicable. A total of 101 children were fed orally and 1 through nasogastric tube. According to the caregivers, the feeds were given more frequently during the day than during the night. Majority of caregivers 72 (72.7%) fed their children at least 4 times (3 hourly) during the day while at night most of them 80 (80.8%) fed their children 2-3 times (4-6 hourly) Most attributed this to lack of night feeds.

Table 6: Begin feeding

| Variable | Frequency (%) |
|---|---|
| F75 prescribed | 98 (96.1%),95% CI 90.3-98.9 |
| Feeding within 1 hr of arrival in the ward | 0 |
| F75 commercially prepared (n=98) | 98 (100.0) |
| 3 hourly feeds prescribed (n=98) | 98 (100.0) |
| Feeding monitored and documented (n=98) daily | 92 (90.2%) 95% CI 82.7-95.2) |
| Other foods given (n=98) | 11 (11.2) |
| Amount of feeds measured as per the prescription | 98 (100%) |

None of the children were fed within 1 hour of arrival in the ward. The median time from admission to the first feed was 12.3 hours. There was a delay in initiating feeds whereby the majority of children 85(83.3%) were started on feeds after 6 hours as shown in the table below.

Table 7: Time to first feed from admission

| Time to 1st feed(hours) | Frequency | % |
|---|---|---|
| <6 hours | 17 | 16.7 |
| >6 hours | 85 | 83.3 |
| | | |

**STEP 8: CATCH UP FEEDS**

Children were started on F100 was earlier than 7 days .The average duration of time the children were on F75 was 2.6 days with only two children on F75 on day 7.Monitoring during transition was not done for all the children. A total 91(89.2%) were started on F100 with appropriate volume increased in 40 (39.2%) of these children after the transition period. Weighing of the children was erratically done.

Table 8: Catch up feeds given

| | Number | percentage |
|---|---|---|
| F100 prescribed | 91 | 89.8 |
| Correct feed volume during transition | 90 (n=91) | 98.9 |
| Feed volume increased after transition | 40 (n=91) | 39.2 |

Overall 89.8%, of the children were properly started on catch up feed F100.However only in 40 (39.2%) of the children was the feeds correctly increased. Therefore, overall correct management as per step 8 of WHO guidelines was only in 39.2 % of the children. (95% CI 33.6-54.8).

**MANAGEMENT OF SEVERE ANAEMIA**

Hemoglobin levels were done in 70 (68.6%) children. Out of these 5 (4.9%) had a hemoglobin count of less than 5g/dl and they therefore required a blood transfusion. All of them were transfused with the correct amount of blood. Four of the children transfused were given a hematinic during rehabilitation. Frusemide was given only to the children who were transfused. One child had a top up transfusion before HAART was initiated .The mean hemoglobin was 10.0g/dl.

Overall 100% of the children who required transfusion were appropriately managed.

## ASSESSMENT OF AVAILABILITY OF ESSENTIAL SUPPLIES AND QUALITY OF NURSING CARE

A total of 20 health workers, 7(35%) nurses, 6 clinicians (30%) and 7(35%) nutritionists were interviewed on the availability of supplies essential in the management of children with severe malnutrition. Information was also sought on their management practices and challenges faced. None of the health workers had been trained on malnutrition management

An inventory of essential supplies was done through a structured interview with the health workers. As shown in the table below, essential supplies were largely available.

Table 9: Inventory of supplies

| | | | | |
|---|---|---|---|---|
| | Always available (%) | Available most times (%) | Rarely (%) | Never (%) |
| Glucostix and glucometer | 3 (15%) | 11 (55%) | 6 (30%) | |
| ReSoMal | 16 (80%) | 4 (20%) | | |
| F75 | 18 (90%) | 2 (10%) | | |
| F100 | 18 (90%) | 2 (10%) | | |
| Multivitamins | 10 (50%) | 9 (45%) | | 1 (5%) |
| Vitamin A | 18 (90%) | 2 (10%) | | |
| Folate | 3 (15%) | 15 (75%) | 2 (10%) | |
| Iron | 1 (5%) | 11 (55%) | 7 (35%) | 1 (5%) |
| Potassium | 1 (5%) | 12 (60%) | 4 (20%) | 3 (15%) |

All the nurses acknowledged that patients are not adequately managed citing that the main reasons are high patient: nurse ratio and inadequate equipment e .g pulse oximeters and glucometers. Monitoring of all children was done once a day.

## CARE GIVERS KNOWLEDGE AND PRACTICES

All the patients were accompanied by primary caregivers and they were solely responsible for feeding their children. A total of 98 caregivers were interviewed to assess their knowledge about their children's illness and actual care they received. Of the remaining 4 caregivers who were not interviewed, one absconded from the ward,another one could not communicate well due to language barrier while for the remained two, the children died before day 7 of admission. Of the 98 caregivers, 92 (93.9%) were mothers. A total of 36 (36.4%) knew that their children had severe malnutrition with 21 (21.2%) having been explained to the cause of the illness and the treatment that the children were receiving. Most of the caregivers fed the children at least four times during the day (72.7%) and between 2-3 times at night (80.8%).The F75 was measured using a measuring cup. It was difficult to assess adequacy of the amount of feeds given due to poor documentation on the feeding charts. Only 16 (15.7%) of all caregivers were educated on how to care for their children. A total of 29 (29.8%) children were discharged through the nutrition clinic for follow up.

Table 10: Frequency of feeding

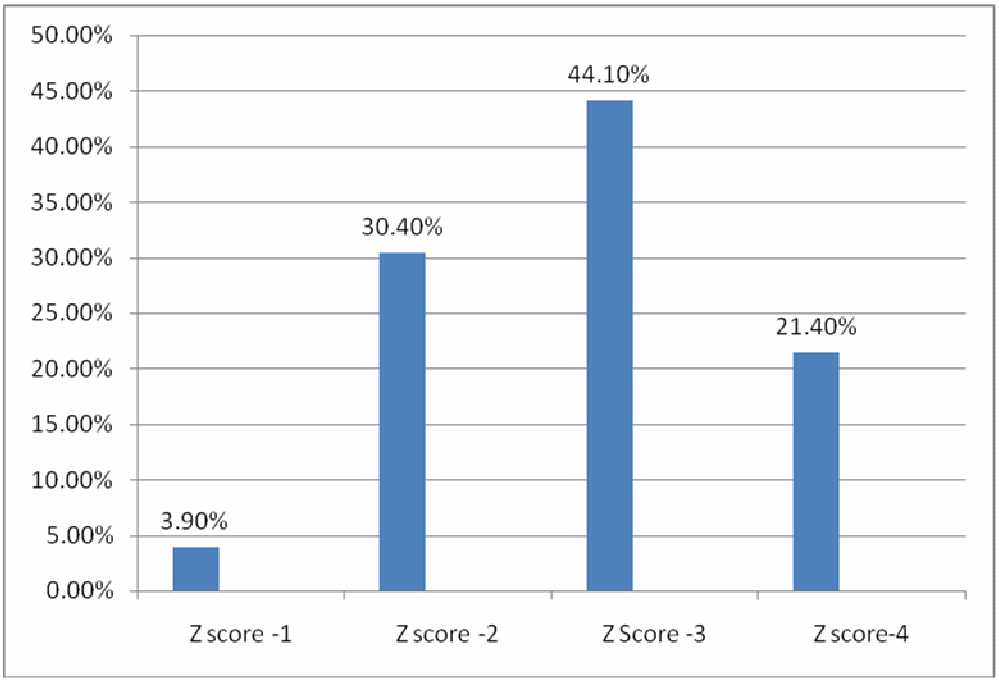
| Number of feeds | Day | | Night | |
|---|---|---|---|---|
| | Frequency (%) | Total (%) | Frequency | Total(%) |
| 0 - 1 | 0 | 0 | 25.2 | 25.2 |
| 2 - 3 | 54.5 | 54.5 | 65.7 | 72.7 |
| >4 | 44.5 | 100.0 | 8.1 | 100.0 |
| | | | | |

Over 44.5% of all children were fed at least 3 hourly during the day whereas only 8.1% of the children were fed at least 3 hourly during the night. Most of the caregivers attributed this to unavailability of night feeds.

**OUTCOME**

Of the 102 children in this study, 94 (92.2%) were discharged, 3 (2.9%) were referred to Kenyatta National Hospital. Two of the children had congenital heart disease and were referred for further management. The third child was suffering from Epilepsy and was referred for neurological management. One patient absconded from the ward. Five of the patients died giving case fatality rate of 4.9%. No deaths occurred in the first 24 hours of admission. All the children who died had marasmus. Septicemia precipitated death whereby two (40%) of the children had concurrent meningitis while the remaining three (60%) had severe pneumonia. Two of the patients who died were diagnosed to have HIV.As illustrated in the figure below, 3.9% of all the patients admitted were discharged at a WHZ score of -1SD,30.4% at -2 SD,44.1% at -3SD and 21.4% at -4SD. The mean duration of hospital stay was 12 days with a range of 4-49 days.

Figure 5: Nutrition status at Discharge.




Overall, only 3.9 %,( 95% CI 2.1-7.8) of all the children discharged met the WHO criteria for discharge.(WHZ Score -1SD).

## 9.0 **DISCUSSION**

This study evaluated the extent to which WHO guidelines are utilized in the management of severe acute malnutrition at Mbagathi District Hospital. In this study, the majority (82.6%) of the children were aged less than 24 months. This age distribution is similar to a study by Nzioki et al [(9)] at a Kenyan tertiary hospital. In this study however, only 19.2% of the children were aged less than 12 months whereas in the Nzioki study, this age group comprised 47.5%.This age distribution is also similar in studies done in Colombia and South Africa [(14, 16)]. Marasmus was the commonest presentation and the burden was highest in the children aged less than 24 months. This presentation could be associated with other causes, such as the early weaning from breast-feeding, the inappropriate introduction of complementary nutrition and a deficit of micronutrients.

The mothers did not identify malnutrition as a health problem because they usually only seek attention for diarrhea, skin infections, respiratory infections, and edema [(13)]. In this study diarrhea was the most common co morbidity in these children and 62.7% of the children had diarrhea at admission. This is similar to findings by Karaolis N. and Nzioki et al who also found that majority of acutely malnourished children had diarrhea (60% and 70.3% respectively) supporting the association between diarrhea and malnutrition.

In this study, 91,3% of the children were appropriately triaged. This is comparable to the finding by Nzioki et al where proper triaging was done to 91.1% of the children. However, major shortfalls in care were noted. These include treatment and prevention of hypoglycemia and hypothermia, delay in prompt start of therapy, especially initial re-feeding of children, and inadequate and erratic nursing care, in particular monitoring of feeds and fluids. However supplies of major commodities were generally good in contrast to the findings of Ashworth et al. in South Africa.[(13)]

Hypoglycemia is a common complication in malnourished children which can lead to brain damage since glucose is the main fuel for the brain and ultimately death. Treating or preventing hypoglycemia is vital during the initial stabilization phase of the treatment.

In the prevention and treatment of hypoglycemia, only 17(16.5%) of the children had an RBS done at presentation despite the availability of glucometers and glucosticks and none of the children was started on presumptive feeds within 30 minutes of arrival to the hospital. Ineffective treatment of this complication was observed in this study which was also documented by Berti A. in his study.[8] Other shortfalls which we observed in this study that can prevent hypoglycemia were long delays in starting of feeds after admission whereby the median time of first feed was 12.3 hours. This compares to a study by Nzioki et al at a Kenyan tertiary hospital whereby the median time of first feed was 14 hours. There was also insufficient monitoring of the feeds by nurses and unavailability of night feeds. Ashworth et al in South Africa,also documented that delay in prompt start of therapy, especially initial re-feeding of children, and inadequate and erratic nursing care, in particular monitoring of feeds mainly lead to improper management of this step. Feeding through nasogastric tube was not common. This may be attributed to lack of knowledge among the health workers on indications of feeding through NG tube in these children.

Hypoglycemia and hypothermia usually occur together and are signs of infection. The main reasons for not following this step properly in this study were the lack of instructions and provisions for the mother to keep her child warm and inability to recognize the importance of this step. Ashworth A. et al also stated in their study the importance of educating accompanying caregiver to warm their child, as mothers could play a pivotal role in carrying this step.[8] A number of studies had emphasized to train mothers and health personnel in order to allow for a successful adoption of simple interventions that prevent/treat hypothermia and that was reported to decrease case fatality.[15]

Children with severe malnutrition and diarrhea or pneumonia were not nursed in ‘malnutrition rooms’ but in non-warmed rooms, together with well nourished children. Thus, despite the availability of heaters (unlike the situation reported by Ashworth, et al [13]) children did not benefit from them.

Because of difficulty in diagnosis of dehydration in severe malnutrition and estimation of its severity, re-hydration fluid should only be given intravenously if children are in shock. Severely malnourished children not in shock should be hydrated orally using ReSoMal which has low sodium and high potassium. Similar to the studies by Nzioki and Ashworth, these guidelines

were not adequately followed and a large number of children not in shock were indiscriminately given intravenous fluids. Monitoring for over-hydration was not done and neither were volumes of fluids given properly recorded. Poor management of dehydration and correction of electrolytes imbalance could be due to lack of knowledge about the dangers of over-hydration and electrolytes imbalance and also the limited number of nursing staff. It is important to note that in the majority of cases, diarrhea improved after the start of F-75, which is low in lactose and has low osmolarity. The early administration of micronutrients had a potential positive effect on the structural and functional integrity of the gastrointestinal tract. In some patients, diarrhea began or was aggravated when F-100 was administered. This formula has a relatively high osmolarity, and it was necessary to withhold it.

Unlike the study in South Africa, correct antibiotics were routinely administered to acutely malnourished children because these children may not present signs or symptoms of infection. In this study, 99.7% of the children received antibiotics, but only 26.4% presented with fever.

High vitamin A, folic acid, other vitamins, and oligoelement supplementation at the start of therapy are fundamental in obtaining a successful outcome in these children. [(6)]. In the correction of micronutrient deficiencies 68% of all the children were given vitamin A which is vital. This is comparatively better than in the study by Nzioki whereby correct vitamin A was given in less than 50% of the children.Most of the children 96.1% received F75 which contains enough Zinc. However only 12.6% and 7% of the children received multivitamins and folate respectively. This is in contrast to the finding by Nzioki whereby multivitamins and folate were given to 90% and 72% of the children respectively This could be attributed to failure of the clinicians to prescribe the oligoelements. On average, the children's appetite improved after hospital day 3, when they attained the minimal necessary metabolic and physiological requirements. Following this, children began the rehabilitation phase . Taking this into consideration, the iron supplements were administered around day 8 of hospitalization when the children recovered their appetite and infections were controlled. Previous studies by Manary et al [(15)] suggest that iron supplements should not be started until children are metabolically and physiologically stable. Additionally, edematous malnourished children present with 'free' iron in serum, low transferrin, and high ferritin concentrations, which makes them prone to oxidative stress, major edema, and infection.[(21)]

Children with severe malnutrition should be given small frequent feeds of starter formula (F75) and continue breast-feeding where applicable. In this study there was a long delay before the first feed and in particular children admitted at night were normally not fed until the following day, though starter formula F75 was available in the ward. This could be attributed to the ignorance by nurses on the importance of prompt feeding and the perception that this was the duty of the nutritionists. Monitoring and computing amount of feed taken was rarely done. Timely bedside decisions were not taken by supervising clinical staff in the majority of cases which is in keeping with studies that have shown that activities that require frequent bedside decisions by physicians and nursing staff are often poorly done .[21]

In this study, caregivers were mainly responsible for feeding and oral rehydration and with time, most children's caregivers developed the ability to feed their children competently. This suggested that training of caregivers in basic duties such as feeding and identifying danger signs may be a useful way to relieve pressure on nurses and improve care.

In this study, initial phase had a mean duration of 2.6 days. This was significantly shorter than in study by Nzioki and Bernal et al whereby it was 6 and 5 days respectively. Though majority of the children were transitioned to F100 (89.2%),only 40.8 had their feeds increased appropriately thereafter and this was mainly due to failure of clinicians to update their prescriptions.
All the children who had severe anemia were appropriately managed and frusemide was only given to children during transfusion .This finding was contrary to that by Ashworth whereby patients with edema were indiscriminately given frusemide.
Similar to the study by Nzioki et al, essential supplies needed for treatment of children with malnutrition were largely available hence deficiencies noted in management of these children may not be explained by unavailability of supplies.
None of the healthcare workers acknowledged that they had undergone training in management in severe malnutrition. This could be attributed to the frequent turnover of the staff between the different departments. Planned follow-up at regular intervals after discharge is essential for ensuring the management of children in the rehabilitation phase as the risk of relapse is the highest soon after discharge, however, only 29 (29.8%) of 97 children who were discharged were advised on a return visit for follow-up .The poor plan for follow up may be attributed to failure by clinicians to recognize the importance of follow up for these patients.

The results of the implementation of the WHO guidelines for severe acute malnutrition therapy in children appear to be promising and even though high indices of mortality are recorded in other areas around the world [13], mortality in this study was relatively low (4.9%).Comparison of mortality rates between different studies is difficult because of differences in applying guidelines and other factors such as associated complications, and disease. The low mortality in this study may be attributed to prompt start of therapy with correct broad spectrum antibiotics, availability of vitamin A, commercial F75 which contains essential oligoelements and presence of trained specialists. Although some deaths could be avoided by optimizing care, some deaths might not be avoidable, especially in children admitted with severe illnesses, e.g. septicemia, severe pneumonia, etc as also mentioned by Brewster et al[22]. It is worthwhile to mention that all the children who died had septicemia (meningitis and severe pneumonia) this is unlike the study in South Africa where they attributed death due to sepsis in only 43% of the fatalities.
The length of hospital stay was also short for most of the children with an average of 11 days hence it was not possible to determine the long term outcome of these children after discharge. The average hospital stay of 11 days in this study is comparable to 14.3 days observed in a study in Bangladesh but inconsistent with the sphere standards/WFP/UNHCR guidelines of 3 to 4 weeks. The ideal discharge should match the goal of -1 SD of weight/height, but this was not always possible. 98 children were dismissed before attaining -1 SD. This occurs due to congestion in the ward and socioeconomic needs of the children's families.

## 8.1 CONCLUSIONS

1. Compliance to the guidelines was lowest in step 1 while compliance to the guidelines was highest in steps 4, 5 and 7
2. Essential supplies were largely available.
3. Most patients were discharged before they recovered and only 3.9 % of all the children discharged met the WHO criteria for discharge (WHZ Score -1SD).

## 8.2 RECOMMENDATIONS

1. It is clear that many health workers (including nutritionists) have a limited understanding of the needs of severely malnourished children and the importance of WHO protocol hence there is need to carry out regular training to the health workers.

2. The establishment at least a specialized malnutrition team to co-ordinate, continually audit care and educate health workers and caregivers.

3. Empowering the caregivers by educating them on appropriate feeding, rehydrating and keeping their children warm while the health workers closely monitor the progress of these children will improve quality of care and ease the workload of the health workers.

4. A mechanism of ensuring that night feeds are always available should be put in place. This will optimize feeds and hence faster recovery of the children eventually easing congestion in the ward and improving quality of care.

5. Further studies to assess barriers to utilization of the WHO protocol which will help identify gaps which can be addressed.

## 10.0 STUDY LIMITATIONS

Data was collected from the medical records which may have limited the quality and quantity of the data collected due to possibility of incomplete documentation.

This study was carried out in one site hence the results cannot be generalized to other hospitals.

.

## 11.0 REFERENCES

1 .World Health Organization.Management of Severe Malnutrition:A Manual for Physicians and other senior health workers. WHO:1999

2. Central Bureau of Statistics.Kenya Demographic and Health Survey. 2008-2009:142–146

3 Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? Lancet. 2003; 361: 2226–34.

4. Scholfield C, Ashworth A.Why have mortality rates for severe protein energy malnutrition remained high? Bull.WHO 1996; 74: 223–29.

5. Rice AL, Sacco L, Hyder A, Black RE.Malnutrition as an underlying cause of childhood deaths associated with infectious diseases in developing countries. Bull WHO 2000; 78:1207–21.

6. UNICEF: The State of the World's Children 2009.Maternal and Newborn Health. New York, USA: UNICEF, 2008

7. Jackson AA, Warrell DA, Cox TM, Firth JD, Benz EJ. Severe Malnutrition, Oxford textbook of medicine, 4th edition. Vol 1. Oxford: Oxford University Press, 2003. 1054–1061.1061

8. Berti A, Bregani E.R, Manenti F, Pizzi C. Outcome of severely malnourished children treated according to UNICEF 2004 guidelines: a one year experience in a zone hospital in rural Ethiopia. Transactions of the Royal Society of Tropical Medicine and Hygiene 2008; 102: 939-44.

9 Nzioki et al. Audit of care for children aged 6-59 months admitted with severe malnutrition at Kenyatta National Hospital, Kenya.PMC April 2010

10. Ministry of Health.Basic Pediatric protocols: September 2010:25-28

11. Khanum S, Ashworth A, Huttly SR. Controlled trial of three approaches to the treatment of severe malnutrition. Lancet 1994; 344:1728-1732.

12. Iqbal H, Nina S,Tahmeed A ,et al. Experience in Managing Severe Malnutrition in a Government Tertiary Treatment Facility in Bangladesh J Health Popul Nutr. 2009 February; 27(1): 72–79

13. Ashworth A, Chopra M, McCoy D, Sanders D, Jackson D, Karaolis N, et al .WHO guidelines for management of severe malnutrition in rural South African hospitals; effect on case fatality and influence of operational factors. Lancet.2004; 363:1110–15.

14. Bernal C, Velásquez C, Alcaraz G, Botero J:Treatment of severe malnutrition in children. experience in implementing the WHO guidelines in Turbo, Colombia. J Pediatr Gastroenterol Nutr. 2008; 46(3):322–328.

15 Manary MJ, Leeuwenburgh C, Heinecke JW. Increased oxidative stress in kwashiorkor. J Pediatr 2000; 137:421-424.

16. Puoane T, Sanders D, Chopra M, Ashworth A, Strasser S, McCoy D, et al. Evaluating the clinical management of severely malnourished children: A study of two rural hospitals. S Africa. Med. J.2001; 91:137–41.

17. Cavalcante AA, Pinheiro LM, Monte C, Guimarães AR, Ashworth A. Treatment of malnutrition in Brazil; simple solutions to common problems. Tropical Doctor. 1998; 28:95–7

18Falbo AR, Alves JG, Batista Filho M, Cabral-Filho JE.Implementation of World Health Organization guidelines for management of severe malnutrition in a hospital in north east Brazil. Cad Saude. Publica, Rio de Jeneiro.2006; 22:561–570.

19. Deen JL, Funk M, Guevara V, *et al*. Implementation of WHO guidelines on management of severe malnutrition in hospitals in Africa. Bull WHO 2003; 81:237-243.

20. Bhan MK, Bhandra M, Bahil R. Management of the severely malnourished child; perspective from developing countries. BMJ.2003;326:146–151

21.Scherbaum V, Furst P. New concepts on nutritional management of severe malnutrition: the role of protein. Curr Opin Clin Nutr Metab Care 2000; 3:31-38.

22.Brewster et al.Improving quality of care in severe malnutrition The Lancet, Volume 363, Issue 9426, Pages 2088 - 2089, 19 June 2004

# 12.0APPENDICES

## 12.1 APPENDIX 1: CONSENT INFORMATION FORM FOR PARENTS AND GUARDIANS

IP NO STUDY NO DATE

**Investigator's statement**

We are carrying out a study to evaluate care given to children admitted with malnutrition in this hospital .Your child has been diagnosed to have severe malnutrition.

I am requesting you to join the study .This form provides you with all the information to enable you decide whether to join or not

Your participation is wholly voluntary.

**The purpose of the study**.

This study will describe treatment given to children admitted with acute malnutrition in the ward

It will identify areas that need to be improved. This will help us serve your child and others with this illness better.

**Procedures**

I'll take the weight and height of your child to determine his/her nutrition status. No laboratory procedures will be undertaken for the purposes of this study.

I'll ask you a few questions about your child's illness. I'll also look at the clinical records of your child.

You are free to ask questions about this study at any stage.

**Rights**

Your participation is wholly voluntary. You may withdraw from the study at any point. The choice to participate or not; and pulling out of the study will not affect in any way the treatment of your child.

Treatment of your child will not be delayed for the purposes of this study. You may ask any question before, during and after joining the study.

The study will enable the hospital pinpoint any weaknesses in the treatment of severe malnutrition. This will aid in improving care given to children with this illness. This may not benefit your child immediately.

**Risks**

No treatment will be delayed or withheld from your child. No invasive procedures will be performed on your child for the purposes of this study. Any treatment that is required will be given

**Confidentiality**

All the information received will be held in strict confidence. No information that can identify your child will be published or discussed in public. You are free to ask any questions or seek any clarifications on the study before or after joining the study from the contacts below.

**CONSENT FORM FOR PARENT/CAREGIVER**

**PARENT'S/CAREGIVER'S STATEMENT**

The study above has been explained to me. I have understood its purpose and my rights as a subject in the study. I have had a chance to ask questions and have been assured that in future if I have any questions about the study or my rights as a subject, I can ask the investigator. I understand I can withdraw from the study at any time.

I voluntarily agree to participate in the study. I the participant confirm that I have understood all the relevant parts of the study and do hereby voluntarily give consent to participate.

Parent/care giver's ~~signature~~ ---------- Date----------

I the investigator confirm that I have given all the relevant information concerning the study and the participant has given consent voluntarily.

Investigators signature ---------- Date ----------

Witness signature ---------- Date ----------

**FOMU YA RIDHAA KWA MZAZI/MLEZI**

**NAMBARI----------** **TAREHE----------**

**TAARIFA YA MCHUNGUZI MKUU**

Tunafanya utafiti kutadhmini kiwango cha huduma wanaopokea watoto ambao wanalazwa na ugonjwa wa utapia mlo katika hospitali hii.

Mtoto wako anakabiliwa na ugonjwa wa utapia mlo.

Nakuomba wewe kujiunga katika utafiti huu.Hii fomu ina taarifa zote zinazohusiana na huu utafiti ili kukuwezesha wewe kuamua kama utajiunga au la .Kushiriki kwako ni kwa hiari

**MADHUMUNI YA UTAFITI**

Utafifi huu utaelezea matibabu hali ya matibabu wanayopokea watoto waliolazwa kwa hospitali hii na ugonjwa wa utapia mlo.Nitaweza kutambua sehemu ambazo zinahitaji kuboreshwa.Hii itawezesha hospitali kuhudumia motto wako na wengine walio na ugonjwa huu bora zaidi.

**TARATIBU ZA UTAFITI**

Nitachukua uzito na urefu wa mtoto wako ili kuamua hali yake ya lishe.Hakuna vipimo vya maabara ambazo zitachukuliwa kwa madhumuni ya utafiti huu.

Nitakuuliza maswali machache kuhusu ugonjwa wa mtoto wako.Nitaangalia pia zile kumbukumbu za hospitali za mtoto wako.

Uko na uhuru kuuliza maswali yoyote juu ya huu utafiti katika hatua yoyote.

**HAKI**

Ushiriki wako wote ni kwa hiari yako.

Unaweza kuamua kujiondoa kwenye utafiti huu katika hatua yoyote.

Uamuzi wako wa kushiriki au kutoshiriki ama kujiondoa katika utafiti huu hakutaathiri kwa njia yoyote matibabu ya mtoto wako.

Utafiti huu utawezesha hospitali kutathimini udhaifu katika matibabu ya ugonjwa wa utapia mlo.Hii itasaidia kuboresha huduma wanayopokea watoto walio na ugonjwa huu.Inawezekana hali hii haitafaidi mtoto wako kwa wakati huu.

**HATARI**

Mtoto wako hatanyimwa au kuchelewela kutibiwa kwa sababu ya utafiti huu.

Hakuna damu itakaochukuliwa ama taratibu zozote ila zile madaktari wanaotibu mtoto wako watakaoagiza.

Matibabu yote ambayo mtoto wako anahitaji atapokea.

**USIRI**

Taarifa zote zitakuwa za siri.Hakuna habari yoyote ambayo inaweza kutambua mtoto wako itachapishwa au kujadiliwa hadharani..

Iwapo kama utakuwa na swali kuhusu utafiti huu au namna ambayo majibu ya utafiti huu yatatumika unaweza kuwasiliana na mchunguzi mkuu: Dr. Ann W.Kamunya kupitia namba ya simu 0722562738.
Ikiwa una maswali yoyote kuhusu haki zako kama mshiriki wa utafiti unaweza kuwasiliana na **Kenyatta National Hospital Ethics and Research Committee (KNH- ESRC)** kwa kupiga namba ya simu **2726300 Ext. 44355** ama barua pepe: uonknh_erc@uonbi.ac.ke.

**CHETI CHA RIDHAA**

**TAARIFA YA MZAZI/MLEZI**

Nimeelezewa kikamilifu juu ya utafiti huu.Nineelewa mathumuni yake na haki zangu kama mshiriki.Nimepatiwa nafasi ya kuuliza maswali na nimehakikishiwa nikiwa na swali juu ya huu utafiti ama haki zangu kama mshiriki ninaweza kumuuliza mpelelezi mkuu wakati wowote.Nimeelewa kuwa ninaweza kujiondoa kutoka kwa utafiti huu wakati wowote.

Nimeamua kwa hiari kushiriki kwenye utafiti huu

Sahihi ya Mzazi ---------- Tarehe ----------

Nadhibiti ya kwamba nimepeana maelezo thabiti kuhusu utafiti huu, naye mhusika ametoa uamuzi wa kushiriki bila ya kulazimishwa.

Sahihi ya Mchunguzi ---------- Tarehe ----------

Sahihi ya Shahidi ---------- Tarehe ----------
.

## 12.2 APPENDIX 2; INFORMATION FOR MEMBERS OF STAFF ABOUT THE STUDY

I'm Dr Ann Wangechi Kamunya, a post graduate student in the department of pediatrics and child health. I'm undertaking a study on management of severe malnutrition at Mbagathi District Hospital. This study is undertaken in part fulfillment of the requirements for Masters of medicine (pediatrics and child health) program. I will be assisted by two research assistants. The study aims to compare the current standards of care with the WHO guidelines. The nutrition status of eligible subjects will be reassessed by taking anthropometric measurements. Relevant information will be retrieved from medical records of children aged 6-59 months with severe malnutrition. Daily observations of treatment practices in the ward will also be carried out and this recorded in a structured data collection tool. .I will give you a questionnaire inquiring about the availability of drugs, feeds and other supplies required for managing children with severe malnutrition. This questionnaire will also inquire about challenges faced by health workers as they care for these patients.

The information obtained will be reviewed and analyzed for research purposes only. Your identity will be kept confidential. The results of the study will serve as a part of monitoring to improve performance and health service delivery.

Your participation is purely voluntary; there are no major benefits or extra costs. Participation poses no additional risk to you. You may withdraw from the study at any stage. You are free to ask any questions about the study if you require clarifications.

If you ever have any questions about the study or about the use of the results you can contact the principal investigator: Dr. Ann W. Kamunya, Telephone number 0722562738.
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** or Email: uonknh_erc@uonbi.ac.ke

**Consent Form:**

I confirm that I have understood the relevant parts of the study and do hereby give consent to participate.

Health worker's signature _____ Date _____

I confirm that I have given all the relevant information concerning the study.

Investigators signature _____ Date _____

Witness signature _____ Date _____

## 12.3 APPENDIX 3: DATA COLLECTION FORM

Severe malnutrition case study

STUDY NO

IP NO

DATE

Fill in the appropriate response in the spaces provided

A**) Demographic characteristics of the children**

1. Date of Birth

2. Age in months

3. Sex M ☐ F ☐

B**) Anthropometric measures**

4. Height in cms

5. Weight kg gms

C) **Clinical evaluation of nutrition status**

6. Visible severe wasting YES/NO

7. Bilateral pedal edema YES/NO

8. W/H Z score -2SD ☐ 2-3SD ☐ -4SD ☐ >4SD ☐

9) Classification of severe malnutrition Kwashiorkor ☐ Marasmus ☐

Marasmic kwashiorkor ☐ Non Severe ☐

D) **Management of the child in casualty**

**(10)**How was the child triaged? ☐ Emergency ☐ priority ☐ not urgent

10 Why was the child admitted? Malnutrition ☐ ☐ severe infection

11**) Step 1: Treat/prevent hypoglycemia**

(i)Was the child alert? YES/NO

(ii) If no, what was done (explain)

(iii) Was RBS done? YES/NO
If yes, what were the results? (------mmol/l

(iv)If hypoglycemia, was treatment given? YES/NO
(Hypoglycemia=RBS<3mmol/l)

If yes, what was given? ☐ 10%Dextrose ☐ other (specify)

(v)Was the correction of hypoglycemia done correctly? YES/NO

(10%dextrose at 5mls/kg and oral/NG tube feeds within 30 minutes)

(12)**Step 2: Treat/prevent hypothermia**

(i) Was the temperature documented on admission? YES/NO

If yes, what was the temperature?

(ii)If hypothermia what was done?

☐ Heater ☐ Warm blankets ☐ other

(Hypothermia =axillary temp<35◦c, rectal temp. <35.5 ◦c)

(13**)Step 3: Treat/prevent Dehydration**

(i)Did the child have diarrhea? YES/NO/Not documented

(ii) Was the child dehydrated? YES/NO/No information

(iii) If yes, what was the level of dehydration? ☐ SHOCK ☐ SEVERE

SOME ☐

If the child was in shock, proceed to (iv) if not skip to (xi)

(iv)Was IV fluids prescribed? YES/NO

(V)Was the choice of IV fluid correct? YES/NO

(VI)Was the amount of IV fluid given in the first 1 hour correct? YES/NO

(Vii)Was the fluid monitored and fluid recorded? YES/NO

(viii)Was the child re- assessed by a clinician after 1 hour? YES/NO

(ix) Was the child out of shock after 1 hour? YES/NO

(x)If no, was the child transfused? YES/NO

(xi If yes, was the amount of blood transfused correct? YES/NO

(xi)Did the child have resomal prescribed? YES/NO

(xii)Was the correct amount of resomal prescribed? YES/NO

**(E)ASSESSMENT IN THE WARD**

**(i)** Was the child reviewed in the ward on admission? YES/NO

(ii)Did the child have visible severe wasting? YES/NO

(iii)Did the child have bilateral edema? YES/NO

(iv)How was the nutrition status of the child classified? Marasmus ☐

Kwashiorkor ☐

☐ Marasmic kwashiorkor ☐ Non severe

(V) Other co morbid conditions specified by the clinician?

a)

b)

c)

F**) MANAGEMENT IN THE WARD**

**(14)STEP 1; Treat/Prevent hypoglycemia**

(i) Was RBS done? YES/NO

(ii)If yes, what were the results? (-------) mmol/l

(iii)If hypoglycemia, what was given? ☐ 10 % Dextrose ☐ NG tube feeds ☐ other

(Hypoglycemia=RBS<3 mmol/l)

(iv)How soon after admission was the first feed given? (-------) hrs

**(15)STEP 2; Treat/prevent hypothermia**

(i)What was the temperature on admission? (----------)◦c

(ii)Was the child kept warm? YES/NO

If yes how? Heater provided ☐ Warm clothing ☐

**(16)STEP 3 Treat/prevent Dehydration**

: (i) Did the child have diarrhea? YES/NO/Not documented

(ii)Was the child vomiting? YES/NO/Not documented

(iii) Was the child dehydrated? YES/NO/No information

(iv) If yes, what was the level of dehydration? ☐ SHOCK ☐ SEVERE

SOME ☐

If the child was in shock, proceed to (iv) if not skip to (xiii)

(v) Was IV fluids prescribed? YES/NO

(Vi)Was the choice of IV fluid correct YES/NO

(Vii)Was the amount of IV fluid given in the first 1 hour correct? YES/NO

(15mls/kg of HSD 5% Dextrose)

(Viii)Was the fluid monitored and fluid recorded?

(ix) Was the child re- assessed by a clinician after 1 hour? YES/NO

(x) Was the child out of shock after 1 hour? YES/NO

(xi)If no, was the child transfused? YES/NO

(xii)If yes, was the correct amount of blood prescribed? YES/NO

(xiii)Did the child have resomal prescribed? YES/NO

(xiv)Was the correct amount of resomal prescribed? YES/NO

**(xv)**Was the intake of resomal monitored YES/NO?

(17**)STEP 4; correct electrolyte imbalance**

(i)Was U/E/C done? YES/NO

(ii)Was extra potassium prescribed? YES/NO

If yes, how much was prescribed per kg body weight?

(18**)STEP 5; Treat infections**

(i)Were antibiotics prescribed? YES/NO

If yes which Crystalline penicillin ☐ Gentamicin ☐

Metronidazole ☐ other ☐

(ii)Was mebendazole given? YES/NO

If yes after how many days was it given?

(19**)STEP 6; correct micronutrient deficiencies**

(i)Was Vitamin A given? YES/NO

If yes, was the dose correct? YES/NO

ii) Was folic acid given? YES/NO

(iii)Was zinc given? YES/NO

(IV)Were multivitamins given? YES/NO

(V)When iron if necessary was started? ☐ Acute phase ☐ Rehabilitation ☐ Not given

(20)**STEP 7; Begin feeding**

(I)Was starter formula F75 prescribed? YES/NO

(ii)Is F75 commercially prepared? YES/NO

(iii)After what duration in hours after admission was the first feed given?

(iv)What was the frequency of feeding? 2hrly ☐ 3hrly ☐ Not specified ☐

(v)What was the route of feeding?

(vi)Was the feed intake monitored daily and documented?

(vii)For how many days was the child on F75?

(Viii)Was the child given other feeds in addition? YES/NO

If yes, specify

(21)**STEP 8; catch up growth**

(i) Was transition F100 prescribed? YES/NO

(ii)Was the initial volume correct? YES/NO

(III)Was the volume increased appropriately after transition period? YES/NO

22) Was a full blood count done? YES/NO

If yes, what was the Hb (---------) g/dl.

(ii)Did the child receive blood transfusion? YES/NO

If yes, was it required? YES/NO

(iii)Was the correct volume given? YES/NO

(iv)Was frusemide given? YES/NO

23) How often were the vital sighs measured in the first 2 days?

24) What was the outcome? Discharged ☐ Died ☐ Alive ☐

25) What was the duration of hospital stay? ( ----------)-days

## 12.4 APPENDIX 4: CAREGIVER'S INTERVIEW IN THE WARD.

**(i)**Have the illness of your child been explained to you? YES/NO

If yes explain

(ii)What have you been told caused your child's illness? (Explain)

(iii) What do you know about the treatment your child is receiving? (Explain)

(iv)Who feeds the child?

(V)How many times should the child feed and how frequently

a. Day

b. Night

(vi)During the past 24 hours how many times did the child feed?

a. Day

b.Night

(vii)How much is your child supposed to take at each feed?

(viii)Are the feeds measured? How?

(ix)How do you keep your child warm (explain)

26) Have you been explained for the importance of playing with your child? YES/NO (explain)

(ii)Are toys available in the ward? YES/NO

27) Have you been explained how to prevent your child and other siblings from getting malnourished? YES/NO

If yes, explain

28) When your child is discharged from hospital, have you been advised about where they will be followed up? YES/NO

If yes, where?

## 12.5 APPENDIX 5: HEALTH WORKERS QUESTIONNAIRE

DATE:

(i)What is your job description? ☐ Clinician ☐ Nurse ☐ Nutritionist

(ii)Have you undergone training on management of severe malnutrition? YES/NO

IF YES, which one? ☐ ETAT+ ☐ Other (specify)

Please rate the availability of the following supplies as follows

1 Always available

2 Available most times

3 Rarely available

4 Never available

1).Glucometer and glucostix ☐

2) Resomal ☐

3) F75 ☐

4) F100 ☐

5) Potassium supplements ☐

6) Multivitamins ☐

7) Vitamin A ☐

8) Folate ☐

9) Iron supplements ☐

(ii)How many functional heaters are available?

(iii) Are patients monitored adequately at least 6 hourly?  YES/NO

If no, .what are the probable reasons (explain)

a.

b.

c.

(iv)In your opinion what are the challenges encountered when managing patients with malnutrition?

a

b

c

## 12.6 APPENDIX 6 : TAKING ANTHROPOMETRIC MEASUREMENTS.

### 1 TAKING A CHILD'S WEIGHT.

1. Before weighing the child take all his/her clothes off.
2. Zero the weighing scale (i.e. make sure the arrow is on 0).
3. Place the child on the weighing scale.
4. Make sure the child is not holding onto anything.
5. Read the child's weight. The arrow must be steady.
6. Record the weight in kg to the nearest 100g e.g. 6.6kg
7. Do not hold the scale while reading the weight.

### 2 TAKING A CHILD'S LENGTH.

For children less than 87 cm, the measuring board is placed on the ground.

1. The child is placed lying down along the middle of the board.
2. The assistant holds the sides of the child's head and positions the head until it firmly touches the fixed headboard with the hair compressed.
3. The measurer places her hands on the child's leg, gently stretches the child and then keeps one hand on the thighs to prevent flexion.
4. While positioning the child's legs, the sliding foot-plate is pushed firmly against the bottom of the child's feet.
5. To read the height measurement, the foot-plate must be perpendicular to the axis of the board and vertical.
6. The height is read to the nearest 0.1 cm.

## 3 TAKING A CHILD'S HEIGHT.

1. The child stands, upright against the middle of the measuring board.
2. The child's head, shoulders, buttocks, knees, and heels are held against the board by the assistant.
3. The measurer positions the head and the cursor.
4. The height is read to the nearest 0.1 cm.
5. Measurement is recorded immediately.

## 4 TAKING A CHILD'S MIDDLE UPPER ARM CIRCUMFERENCE (MUAC).

MUAC is an alternative way to measure thinness (alternative to weight for height). It is especially used for children 6 months to 5 years old.

How to Measure MUAC.

1. Ask the mother to remove any clothing covering the child's left arm.
2. Calculate the midpoint of the child's left upper arm: first locate the tip of the child's shoulder with your fingertips.
3. Bend the child's elbow to make the right angle.
4. Place the tape at zero, on the tip of the shoulder and pull the tape straight down past the tip of the elbow.
5. Read the number at the tip of the elbow to the nearest centimeter. Divide this number by two to estimate the midpoint.
6. Mark the midpoint with a pen on the arm.
7. Straighten the child's arm and wrap the tape around the arm at the midpoint. Make sure the numbers are right side up and the tape is flat around the skin.
8. Inspect the tension of the tape on the child's arm. Make sure the tape has the proper tension and is not too tight or too loose.
9. With the tape in correct position on the arm with the correct tension, read and call out the measurement to the nearest 0.1cm.
10. Immediately record the measurement.

## 12.7 **APPENDIX 7 :NCHS/WHO NORMALIZED REFERENCE VALUES FOR WEIGHT-FOR-HEIGHT AND WEIGHT-FOR-LENGTH**

| Boys' weight (kg) | | | | | Length[a] (cm) | Girls' weight (kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| -4 SD | -3 SD | -2 SD | -1 SD | Median | | Median | -1 SD | -2 SD | -3 SD | -4 SD |
| 1.8 | 2.1 | 2.5 | 2.8 | 3.1 | 49 | 3.3 | 2.9 | 2.6 | 2.2 | 1.8 |
| 1.8 | 2.2 | 2.5 | 2.9 | 3.3 | 50 | 3.4 | 3.0 | 2.6 | 2.3 | 1.9 |
| 1.8 | 2.2 | 2.6 | 3.1 | 3.5 | 51 | 3.5 | 3.1 | 2.7 | 2.3 | 1.9 |
| 1.9 | 2.3 | 2.8 | 3.2 | 3.7 | 52 | 3.7 | 3.3 | 2.8 | 2.4 | 2.0 |
| 1.9 | 2.4 | 2.9 | 3.4 | 3.9 | 53 | 3.9 | 3.4 | 3.0 | 2.5 | 2.1 |
| 2.0 | 2.6 | 3.1 | 3.6 | 4.1 | 54 | 4.1 | 3.6 | 3.1 | 2.7 | 2.2 |
| 2.2 | 2.7 | 3.3 | 3.8 | 4.3 | 55 | 4.3 | 3.8 | 3.3 | 2.8 | 2.3 |
| 2.3 | 2.9 | 3.5 | 4.0 | 4.6 | 56 | 4.5 | 4.0 | 3.5 | 3.0 | 2.4 |
| 2.5 | 3.1 | 3.7 | 4.3 | 4.8 | 57 | 4.8 | 4.2 | 3.7 | 3.1 | 2.6 |
| 2.7 | 3.3 | 3.9 | 4.5 | 5.1 | 58 | 5.0 | 4.4 | 3.9 | 3.3 | 2.7 |
| 2.9 | 3.5 | 4.1 | 4.8 | 5.4 | 59 | 5.3 | 4.7 | 4.1 | 3.5 | 2.9 |
| 3.1 | 3.7 | 4.4 | 5.0 | 5.7 | 60 | 5.5 | 4.9 | 4.3 | 3.7 | 3.1 |
| 3.3 | 4.0 | 4.6 | 5.3 | 5.9 | 61 | 5.8 | 5.2 | 4.6 | 3.9 | 3.3 |
| 3.5 | 4.2 | 4.9 | 5.6 | 6.2 | 62 | 6.1 | 5.4 | 4.8 | 4.1 | 3.5 |
| 3.8 | 4.5 | 5.2 | 5.8 | 6.5 | 63 | 6.4 | 5.7 | 5.0 | 4.4 | 3.7 |
| 4.0 | 4.7 | 5.4 | 6.1 | 6.8 | 64 | 6.7 | 6.0 | 5.3 | 4.6 | 3.9 |
| 4.3 | 5.0 | 5.7 | 6.4 | 7.1 | 65 | 7.0 | 6.3 | 5.5 | 4.8 | 4.1 |
| 4.5 | 5.3 | 6.0 | 6.7 | 7.4 | 66 | 7.3 | 6.5 | 5.8 | 5.1 | 4.3 |
| 4.8 | 5.5 | 6.2 | 7.0 | 7.7 | 67 | 7.5 | 6.8 | 6.0 | 5.3 | 4.5 |
| 5.1 | 5.8 | 6.5 | 7.3 | 8.0 | 68 | 7.8 | 7.1 | 6.3 | 5.5 | 4.8 |
| 5.3 | 6.0 | 6.8 | 7.5 | 8.3 | 69 | 8.1 | 7.3 | 6.5 | 5.8 | 5.0 |
| 5.5 | 6.3 | 7.0 | 7.8 | 8.5 | 70 | 8.4 | 7.6 | 6.8 | 6.0 | 5.2 |
| 5.8 | 6.5 | 7.3 | 8.1 | 8.8 | 71 | 8.6 | 7.8 | 7.0 | 6.2 | 5.4 |
| 6.0 | 6.8 | 7.5 | 8.3 | 9.1 | 72 | 8.9 | 8.1 | 7.2 | 6.4 | 5.6 |
| 6.2 | 7.0 | 7.8 | 8.6 | 9.3 | 73 | 9.1 | 8.3 | 7.5 | 6.6 | 5.8 |
| 6.4 | 7.2 | 8.0 | 8.8 | 9.6 | 74 | 9.4 | 8.5 | 7.7 | 6.8 | 6.0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6.6 | 7.4 | 8.2 | 9.0 | 9.8 | 75 | 9.6 | 8.7 | 7.9 | 7.0 | 6.2 |
| 6.8 | 7.6 | 8.4 | 9.2 | 10.0 | 76 | 9.8 | 8.9 | 8.1 | 7.2 | 6.4 |
| 7.0 | 7.8 | 8.6 | 9.4 | 10.3 | 77 | 10.0 | 9.1 | 8.3 | 7.4 | 6.6 |
| 7.1 | 8.0 | 8.8 | 9.7 | 10.5 | 78 | 10.2 | 9.3 | 8.5 | 7.6 | 6.7 |
| 7.3 | 8.2 | 9.0 | 9.9 | 10.7 | 79 | 10.4 | 9.5 | 8.7 | 7.8 | 6.9 |
| 7.5 | 8.3 | 9.2 | 10.1 | 10.9 | 80 | 10.6 | 9.7 | 8.8 | 8.0 | 7.1 |
| 7.6 | 8.5 | 9.4 | 10.2 | 11.1 | 81 | 10.8 | 9.9 | 9.0 | 8.1 | 7.2 |
| 7.8 | 8.7 | 9.6 | 10.4 | 11.3 | 82 | 11.0 | 10.1 | 9.2 | 8.3 | 7.4 |
| 7.9 | 8.8 | 9.7 | 10.6 | 11.5 | 83 | 11.2 | 10.3 | 9.4 | 8.5 | 7.6 |
| 8.1 | 9.0 | 9.9 | 10.8 | 11.7 | 84 | 11.4 | 10.5 | 9.6 | 8.7 | 7.7 |

| **Boys' weight (kg)** | | | | | **Height(cm)** | **Girls' weight (kg)** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **-4 SD** | **-3 SD** | **-2 SD** | **-1 SD** | **Median** | | **Median** | **-1 SD** | **-2 SD** | **-3 SD** | **-4 SD** |
| 7.8 | 8.9 | 9.9 | 11.0 | 12.1 | 85 | 11.8 | 10.8 | 9.7 | 8.6 | 7.6 |
| 7.9 | 9.0 | 10.1 | 11.2 | 12.3 | 86 | 12.0 | 11.0 | 9.9 | 8.8 | 7.7 |
| 8.1 | 9.2 | 10.3 | 11.5 | 12.6 | 87 | 12.3 | 11.2 | 10.1 | 9.0 | 7.9 |
| 8.3 | 9.4 | 10.5 | 11.7 | 12.8 | 88 | 12.5 | 11.4 | 10.3 | 9.2 | 8.1 |
| 8.4 | 9.6 | 10.7 | 11.9 | 13.0 | 89 | 12.7 | 11.6 | 10.5 | 9.3 | 8.2 |
| 8.6 | 9.8 | 10.9 | 12.1 | 13.3 | 90 | 12.9 | 11.8 | 10.7 | 9.5 | 8.4 |
| 8.8 | 9.9 | 11.1 | 12.3 | 13.5 | 91 | 13.2 | 12.0 | 10.8 | 9.7 | 8.5 |
| 8.9 | 10.1 | 11.3 | 12.5 | 13.7 | 92 | 13.4 | 12.2 | 11.0 | 9.9 | 8.7 |
| 9.1 | 10.3 | 11.5 | 12.8 | 14.0 | 93 | 13.6 | 12.4 | 11.2 | 10.0 | 8.8 |
| 9.2 | 10.5 | 11.7 | 13.0 | 14.2 | 94 | 13.9 | 12.6 | 11.4 | 10.2 | 9.0 |
| 9.4 | 10.7 | 11.9 | 13.2 | 14.5 | 95 | 14.1 | 12.9 | 11.6 | 10.4 | 9.1 |
| 9.6 | 10.9 | 12.1 | 13.4 | 14.7 | 96 | 14.3. | 13.1 | 11.8 | 10.6 | 9.3 |
| 9.7 | 11.0 | 12.4 | 13.7 | 15.0 | 97 | 14.6 | 13.3 | 12.0 | 10.7 | 9.5 |
| 9.9 | 11.2 | 12.6 | 13.9 | 15.2 | 98 | 14.9 | 13.5 | 12.2 | 10.9 | 9.6 |
| 10.1 | 11.4 | 12.8 | 14.1 | 15.5 | 99 | 15.1 | 13.8 | 12.4 | 11.1 | 9.8 |
| 10.3 | 11.6 | 13.0 | 14.4 | 15.7 | 100 | 15.4 | 14.0 | 12.7 | 11.3 | 9.9 |
| 10.4 | 11.8 | 13.2 | 14.6 | 16.0 | 101 | 15.6 | 14.3 | 12.9 | 11.5 | 10.1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10.6 | 12.0 | 13.4 | 14.9 | 16.3 | 102 | 15.9 | 14.5 | 13.1 | 11.7 | 10.3 |
| 10.8 | 12.2 | 13.7 | 15.1 | 16.6 | 103 | 16.2 | 14.7 | 13.3 | 11.9 | 10.5 |
| 11.0 | 12.4 | 13.9 | 15.4 | 16.9 | 104 | 16.5 | 15.0 | 13.5 | 12.1 | 10.6 |
| 11.2 | 12.7 | 14.2 | 15.6 | 17.1 | 105 | 16.7 | 15.3 | 13.8 | 12.3 | 10.8 |
| 11.4 | 12.9 | 14.4 | 15.9 | 17.4 | 106 | 17.0 | 15.5 | 14.0 | 12.5 | 11.0 |
| 11.6 | 13.1 | 14.7 | 16.2 | 17.7 | 107 | 17.3 | 15.8 | 14.3 | 12.7 | 11.2 |
| 11.8 | 13.4 | 14.9 | 16.5 | 18.0 | 108 | 17.6 | 16.1 | 14.5 | 13.0 | 11.4 |
| 12.0 | 13.6 | 15.2 | 16.8 | 18.3 | 109 | 17.9 | 16.4 | 14.8 | 13.2 | 11.6 |
| 12.2 | 13.8 | 15.4 | 17.1 | 18.7 | 110 | 18.2 | 16.6 | 15.0 | 13.4 | 11.9 |

World Health Organization. Management of Severe Malnutrition: A Manual for Physicians and Other Senior Health Workers. Geneva: World Health Organization; 1999