

Assessment and evaluation of in-patient diagnosis and discharge protocols of Ghanaian infants and children (0 - 59 months) diagnosed with severe acute malnutrition - the SAMAC study

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PREFACE

This mini-dissertation consists of four chapters and is written in an article format. Chapter 1 is an introduction to the topic. Chapter 2 is a detailed review of literature on the topic while chapter 3 is an article to be submitted to the journal of *Maternal and Child Nutrition* titled: "Admission and discharge guidelines of Ghanaian infants and children (0 – 59 months) admitted for severe acute malnutrition" written by Janet Adede Carboo, the MSc student, according to the author's instructions of the journal. The article is co-authored by Dr Robin Dolman, Dr Martani Lombard, Dr Cristian Ricci, Ms Hannah Asare and Prof Etienne Nel who have all permitted the inclusion of the article in this mini-dissertation for the purpose of examination and completion of the Master of Science degree in Dietetics. Chapter 4 provides a general discussion of the findings of the study together with recommendations and conclusion.

I hereby declare that with the exception of the acknowledged references, I Janet Adede Carboo planned, implemented and wrote up this research work at the Centre of Excellence for Nutrition at the North-West University under the supervision and guidance of Dr Robin Dolman and Dr Martani Lombard.



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ABSTRACT

Introduction: Complicated severe acute malnutrition (SAM) poses an enormous threat to the survival of children 0 - 59 months old. Even though the World Health Organisation (WHO) has provided diagnostic guidelines for in-patient management of SAM, these are not based on strong evidence. Furthermore, knowledge of the protocols used in various hospitals and the actual clinical practices regarding SAM diagnosis, admission and discharge remains limited. In addition, information on the relationship between the admission characteristics of children with complicated SAM and length of hospital stay (LOS), mortality and weight gain is scant. This study, therefore, aimed to assess the protocols of the hospitals compared with actual clinical practices and the WHO guidelines, with regard to the diagnosis, in-patient admission and discharge of children with SAM in relation to patient treatment outcomes.

Methods: Data on the protocols of two Ghanaian hospitals for SAM diagnosis, admission and discharge were collected and compared with the WHO guidelines. The study also involved a retrospective collection of data from the medical records of children aged 0 - 59 months, diagnosed and admitted with SAM, treated and subsequently discharged between January 2013 and June 2017 at the Princess Marie Louis Children's hospital and the Komfo Anokye teaching hospital in Ghana. Anthropometric and clinical characteristics on admission were assessed in relation to LOS, mortality, daily weight gain, weight-for-age z-scores (WHZ) and improvement in mid-upper arm circumference (MUAC). Data was analysed using SAS version 9.4. Spearman's correlation and linear regression were used to determine the association between admission characteristics and the treatment outcomes.

Results: There were some similarities but a few disparities between the hospitals' protocols and the WHO guidelines. In the hospitals' protocols, MUAC was the only anthropometric tool recommended for SAM diagnosis as compared with the use of MUAC or WHZ as anthropometric tools recommended by the WHO. Additionally, children 6 - 59 months weighing < 4 kg are considered severely malnourished and require in-patient treatment according the protocols of the hospitals. There were also some differences between the protocols of the hospitals and the practices as observed in the medical records. Although, MUAC is the only anthropometric tool recommended by the hospitals for SAM diagnosis, only 34.3% of the children had MUAC assessed at admission. Among the discharged children, only 58.5% had their infections resolved and 74.1% had good appetite while only 44.2% had both good appetite and all infections treated at the time of discharge.

In total, 289 medical records were included in the study. Discharge, death and abscond rates were 77.7%, 17.7% and 3.8% respectively. Average LOS was 11.4 days with 5.8 g/kg/day weight gain. Oedema and WHZ < -5 SD were associated with longer LOS (14.1 days; 95% CI: 11.5; 17.2; $P = 0.02$ and 14.0; 95% CI: 11.1; 17.7; $P = 0.02$ respectively). Average time to death was 4.8 days, with infants < 6 months dying earlier (1.5 days; 95% CI: 0.7; 3.2; $P = 0.001$) than the 6 - 59 month group (5.9 days). No significant changes in MUAC ($P = 0.31$) and WHZ ($P = 0.69$) were observed from admission to discharge.

MUAC < 11.5 cm and WHZ < -3 SD were associated with a 3.9 and 1.7 times increased risk of death, although this increase was not statistically significant ($P = 0.38$ and $P = 0.53$ respectively). Shock, oedema and HIV-positive status were associated with an increased risk of death that was 7.1 (95% CI: 2.7; 20.5; $P < 0.001$), 2.5 (95% CI: 1.2; 5.5; $P = 0.02$) and 3.1 (95% CI: 1.3; 7.2; $P = 0.03$) higher.

Conclusion and recommendations: There were differences between the hospitals' protocols and the WHO guideline. The clinical practices observed regarding SAM diagnosis, admission and discharge in the hospitals are not adequately commensurate with the hospitals' protocols. MUAC was not assessed in a large proportion of the children, although it was the only anthropometric diagnostic indicator for SAM, recommended in the protocols of the hospitals. The average weight gain was 5.8 g/kg/day over a LOS of 11.4 days. Furthermore, the high mortality rate was beyond the acceptable SPHERE minimum. These results emphasise the need for detailed health systems research and an in-depth investigation into additional factors contributing to the results found in this study in order to curb the high SAM mortality rate. They also highlight the urgent need for the Ghana Health Service, the Ministry of Health, the administration of the hospitals and the healthcare professionals to implement strategies to optimise the healthcare system in order to reduce SAM deaths in the hospitals by early identification, diagnosis and optimum treatment.

Keywords: Severe acute malnutrition (SAM), medical complications, admission criteria, discharge criteria, treatment outcomes, mortality

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LIST OF ABBREVIATIONS

CI	Confidence interval
CMAM	Community-based management of acute malnutrition
Cont	Continued
GHS	Ghana Health Service
HIV	Human immunodeficiency virus
IMCI	Integrated management of childhood illness
IQR	Inter-quartile range
LAZ	Length/height-for-age z-score
LOS	Length of hospital stay
MAM	Moderate acute malnutrition
MUAC	Mid-upper arm circumference
NWU	North-West University
PEM	Protein energy malnutrition
PML	Princess Marie Louis children's hospital
ReSoMal	Rehydration solution for malnutrition
RUTF	Ready-to-use therapeutic food
SAM	Severe acute malnutrition
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WAZ	Weight-age-z-score
WHO	World Health Organisation
WHZ	Weight-for-height z-score

LIST OF SYMBOLS AND UNITS

°C	degree Celsius
cm	centimetres
g	gram
g/kg	gram per kilogram
g/kg/day	gram per kilogram body weight per day
>	greater than
≥	greater than or equal to
kg	kilogram
<	less than
≤	less than or equal to
mL	millilitre
mmol/L	millimoles per litre
-	negative
%	percentage
±	plus or minus
SD	standard deviation

CHAPTER 1 INTRODUCTION

1.1 Background

Undernutrition in children continues to be a formidable public health burden, contributing close to half of all under-five deaths globally (Black *et al.*, 2013:427). Although significant progress has been made globally in the reduction of child malnutrition over the past two and half decades, the overall reduction is unsatisfactory, given that millions of infants and children, especially in the African and Asian sub-regions, still remain at risk (UNICEF (United Nations Children's Fund) *et al.*, 2017:1). According to the 2012 UNICEF, World Health Organisation (WHO) and World Bank Joint Child Malnutrition Estimate, out of the 34 countries which accounted for 90% of the global burden of malnutrition, 22 were African, with the highest wasting prevalence recorded in Western Africa at 10.4% in 2011 (UNICEF *et al.*, 2012). Current trends show that none of the African sub-regions recorded an acceptable level of wasting according to the WHO's levels of the public health significance of wasting (UNICEF *et al.*, 2017:8). In Africa, an estimated 14.1 million children under-five years of age are wasted, of which 4.3 million are severely wasted, with one-quarter of the world's wasted children living in sub-Saharan Africa (UNICEF *et al.*, 2016:6).

Ghana has made substantial headway in the West African sub-region in the reduction of the prevalence of under-five wasting from 9.5% in 1998 to 4.7% in 2014 (Ghana Statistical Service *et al.*, 2015:156; Ghana Statistical Service & Macro International Incorporated, 1999:120; The World Bank, 2017). Despite this progress, almost 19% of all under-five Ghanaian children are considered chronically undernourished while some 4.7% and 0.7% are still affected by acute and severe acute malnutrition respectively (Ghana Statistical Service *et al.*, 2015:156).

1.2 Severe acute malnutrition

Severe acute malnutrition (SAM) is an extreme form of nutrient deprivation that causes organ dysfunction and metabolic and physiological alterations that are evidenced by severe muscle wasting and/or oedema. It is manifested in three clinical forms: severe wasting, oedema and a combination of severe wasting and oedema (Rodriguez *et al.*, 2011:1177). Severe wasting is associated with extreme breakdown of muscle and subcutaneous fat for energy. Typical characteristics include visibly protruding bones and ribs, thin face (old man's face) and loose skin around upper arm and buttocks (Walton & Allen, 2011:421). In an effort to conserve energy for physiological functions, the body becomes hypothermic and hypoglycaemic (Ashworth, 2001:517).

Oedematous SAM on the other hand, is characterised by oedema, which may be bilateral (affecting both lower limbs) or generalised (affecting arms and face). The third, which is a blend of severe wasting and oedema, has features of severe visible muscle depletion and oedema. In all three clinical forms, there is a high susceptibility to infection and death. Severe childhood malnutrition has been found to impair thymus development, resulting in a reduction of peripheral lymphocyte count and subsequent immunodeficiency (Savino, 2002:S47). According to the joint statement by UNICEF, the WHO and the World Bank, severe wasting affects about 16 million children under five and accounts for 7.8% of all deaths that occur in children between the ages of 1 and 59 months globally (Black *et al.*, 2013:433; UNICEF *et al.*, 2015:2). Moreover, it is known that this level of mortality is relatively higher in infants < 6 months compared with older infants and children (Grijalva-Eternod *et al.*, 2016:6) because of their higher propensity for related pathologies and their vulnerability (WHO, 2013:60). In view of the high mortality burden associated with SAM in infants and children, a description of existing guidelines for the identification, diagnosis and treatment of SAM is necessary.

1.3 WHO guidelines for identifying SAM

The World Health Organisation, the most authoritative institution globally in the setting and reviewing of guidelines for the management of childhood malnutrition, defines SAM in children between the ages of 6 - 59 months as a mid-upper arm circumference (MUAC) < 11.5 cm or weight-for-height z-score (WHZ) < -3 SD or the presence of bilateral pitting pedal oedema. The guideline encourages early identification of children with SAM *via* the use of MUAC as a community screening tool; because of its convenience and simplicity, whereas either MUAC < 11.5 cm, WHZ < -3 SD and/or the presence of bilateral pedal oedema can be used for institutional diagnosis (WHO, 2013:2). Until recently, there were no guidelines for the identification and treatment of SAM in infants less than 6 months, despite the prevalence and high burden of wasting in this group (WHO, 2013:60; WHO & UNICEF, 2009). According to the latest WHO guideline on the management of SAM in infants < 6 months, SAM is defined as WHZ < -3 SD or the presence of bilateral pitting oedema (WHO, 2013:63)

1.4 WHO guidelines for treatment of SAM

Treatment of SAM has been categorised into facility- and community-based management, depending on the medical and physical status of the child. Children (6 - 59 months) diagnosed as severely malnourished, but who have appetite and are medically well and alert, are treated as out-patients with ready-to-use therapeutic food (RUTF) and basic medical care with consistent follow-ups. On the other hand, those who present with medical complications, severe oedema,

poor appetite and/or one or more of the danger signs of the Integrated Management of Childhood Illness (IMCI), are treated as in-patients (WHO, 2013:3).

Similarly, treatment of SAM in infants < 6 months is also categorised into in-patient and out-patient care. Infants < 6 months diagnosed with uncomplicated SAM are managed as out-patients. Infants with SAM in addition to one or more of the following conditions are to be admitted for in-patient care: serious medical complications; recent weight loss or failure to gain weight; presence of any pitting oedema; ineffective feeding or any medical or social concern that requires thorough assessment or intensive support (WHO, 2013:63).

Owing to the profound metabolic and physiological alterations that occur with SAM, the WHO recommends the implementation of a 10-step treatment guideline for in-patient management (Ashworth *et al.*, 2003:10). This treatment guideline for the healthcare team to ensure successful recovery, highlights the prevention or treatment of hypoglycaemia, hypothermia and dehydration; correction of electrolyte imbalance; treatment or prevention of infection; correction of micronutrient deficiencies; cautious commencement of feeding; achievement of growth catch-up; provision of sensory and emotional support; and preparation for follow-up after recovery (Ashworth *et al.*, 2003:10). It is quite clear that strategies for the management of SAM in older infants and children (6 - 59 months) are somewhat well developed compared with those for infants of 0 - 5 months. There is still little evidence regarding the outcome of extrapolating SAM treatment guidelines for infants and children 6 - 59 months to infants < 6 months (WHO, 2013:60-65).

1.5 WHO guidelines for discharging SAM

In-patients showing signs of recovery are transitioned into community-based management when a reduction in oedema, resolution of medical complications and consumption of 75% of the daily ration of RUTF is achieved. Depending on which anthropometric measure informed the diagnosis of SAM, discharge of both in- and out-patients from treatment is based on the achievement of $WHZ \geq -2$ SD or $MUAC \geq 12.5$ cm without the presence of oedema for at least two weeks (WHO, 2013:20). For infants < 6 months old, transfer from in-patient to out-patient care can be made when all clinical complications and oedema are resolved and the child has appetite and is alert and weight gain, on either exclusive breastfeeding or replacement feeding alone, is adequate (classified as 5 g/kg/day for 3 consecutive days). Prior to the transfer, structures must be put in place for community-based follow-up and support for the care-giver and for ensuring the up-to-date immunisation of the child (WHO, 2013:64-65).

1.6 WHZ and MUAC

WHZ has been used for years in clinical facilities in the diagnosis and monitoring of SAM in children (WHO, 1999:4). It involves measurement of the weight and assessment of the standing height of children over 24 months or the recumbent length of children and infants below 24 months (which is rather difficult in sick children) and comparing this with a reference chart. MUAC, on the other hand, involves measuring mid-upper arm circumference and comparing this with a single reference cut-off; and this method requires minimum training of community health workers and volunteers (WHO *et al.*, 2007:3). Both tools measure the nutritional status of children and have been instrumental in identifying and diagnosing SAM.

There is, however, a gradual deflection from WHO guidelines towards a lone-criterion diagnosis of SAM (Ali *et al.*, 2013:319; Goossens *et al.*, 2012:8; Roberfroid *et al.*, 2013:3). It therefore stands to reason that there may be variations in different hospitals' protocols and practices regarding the diagnosis, management and discharge of SAM, which may consequently yield different treatment outcomes.

1.7 Study rationale

Although WHO stipulates guidelines for the diagnosis, and discharge of SAM in children 0 - 59 months, it is not based on strong evidence. According to the WHO 2013 guidelines on the management of SAM in infants and children, no randomised studies were identified that compared the treatment outcomes of children with SAM diagnosed on the basis of the different diagnostic indices at the time of the guideline update (WHO, 2013:16). The WHO further considers the criteria for diagnosing and treating children with SAM as a strong recommendation, but this is based on evidence of low quality. Moreover, recent recommendations stipulated for the management of SAM in infants < 6 months are similarly based on very low-quality evidence, owing to the paucity of research data in this age category (WHO, 2013:61; Angood *et al.*, 2015:1-14). There is, therefore, an acknowledged obligation to develop the evidence base in order to advance care in this age group (Angood *et al.*, 2015:14). As a result, there has been a recommendation by the guideline development group for further studies in this area (WHO, 2013:66).

Furthermore, WHO guidelines recommend the use of MUAC and WHZ independently in the diagnosis of non-oedematous SAM in children aged 6 - 59 months. However, some uncertainties also exist on how MUAC relates to WHZ as a diagnostic index for SAM. Studies conducted by Berkley *et al.* (2005:594-595) and Laillou *et al.* (2014:1) indicate that MUAC and WHZ correlate poorly and identify different populations of malnourished children with some level of overlap which

varies greatly among populations and different geographical settings (Myatt *et al.*, 2009:5). This means that children diagnosed on the basis of either of the two indices may vary in their response to treatment and mortality patterns. Unfortunately, there is limited knowledge and research in this regard, particularly in Ghana.

Recent studies have further reported a gradual shift from the WHO's recommendation of WHZ < -3 SD or MUAC < 11.5 cm admission criteria to using MUAC as a lone anthropometric tool for SAM admission (Ali *et al.*, 2013:319; Goossens *et al.*, 2012:8). This means that, there may be disparities in the protocols used in various hospitals, as well as the actual clinical practices compared with the WHO guidelines regarding diagnosis and discharge of children with SAM. However, little is known about the different hospital protocols and actual clinical practices concerning the diagnosis and discharge of SAM and the consequent treatment outcomes.

This study, therefore, sought to assess the protocols for SAM diagnosis, admission and discharge and actual clinical practices in two Ghanaian hospitals compared with WHO guidelines, in relation to the patients' treatment outcomes.

1.8 Research aim

The aim of this observational study was to assess and compare hospital protocols, actual clinical practices, and WHO recommendations regarding the admission and discharge criteria of SAM in relation to treatment outcomes among Ghanaian children 0 - 59 months.

1.9 Specific objectives

The objectives of this study were to:

- 1.9.1 Assess the various hospitals' SAM protocols with regards to diagnosis, admission and discharge for children 0 - 59 months.
- 1.9.2 Compare the SAM protocol of the various hospitals with WHO SAM diagnosis, admission and discharge guidelines.
- 1.9.3 Assess hospital practices regarding diagnosis, in-patient admission and discharge of children (0 - 59 months) with SAM compared with the protocols of the hospitals.
- 1.9.4 Assess treatment outcomes in relation to actual practices, adherence to the hospital protocol and/or WHO guidelines.

1.10 Treatment outcomes

These objectives were measured by the following outcome measurements:

1.10.1 Length of hospital stay

1.10.2 Mortality

1.10.3 Growth: weight gain and changes in z-scores

1.10.4 MUAC

1.11 Structure of this mini-dissertation

This mini-dissertation is presented in an article layout in accordance with the postgraduate guidelines of the North-West University (NWU). It consists of four chapters. All applicable references in this mini-dissertation are compiled at the end of each chapter. The language and referencing format used is stringently according to the NWU referencing guide, with the exception of the article for publication, which follows the directives of the journal in which it is being published.

Chapter one provides brief information on the background of the study and expands on the study rationale. It also outlines the aim and objectives and the output of the research. Details of the roles played by each research team member are also provided in this chapter.

Chapter 2 is a review of the available literature on the diagnostic and discharge criteria for SAM in infants and children by the WHO and various nutrition rehabilitation programmes. It also expatiates on the background information in order to facilitate understanding and enable interpretation of data in chapters 3 and 4.

Chapter 3 consists of the article for publication, which contains the methods and results of the study. The article, which is entitled “Admission and Discharge Guidelines of Ghanaian Infants and Children Diagnosed with Severe Acute Malnutrition”, will be submitted for publication in the *Maternal and Child Nutrition* journal. All references and language format in this chapter are according to the specifications stipulated for authors by the journal (ANNEXURE A).

Chapter 4, which is the concluding chapter of this mini-dissertation, provides a summary of the study, along with proposed recommendations for policy formulation and future research, and draws conclusions based on the output of the study.

1.12 Research output

The findings of the study have been compiled and written into a mini-dissertation for a Master of Science degree. Findings will also be presented at the various hospitals' monthly mortality meetings and copies of the results will be provided to the management. An article has also been submitted for publication in the *Maternal and Child Nutrition* journal. Results will be presented at both national and international congresses.

1.13 Contributions of the members research team

The various roles played by members of the research team are outlined in **Table 1.1** below

Table 1.1: Research team members

Name of Team Member	Institution of Affiliation	Role
Ms Janet Adede Carboo (MSc student)	North-West University School of Physiology, Nutrition and Consumer Science, Centre of Excellence for Nutrition	Responsible for the planning, implementation and management of this project. Compiled the literature review, conducted data collection, statistical analysis, interpretation of data and writing-up of this mini-dissertation
Dr R.C. Dolman (Supervisor)	North-West University School of Physiology, Nutrition and Consumer Science Centre of Excellence for Nutrition	Played a supervisory role in the conceptualisation, planning, implementation, data interpretation and completion of this study.
Dr Martani Lombard (Principal Investigator and Co-supervisor)	North-West University School of Physiology, Nutrition and Consumer Science Centre of Excellence for Nutrition	Played a co-supervisory role in the conceptualisation, planning, implementation, data interpretation and completion of this study.
Dr Cristian Ricci (Biostatistician)	North-West University School of Physiology, Nutrition and Consumer Science Centre of Excellence for Nutrition	Supervised the development of the data capturing tool, data analysis and interpretation of data and the finalisation of the thesis.
Mrs Freda Intiful (Local collaborator)	University of Ghana School of Biomedical and Allied Health Sciences Department of Nutrition and Dietetics	Facilitated ethics application and data collection in Ghana.

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CHAPTER 1 INTRODUCTION

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CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

Malnutrition refers to all forms of conditions that result from imbalances, excesses and/or deficiencies in the consumption of macronutrients and micronutrients. It encompasses both undernutrition and overnutrition (Stratton *et al.*, 2003). However, more commonly, it is used in reference to undernutrition, especially in developing countries, despite the current emergence of overnutrition in these areas (Chopra *et al.*, 2002:952). In the context of this study, malnutrition is used in reference to undernutrition, which is defined as an inadequate supply of energy and nutrients for optimum growth and development, which results in compromise of the body's natural capacity to resist infection, heal and recover from illness (UNICEF, 2006:3).

Globally, malnutrition is related to several inter-linked factors, including poverty, famine, gender inequality, poor health and forced migration usually caused by civil war, among many others (Muller & Krawinkel, 2005:280; Smith *et al.*, 2000:200; UNICEF, 1998:10). In such situations, the burden of undernutrition falls disproportionately on the most critically vulnerable cohort of the population which includes the following: infants, children and pregnant and lactating mothers (Lartey, 2008:105).

In infants and children, failure to achieve optimum nutrition is attributable, but not limited, to a number of factors, including suboptimal breast and complementary feeding practices, poverty and poor diet, in tandem with repeated infections and illnesses such as malaria, diarrhoea, pneumonia, HIV/AIDS and helminthic infestation (Blössner & de Onis, 2005:1; UNICEF, 2006:3). According to the UNICEF conceptual framework on malnutrition, the causes of malnutrition in children are categorised into three hierarchical domains which contribute to child malnutrition on different levels. As illustrated in **Figure 2.1**, these include the immediate causes that comprise of inadequate food intake with or without the presence of infections. There are also underlying causes that hinge on poor maternal and childcare practices, inadequate prevention and control of disease and insufficient access to food. At the societal level, the basic causes of child malnutrition are related to resource availability and distribution (UNICEF, 1998:24). Inequity in distribution and access to resources predispose vulnerable groups to malnutrition. In contrast, socioeconomic and political alterations that advance health, nutrition and equity in terms of resource accessibility can potentially break the cycle of malnutrition.

Child malnutrition comprises macronutrient and micronutrient deficiencies, which both have short- and long-term deleterious effects on the growth of the young child, inhibiting the attainment of full

developmental and cognitive potential (International Food Policy Research Institute *et al.*, 2014:21).

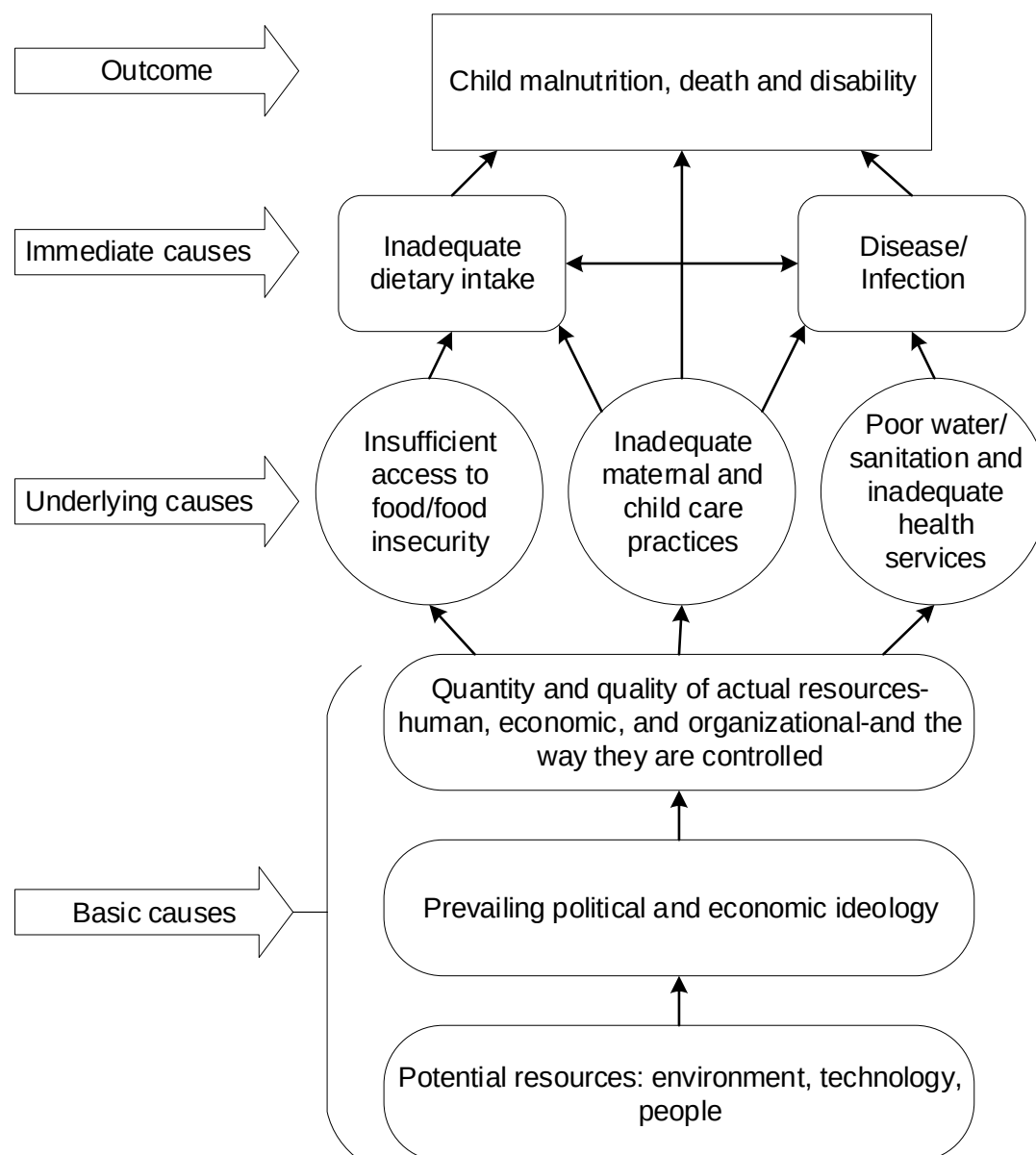


Figure 2.1: UNICEF conceptual framework of malnutrition. Source: Adapted from State of the World's Children, 1998.

A deficit in macronutrients (carbohydrates, protein and fat), which is termed protein-energy malnutrition (PEM), is associated with severe muscle and fat mass depletion, evidenced by visible signs of wasting. PEM is usually manifested in children between the ages of 6 and 24 months owing to inadequate complementary feeding (Kwena *et al.*, 2003:97); however, recent reports are revealing an unbelievably high prevalence of wasting among infants < 6 months in developing

countries (Chiabi *et al.*, 2017:36; Kerac *et al.*, 2011:1008; WHO, 2013:60). Unfortunately, this is a group that has been side-lined for too long in malnutrition management, treatment policies and programmes (Kerac *et al.*, 2015:S30). PEM has been attributed to early weaning from breast milk, delayed introduction of complementary foods, low-protein diet and severe or frequent infections in older infants and children (Kwena *et al.*, 2003:96; Rice *et al.*, 2000). However, in infants < 6 months, aetiologies such as low birth weight, persistent diarrhoea, recurring sepsis, underlying neurological or metabolic disease and substandard breastfeeding practices are culpable (Emergency Nutrition Network *et al.*, 2009:6; WHO, 2013:60).

Micronutrient deficiency, on the other hand, although much less overtly conspicuous, is nonetheless equally devastating (USAID (United States Agency for International Development) *et al.*, 2009). This deficiency in various micronutrients is hence, collectively known as “hidden hunger”. It is caused by a lack or an insufficient intake or absorption of vitamins and minerals as a result of poor diet, increased physiological need, disease or infection (Muthayya *et al.*, 2013:7). It affects the core of health and vitality, leading to poor health, mental impairment and even death in severe cases. In child health, these adverse effects are particularly intense, especially within the first 1000 days of life, which is from conception to 24 months (International Food Policy Research Institute *et al.*, 2014:21). Even mild to moderate micronutrient deficiencies lead to impaired cognitive and psychomotor development, poor physical growth, increased morbidity from infectious diseases in infants and young children, and decreased work productivity in adulthood (Haas & IV, 2001:676S; International Food Policy Research Institute *et al.*, 2014:21; Zimmermann *et al.*, 2008:1253).

Deficiencies of vitamin A and zinc pose a threat to the survival of young infants and children by compromising the immune system (Black *et al.*, 2008:248; Shankar & Prasad, 1998:447S). Additionally, suboptimal levels of zinc impair growth, leading to stunting in children (International Zinc Nutrition Consultative Group (IZiNCG), 2004:S131). Iodine, similarly, has been identified as the most common cause of preventable mental impairment in children (Zimmermann *et al.*, 2008:1251). The life-long detrimental consequence of malnutrition to the development of a child cannot be overemphasised. It is by far the most important risk factor for the burden of disease in developing countries (Nemer *et al.*, 2001:6), with the risk of death correlating directly with the severity of malnutrition (Black *et al.*, 2008:247). Even mild to moderate malnutrition in children increases their susceptibility to infections and consequent death, in comparison with to their well-nourished peers (Black *et al.*, 2008:247; Blössner & de Onis, 2005:7; Rice *et al.*, 2000:1207).

This literature review provides an overview of the classification, prevalence, and global burden of malnutrition, including current management protocols.

2.2 Classification of child malnutrition

Child malnutrition is categorised according to three anthropometric indices: length/height-for-age (LAZ), WHZ, and weight-for age (WAZ). Low LAZ reflects prolonged macro- and micro-nutrient deprivation that results in a failure in linear growth known as stunting. It is an indicator of poor socioeconomic conditions and increased exposure to adverse environmental factors such as illness and sub-standard feeding practices during early childhood. Low WHZ, on the other hand, is a reflection of severe weight loss commonly related to severe ailment and/or acute starvation, although prolonged adverse conditions such as famine can be an alternative cause (WHO, 1997:46). Weight-for-age is a measure of body weight comparative to chronological age. It is influenced by both the weight and height of the child, and is thus complex to interpret (WHO, 1997:47).

For each of these indices, malnutrition is defined as a Z-score below -2 standard deviations from the WHO's growth reference median (WHO, 1997:45). Based on these categorisations, child malnutrition is defined as either chronic or acute, with further sub-classifications depending on its severity.

2.3 Chronic malnutrition

Chronic malnutrition, commonly known as stunting, is the result of protracted nutrient inadequacy and infection in early childhood, rather than genetic predisposition, leading to a lasting restriction of a child's full linear growth and cognitive development through adolescence and adulthood (Grantham-McGregor *et al.*, 2007:62; UNICEF *et al.*, 2017:2). It is defined by a length/height-for-age Z-score (LAZ) of < -2 standard deviation (SD) of WHO growth median (UNICEF, 2013:7). Stunting is usually initiated *in utero* in the face of maternal undernutrition and continues through early childhood when nutrient requirements are persistently not met. It may linger on through childhood and give rise to an adult of short stature (Dewey & Begum, 2011:7-8). Chronic malnutrition is usually inconspicuous; may be shrouded by a normal appearance and does not present an immediate threat to life. This, however, does not make stunting less of a risk to the growth and development of a child in the long term. Severely stunted children have a four-fold increased risk of mortality (Black *et al.*, 2008:247).

Globally, about 155 million children under five years are short for their age (UNICEF *et al.*, 2017:1). Fifty nine million of these stunted children are in Africa, which indicates a rise of 17% in prevalence since the year 2000 (UNICEF *et al.*, 2017:5). According to the 2014 WHO policy brief on stunting, stunted children below age 2 are predisposed to poor cognitive development, which consequently impacts negatively on their educational outcomes during adolescence. Evidence

for this assertion is demonstrated in a multi-national longitudinal study of children from Brazil, South Africa, Guatemala, India, and the Philippines which revealed an association between stunting at 2 years of age and a decline in schooling with a 16% increased risk of failing at least one grade, and older ages at enrolment in school (Martorell *et al.*, 2010:351). Further, stunting is an impediment to human and economic development, in the sense that growth restriction in early childhood has a resultant negative effect on physical work capacity in adulthood, thus influencing the stunted child's economic (income) potential (WHO, 2014:2) and, as a result, perpetuating the cycle of poverty and malnutrition.

2.4 Acute malnutrition

Acute malnutrition, as suggested by the name, is indicative of acute deprivation of one or more macronutrients, which usually results from inadequate dietary consumption, malabsorption of ingested nutrients and/or acute or chronic disease or infection which increases nutrient requirements while promoting nutrient loss and catabolism (Manary & Sandige, 2008:1227). The resultant loss of weight compromises the immune defences of the wasted child, predisposing him/her to infection and subsequent malnutrition, thus fuelling the vicious cycle of infection and wasting (UNICEF *et al.*, 2017:2). In severe cases, it may present as a medical emergency requiring prompt and intense intervention (Walton & Allen, 2011:418). It is defined as a weight-for-height z-score (WHZ) below -2 SD from the median WHZ of the WHO reference population, which is a measure of wasting or thinness (UNICEF, 2013:7). Given the dissimilar assessment indices for acute and chronic malnutrition, it may be perceived that both forms of malnutrition are mutually exclusive of each other. However, stunting and wasting can occur concurrently (McDonald *et al.*, 2013:899; UNICEF *et al.*, 2017:2). Some malnourished children may present a combination of wasting, stunting and underweight while others may present with a combination of wasting with either underweight or stunting (Dasgupta *et al.*, 2015:417). Nutrient deficit in early childhood may retard linear growth, which may not be completely averted by subsequent adequate nutrient intake that supports normal growth, resulting in stunting without wasting. On the other side, adequate nutrition in early childhood may promote linear growth; however, abrupt illness or starvation may lead to wasting in the absence of stunting (McDonald *et al.*, 2013:899).

According to the WHO growth reference for WHZ, acute malnutrition is further classified as either moderate or severe (WHO, 2006). Globally, it is estimated that 52 million children below the age of five are wasted (UNICEF *et al.*, 2017:2).

2.4.1 Moderate acute malnutrition

Moderate acute malnutrition (MAM) is defined as a WHZ score between -2 and -3 SD or a MUAC between 11.5 cm and 12.5 cm without the presence of oedema (WHO *et al.*, 2010:5). Although the risk of death associated with undernutrition is increased in severe malnutrition (Black *et al.*, 2008:247), MAM imposes an increased burden of malnutrition-associated morbidity and mortality, considering the relatively significant number of children who are moderately malnourished (UNICEF *et al.*, 2017:9). MAM affects approximately 67% of all children considered acutely malnourished and is associated with detrimental nutrient deficiencies such as anaemia, xerophthalmia, scurvy and beriberi, which increase the risk of morbidity and mortality (Action Against Hunger, 2009; UNICEF *et al.*, 2017:9). Without rigorous nutrition rehabilitation, most of these moderately malnourished children regress into SAM and subsequent death after a year following recovery (Chang *et al.*, 2013:218; James *et al.*, 2016:9).

2.4.2 Severe acute malnutrition

Severe acute malnutrition (SAM) is an extreme form of nutrient deprivation that causes organ dysfunction and metabolic and physiological alterations that are evidenced by severe muscle wasting and/or bilateral pitting oedema. It is defined as WHZ < -3 SD or MUAC < 11.5 cm or the presence of oedema in both lower limbs (WHO, 2013:2). It is manifested in three clinical forms: severe wasting, oedema and a combination of severe wasting and oedema (Rodriguez *et al.*, 2011:1177). Severe wasting is associated with extreme muscle and subcutaneous fat breakdown on the upper arms, thighs, ribs and shoulder blades. Typical characteristics include “skin and bone” appearance, visible ribs, thin face (old man’s face), sunken eyes due to dehydration and fat loss in the tissues around and behind the eyes, dry mouth and lack of tears due to atrophy of salivary and lachrymal glands respectively. Signs also include loose skin around upper arm and buttocks, and irritability (Ashworth, 2008; Walton & Allen, 2011:419, 421). Depleted subcutaneous fat and body energy reserves result in complications such as hypothermia and hypoglycaemia (Ashworth, 2001:517).

Oedematous SAM, on the other hand, is characterised by nutritional oedema, either bilateral pedal or generalised (affecting arms and face) oedema. In addition to oedema, other classical signs include: anaemia, alopecia (sparse, hypo-pigmented brittle hair), dermatitis, hepatomegaly, fatty liver, profound apathy, loss of appetite, lethargy and severe immune deficiency (Ashworth, 2008:546; Muller & Krawinkel, 2005:280). Further pathological alterations such as atrophy of the pancreas and myocardium may also occur; partly resulting in cardiac insufficiency and impaired glucose control (Muller & Krawinkel, 2005:281; Spoelstra *et al.*, 2012:1229).

The third manifestation, which is a combination of severe wasting and oedema, is a superimposition of oedema on some grade of muscle wasting and is characterised by features of severe visible muscle depletion and oedema. It is the most commonly presented form of severe acute malnutrition in children (Scrimshaw & Viteri, 2010:34).

In all forms of SAM, there is derailment of the normal physiological processes and down-regulation of metabolism in the body's effort to adapt and survive on the scant energy available. Anabolic processes such as growth cease, while catabolism of tissue reserve of carbohydrate, fat and protein occur (Walton & Allen, 2011:420). Similarly, severe childhood malnutrition has been found to impair thymus development, resulting in a reduction of peripheral lymphocyte count and subsequent immunodeficiency, increasing infection susceptibility and death (Savino, 2002:S47). Common comorbid infections of malnutrition which increase the risk of death include persistent diarrhoea, pneumonia, measles and malaria (Black *et al.*, 2008:247).

2.5 Prevalence of malnutrition

Child malnutrition continues to be a public health burden in especially low and middle income countries, accounting for 45% of all under-five child mortalities worldwide (WHO, 2017). This translates into an avoidable loss of over 2.5 million children every year (WHO, 2017). In 2011, global statistics on child malnutrition revealed that about 101 million children below the age of five are underweight, representing approximately 16% of children within this age category (Black *et al.*, 2013:435). This indicates a reduction in underweight prevalence from 25% in 1990. About 87% of this global decline in underweight was achieved in Central and Eastern Europe while a relatively marginal decline of 26% was realised in sub-Saharan Africa (UNICEF, 2013:12). Globally, prevalence of underweight is highest among South Asian children, at a level of roughly 33%. This is closely matched by sub-Saharan Africa, with about 30 million underweight children at a prevalence rate of 21% (UNICEF, 2013:12). The widespread child malnutrition in Asia and sub-Saharan Africa indicates the slow progress that was made towards the achievement of the Millennium Development goals and more importantly the massive work that needs to be done in the attainment of the Sustainable Development goals.

According to the 2017 UNICEF, WHO and World Bank Joint Child Malnutrition Estimates, globally, a total of 52 million children under-five are wasted and 17 million severely wasted (UNICEF *et al.*, 2017:2), not forgetting the approximately 8.5 million infants less than 6 months old who are also affected (Kerac *et al.*, 2011:1008). Fourteen million of these children, of which 4.1 million are severely wasted, are found in Africa (UNICEF *et al.*, 2017:9). In the Africa sub-region, western

Africa has consistently recorded the highest prevalence of wasting despite the decline from 11.6% in 1990 to 8.5% in 2017 (UNICEF *et al.*, 2017:8; UNICEF *et al.*, 2012). This indicates that child malnutrition is still far from eradication and that unsatisfactory progress has been made towards the achievement of the Sustainable Development goal 2 and the Global Nutrition Target for 2025 in the sub-region. This notwithstanding, Ghana has made some headway in the reduction of under-five wasting prevalence, at 10% in 1998 to 5% in 2014 (Ghana Statistical Service *et al.*, 2015:156; Ghana Statistical Service & Macro International Incorporated, 1999:121).

2.6 Current nutrition situation of Ghana

Approximately one in every five Ghanaian children under-five is considered chronically malnourished (Ghana Statistical Service *et al.*, 2015:156). According to the 2008 Lancet series on maternal and childhood undernutrition, Ghana is categorised among the 36 countries of the world with the highest burden of chronic childhood undernutrition (Black *et al.*, 2008:246). The current level of under-five malnutrition in Ghana shows that 5% of children are wasted of which 1% is severely wasted, while 11% are underweight, with 2% being severely underweight. Further stratification by gender and age indicate that children within the age group 9 - 11 months have the highest prevalence of wasting (11%) whereas children aged between 36 - 47 months are the least likely to be wasted (1%). Additionally, female children are more likely to be wasted (5%) than their male counterparts (4%). Wasting predominates among children living in rural areas (6%) rather than in urban residence (4%). Children within the ages of 18 and 23 months have been identified as the peak prevalence group for underweight, while children born to mothers with little or no education are markedly more likely to be underweight than children of highly educated women (Ghana Statistical Service *et al.*, 2015). A comparison of childhood malnutrition trends from 2003 to 2014 in Ghana indicates a stable progressive decline in all forms of under-five malnutrition, as shown in **Figure 2.2**. However, prevalence levels of wasting and underweight pose a medium magnitude of malnutrition severity, according to the WHO's classification of the severity of malnutrition by prevalence (WHO, 1997:52). Having reached this benchmark, however, should offer no grounds for complacency until childhood malnutrition is totally eradicated.

An emerging challenge that may potentially undermine the steady progress made in the eradication of child malnutrition in the country is the decline in breastfeeding rates. Data on breastfeeding trends indicate a deterioration in exclusive breastfeeding rates by 17% between 2008 and 2014, while the use of feeding bottles with nipples among infants < 6 months also increased by 5% within the same period (Ghana Statistical Service *et al.*, 2015:160). This is a cause for concern, considering the established benefits of exclusive breastfeeding during the first

6 months of life and the risk of infection associated with unhygienic handling of feeding bottles. In Ghana, the leading causes of under-five mortality are infectious diseases particularly malaria, pneumonia and diarrhoea, which are compounded by malnutrition (Ghana Statistical Service *et al.*, 2015). It is estimated that over 40% of all under-five deaths in Ghana are attributable to malnutrition (Aheto *et al.*, 2015:552).

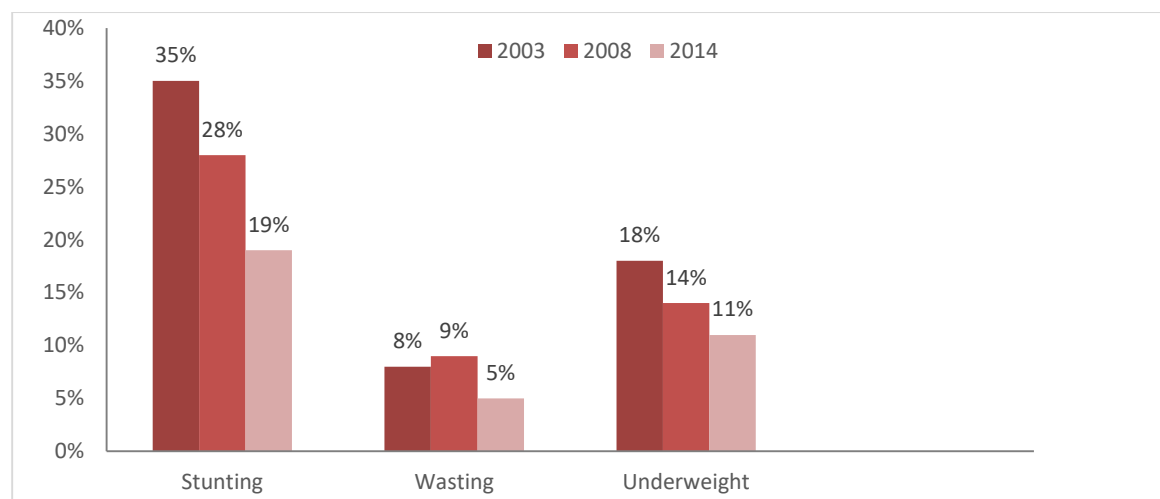


Figure 2.2: Trends of under-five malnutrition in Ghana, 2003-2014. Source: National Demographic Health Survey

2.7 Global public health significance of severe acute malnutrition

Across the world, nearly 17 million children under the age of five, mostly from developing countries, are plagued by SAM, which accounts for over half a million deaths annually (7.4%-7.8% of the proportion of total under-five deaths) (Black *et al.*, 2013:433; UNICEF *et al.*, 2017:2). Among this number of severely malnourished children, about 3.8 million are infants under 6 months (Kerac *et al.*, 2011:1011). Undernutrition is considered the most important underlying factor in the development of severe infections and disease during infancy and early childhood. SAM-related deaths are therefore undeniably a result of the synergistic effect of infectious disease and consequences of undernutrition rather than the singular effect of nutrient deprivation (Rodriguez *et al.*, 2011:1180). A comparison of the odds of mortality associated with nutritional indices for malnutrition in children revealed that children with SAM (WHZ < -3 SD) are over nine times more likely to die than their well-nourished (WHZ > -1 SD) counterparts (Black *et al.*, 2008:247). SAM also presents an enormous disease burden on paediatric healthcare, especially in sub-Saharan Africa, contributing about 50% of case fatalities in hospitalised children (Bhutta *et al.*, 2008:422). In Ethiopia, 20% of all paediatric hospital admissions are attributed to SAM, and

are associated with approximately 3 times increased risk of death (Gordon *et al.*, 2013:350). Moreover, this level of mortality is relatively higher in infants < 6 months compared to older children (Emergency Nutrition Network *et al.*, 2009:9; Grijalva-Eternod *et al.*, 2016:6) as a result of their higher propensity for related pathologies and their vulnerability (Emergency Nutrition Network *et al.*, 2009:5; WHO, 2013:60).

Besides the loss of life caused by SAM in the interim, it is also associated with long-term developmental impairment, educational underachievement and increased risk of development of chronic cardiovascular and metabolic disease in later life among survivors. A Malawian study in which children who received treatment for SAM were followed up seven years after discharge from hospital, it was revealed that survivors had less lean mass and resultant functional deficits including weaker handgrip strength and fewer steps per hour in an exercise test compared with their healthy control siblings. Furthermore, cases were more likely to be in lower school grades than their community and sibling controls. The authors of this study concluded that SAM is associated with long-term detrimental effects such as thrifty growth, which is known to be associated with future cardiovascular and metabolic disease (Lelijveld *et al.*, 2016:e654-e659). Undernutrition in early life induces infantile biological reprogramming which confers an extra vulnerability to chronic diseases of lifestyle later in life (Vorster & Bourne, 2016:58-59). The burden of SAM goes beyond the strain it imposes on the medical and family systems. It has negative implications for socioeconomic variables such as income and education, often referred to as decreased human capital (Vorster & Bourne, 2016:59). In view of the high mortality burden associated with SAM in infants and children, a look at existing protocols for the identification and treatment of SAM is necessary.

2.8 Current SAM management protocols

2.8.1 WHO guidelines for diagnosing SAM

The diagnosis of SAM is typically based on anthropometric measurements and clinical signs. The WHO defines SAM in children between the ages of 6 - 59 months as MUAC < 11.5 cm or WHZ < -3 SD or the presence of bilateral pitting oedema. The guideline further encourages early identification of children with SAM by means of the use of MUAC as a community screening tool; because of its convenience and simplicity, whereas either a MUAC < 11.5 cm, WHZ < -3 SD and/or the presence of bilateral oedema can be used for institutional diagnosis (WHO, 2013:2). By WHO standards, all infants and children between the ages of 6 and 59 months with MUAC < 11.5 cm, or any degree of bilateral pitting oedema at the community level must be referred immediately for detailed assessment and management at a treatment facility (WHO, 2013:2).

Similarly, all infants and children who present at primary health-care facilities and hospitals, whatever the reason, should be assessed for MUAC or WHZ and also examined for bilateral pitting oedema. Prescription of treatment for the presenting condition without identification and management of underlying malnutrition diminishes the prospects for long-term mortality reduction and improved treatment outcomes. Infants and children aged 6 - 59 months with MUAC < 11.5 cm or WHZ < -3 SD with or without bilateral oedema, must be diagnosed for SAM and referred immediately for SAM management (WHO, 2013:2).

In facilities where accurate measurement of weight and height may not be feasible due to the scarcity or unavailability of resources, diagnosis is usually based on the presence of physical signs of wasting and bilateral pitting oedema (Walton & Allen, 2011:419). Caution must be used, however, in the diagnosis of SAM on the basis of the presence of oedema in order to avoid misdiagnosis of nephrotic syndrome. SAM-associated oedema affects both legs and is assessed by pressing down the dorsum of both swollen feet with the thumb for a few seconds. If the pressure exerted produces a bilateral indent which remains for some time, then certainly the oedema is of nutritional origin. It is noteworthy that oedema affecting just one foot is not a result of SAM but may be indicative of an injury or infection (WHO, 2008:13). Oedema may induce an increase in weight and therefore result in false WHZ scores. Likewise, dehydration may also potentially confound weight readings and present false WHZ scores (Berkley *et al.*, 2005:595).

Until quite recently, infants < 6 months were not included in the guidelines for identification and treatment of SAM, in spite of the prevalence and problem of wasting in this group (WHO, 2013:60; WHO & UNICEF, 2009). This omission could be attributed to the paucity of research and disease prevalence data in this cohort (Emergency Nutrition Network *et al.*, 2009:6-7; WHO, 2013:61). According to the latest WHO guideline on the management of SAM in infants 0 - 5 months, SAM is defined as weight-for-length z-score < -3 SD or the presence of bilateral pitting oedema (WHO, 2013:63). Aside from this definition, infants with unsatisfactory weight gain and who are non-responsive to nutrition counselling and support, are candidates for further investigation and treatment. Furthermore, the presence of any of the following danger signs from the Integration Management of Childhood Illness (IMCI), warrants urgent treatment and care: inability to suckle, profuse vomiting, prolonged convulsion > 15 minutes, lethargy or unconsciousness and present convulsion (WHO, 2013:63). Inclusion of infants < 6 months in the WHO guidelines denotes a significant development, although these are hinged on evidence of very low quality. No studies were identified that directly examined the admission and discharge criteria of infants < 6 months using the WHO growth standard at the time of the guideline update (WHO, 2013:61-65). There

is, therefore, an acknowledged obligation to provide the scientific evidence in order to advance care in this age group (Angood *et al.*, 2015).

It follows that, even though the WHO recommends the use of WHZ and MUAC as independent tools for the diagnosis of SAM in infants and children 6 - 59 months, there are some concerns about how the two relate to each other. A discussion of WHZ and MUAC follows in the subsequent section.

2.8.2 WHZ and MUAC

WHZ has been used for years in clinical facilities for the diagnosis and monitoring of SAM in children (WHO, 1999:4). It involves the measurement of the weight and the height of children over 24 months or the recumbent length of children and infants below 24 months and comparing this measurement with a reference chart. According to WHO recommendations, weight assessment must ideally be done using a robust scale that measures to a precision of 0.1 kg and allows tared weighing. In instances where the infant or child to be weighed is unable to stand, the mother or caregiver may be weighed and the scale tared while he/she remains on the scale and is handed the child. This method gives an accurate weight of the child alone without having to subtract weights, thus minimising the risk of error (WHO, 2008:15). Weighing of the child must be done with minimal clothing on where possible, to prevent false readings. For children who are 24 months and/or older and have the capacity to stand upright, weight can be assessed by allowing the child to stand alone in the middle of the scale with feet slightly apart without shoes and outer garments. Measurement is to be recorded to the nearest 0.1 kg (WHO, 2008:15-18).

Again, for children who are 24 months or older and are able to stand, standing height can be measured using a stadiometer, whereas recumbent length can be assessed using a length board or an infantometer for children who are < 24 months old. For children who are > 24 months, but nonetheless unable to stand, recumbent length can be measured and converted to height by subtracting a correction factor of 0.7 cm, since recumbent length is 0.7 cm greater than standing height. Similarly, if a child is below the age of 24 months but will not submit to lying down, standing height may be measured and converted to recumbent length by adding 0.7 cm (WHO, 2008:19-24). The recorded weight and height are plotted as coordinates on the WHO growth standard curves specific for age and gender, which are represented as Z-scores. Height assessment and, especially recumbent length measurement is somewhat cumbersome and burdensome for the child being assessed and may be difficult, particularly in children who are sick and irritable. Other limitations associated with WHZ are the incorrect plotting of weight and height variables on the growth charts observed among nursing staff, faulty or poorly calibrated scales or scales which

are often unavailable, inappropriate measurement techniques and the unavailability of reference growth charts for plotting in resource-deprived facilities (Lipman *et al.*, 2009:328; Lipman *et al.*, 2000:170).

MUAC, on the other hand, has been endorsed much more recently as an independent diagnostic tool alongside WHZ and/or nutritional oedema with the creation of community-based management of SAM (WHO *et al.*, 2007:2). It involves measuring the circumference of the mid-upper arm using a flexible non-stretchable colour-coded tape and comparing the measurement with a single reference cut off with the colours of the tape (red, yellow and green) categorising the various degrees of malnutrition. In contrast to WHZ, MUAC is independent of age and gender. It is a simple and non-invasive tool for the assessment and identification of SAM in children 6 - 59 months. It requires minimum training and supervision of health workers and volunteers and can be used conveniently in busy wards with limited time and staff (Mwangome *et al.*, 2012).

Both tools measure the nutritional status of children and have been instrumental in identifying and diagnosing SAM. MUAC < 11.5 cm and WHZ < -3 SD are both associated with increased risk of mortality in children; however, MUAC is considered a better indicator of the risk of death than WHZ (Briend *et al.*, 2012:130-132; Sachdeva *et al.*, 2016:2513). Although MUAC and WHZ are used as independent tools in the assessment of the nutritional status of children, several studies have reported poor correlations between these tools (Berkley *et al.*, 2005:594-595; Laillou *et al.*, 2014:1-5). In a study by Berkley *et al.* (2005:593-595), which compared the risk of mortality of hospitalised children, it was observed that MUAC and WHZ identified different sets of children; with a significantly higher number of children diagnosed with MUAC < 11.5 cm alone presenting with oedema, stunting and visible wasting. A MUAC < 11.5 cm was more likely to identify female and younger children compared with those with admitted with WHZ ≤ -3 SD only. This trend is consistent with studies conducted by Burza *et al.* (2015:853-854) and Grellety *et al.* (2015:2577). Children with MUAC ≤ 11.5 cm were more likely to have a longer history of moderate anaemia, illness, diarrhoea, cough, subcostal in-drawing and bacteraemia. The rate of mortality, however, was similar for children presenting with MUAC ≤ 11.5 cm alone (10.9%) and WHZ ≤ -3 only (10.1%). The highest death rate was recorded among children whose indicators were both low (25.4%) (Berkley *et al.*, 2005:593-595).

Studies by Chomtho *et al.* (2006:860-864) concluded that MUAC is strongly correlated to fat mass rather than predicting total or regional fat-free mass in children. On the other hand, WHZ measurements encompass both fat and fat-free body mass. This implies that MUAC and WHZ are likely to measure different components of body stores and therefore identify different subsets of nutritionally compromised children.

Studies have revealed that different compartments of the body play distinct roles in immune defence and survival and affect immunological processes differently. Fat mass has been shown to influence immune function *via* the role played by leptin, primarily produced by adipocytes in the promotion of Type 1 T helper (Th1) cell differentiation and pro-inflammatory cytokine production (Naylor & Petri, 2016:88-89). Fat-free mass, on the other hand, modulates immune function by means of the roles of different amino acids in antibody production, lymphocyte gene expression and proliferation and regulation of cellular redox state, among many others (Li *et al.*, 2007:237). Hence, it is likely that the different groups of malnourished children identified by either MUAC or WHZ have distinct immune deficits (cell-mediated or humoral immune deficits), which may influence their immune response to different infection types, recovery rate, death and response to treatment.

Additionally, MUAC has been shown to be much more sensitive to identifying stunted and younger children at risk of death compared with WHZ (Dasgupta *et al.*, 2013:154; Grellety & Golden, 2016:10). This implies that MUAC offers an additional advantage for detecting children who are most vulnerable to sickness and death, considering that stunting is associated with increased overall mortality risk and death from diarrhoeal infections, pneumonia and measles (Black *et al.*, 2008:247). Disparities, therefore, in the LAZ status of severe acutely malnourished children may have an impact on treatment outcomes.

Again, although guidelines stipulated for identifying and admitting children with SAM are regarded as strong recommendations by the WHO, evidence regarding the relationship between the reference anthropometric indicators and mortality risk on admission is scarce. Similarly, there is insufficient evidence on the association between admission criteria and recovery time, growth and weight gain (WHO, 2013:21). This is, however, not to discredit the WHO guidelines but to expose research gaps that need to be bridged.

A systematic review of literature prior to the latest WHO guideline update on the management of SAM in infants and children showed the scarcity of evidence upon which the diagnostic and discharge criteria of SAM are based. In the review, only one observational cohort study compared the treatment outcomes of hospitalised children who were severely malnourished and diagnosed on the basis of MUAC versus WHZ. Mortality rate was the only outcome reported. There were no reports on recovery rate and complications (Roberfroid *et al.*, 2013:8).

In table 2.1, a summary is provided of the studies which investigated the treatment outcomes of children with SAM diagnosed by MUAC and/or WHZ. As illustrated in **Table 2.1**, Grellety *et al.* (2015), compared the characteristics and treatment outcomes of children admitted into an out-

patient therapeutic management of SAM based on MUAC < 11.5 cm (irrespective of WHZ), versus WHZ < -3 SD and MUAC $\geq$ 11.5 cm. Children admitted using MUAC < 11.5 cm as a single anthropometric admission criterion, were significantly less likely to recover (54% vs. 69%; $P < 0.0001$) and experienced a higher risk of death (4% vs. 1%) and transfer to in-patient care, compared with patients admitted with WHZ < -3 SD and MUAC > 11.5 cm (12% vs. 7%). Among recovered children, those with MUAC < 11.5 cm had a greater average weight and MUAC gain per day compared with the WHZ < -3 SD and MUAC > 11.5 cm group. After adjusting for age and gender, the risk of death was over four times higher among children in the MUAC < 11.5 cm group in comparison with the WHZ < -3 SD and MUAC > 11.5 cm group. This shows that children with MUAC < 11.5 cm are more severely malnourished and are at an increased risk of death compared with those with WHZ < -3 SD (Grellety *et al.*, 2015:2575-2575). This finding, however, may not be applicable to in-patients with complicated SAM whose response to treatment may be influenced by various underlying medical complications.

Several other studies have reported consistently positive outcomes for children diagnosed with SAM and enrolled into community-based nutrition rehabilitation on the basis of MUAC alone. A study of children admitted by MUAC $\leq$ 11.8 cm or oedema into a community-based therapeutic feeding programme in Burkina Faso showed that patients with low MUAC ($\leq$ 11.4 cm) had a higher average daily weight and MUAC gain at discharge than those with higher MUAC (11.6 - 11.8 cm) on admission. Generally, 89.1% of patients recovered (15% weight gain or resolution of oedema) at discharge, 7.8% defaulted, 1.5% failed to respond to treatment, while 1% died. Mean weight gain was 5.4 g/kg/day, while mean MUAC gain was 0.42 mm/day (Goossens *et al.*, 2012).

In another study conducted in India, which admitted children into a community-based therapeutic feeding programme comprised of an out-patient care (ambulatory therapeutic feeding centre) and an in-patient treatment component (stabilisation centre), treatment outcomes were stratified by admission MUAC (Burza *et al.*, 2015:854-855). In this study, it was observed that patients with lower MUAC (< 11.0 cm) had a longer length of stay and recorded higher mortality levels. Despite the high default rate (36.2%), the majority of patients recovered (57.4%) while only 0.8% of the children who received out-patient care died. Among those who were treated at the stabilisation centre, 4.6% died while 93.3% were transitioned to out-patient care. Study authors reported that, considering the small proportion (0.9%) of children who required in-patient treatment at the time of programme entry in comparison with that reported in some African countries, it is likely that the morbidity associated with SAM may be more severe in the African context (Burza *et al.*, 2015:854-855; Tectonidis, 2006:226); and that this may have implications for response to and outcome of treatment.

A study by Nielsen *et al.* (2004) provides further evidence that children classified as severely malnourished on the basis of MUAC, respond positively to nutritional rehabilitation. These studies, however, were conducted in children receiving community-based interventions rather than in-patient care. With the current stratification of SAM treatment into in- and out-patient care, it may be impossible to extrapolate results from a community-based therapeutic feeding programme to in-patient management of complicated SAM.

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Table 2.1 Studies reporting the treatment outcomes of children with SAM diagnosed by MUAC and/or WHZ

Reference	Age Group	Country	Sample Size	Study Design	Care Delivered	SAM Diagnostic Criteria	Discharge Criteria	Treatment	Outcome
(Grellety <i>et al.</i> , 2015)	6 - 59 months	South Sudan	2205	Retrospective	Out-patient care	MUAC < 11.5 cm (irrespective of WHZ); WHZ < -3 SD and MUAC ≥ 11.5 cm and the presence of oedema	WHZ ≥ -2 SD and MUAC > 11.5 cm at two consecutive visits, No oedema for > 7 days, and clinical wellness for at least two consecutive follow-up visits	Ready-to-use therapeutic food (Plumpy nut)	Death rate MUAC < 11.5 cm group = 4% WHZ < -3 SD and MUAC ≥ 11.5 cm group = 1% (p-value < 0.0001) Recovery MUAC < 11.5 cm group = 54% WHZ < -3 SD and MUAC ≥ 11.5 cm group = 69% (p-value < 0.0001) Transfer to in-patient care MUAC < 11.5 cm group = 12% WHZ < -3 SD and MUAC ≥ 11.5 cm group = 7% (p-value < 0.0001) Default (failure to show up for two consecutive follow-ups) MUAC < 11.5 cm group = 30% WHZ < -3 SD and MUAC ≥ 11.5 cm group = 23% (p-value < 0.0001) Length of stay (days) MUAC < 11.5 cm group = 51.57 WHZ < -3 and MUAC ≥ 11.5 cm group = 50.82 (p-value = 0.647) Weight gain (g/kg/body weight) MUAC < 11.5 cm group = 6.01 WHZ < -3 SD and MUAC ≥ 11.5 cm group = 5.12 (p-value < 0.0001) MUAC gain (cm/day) MUAC < 11.5 cm group = 0.045 WHZ < -3 SD and MUAC ≥ 11.5 cm group = 0.025 (p-value < 0.0001)
(Gebremichael <i>et al.</i> , 2014)	6 - 59 months	Ethiopia	469	Retrospective	In-patient care	WHZ < -3 SD, MUAC < 11.0 cm or presence of bilateral oedema	Not reported	Not reported	Median LOS = 17days Median weight gain = 12.1 g/kg/day=12.8% Overall incidence of death = 7.3 per 1000 persons-days.

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Table 2.1 Studies reporting the treatment outcomes of children with SAM diagnosed by MUAC and/or WHZ (Cont.)

Reference	Age Group	Country	Sample Size	Study Design	Care Delivered	SAM Diagnostic Criteria	Discharge Criteria	Treatment	Outcome
(Berkley <i>et al.</i> , 2005)	12 - 59 months	Kenya	8,500	Cohort	In-patient care	MUAC $\leq$ 11.5 cm and WHZ $\leq$ -3 SD	Not reported	F-75 and F-100	19% and 19.9% of patients with MUAC $\leq$ 11.5cm and WHZ $\leq$ -3 SD died respectively.
(Goossens <i>et al.</i> , 2012)	6 - 24 months	Burkina Faso	24,792	Retrospective	In-patient and out-patient care	MUAC $\leq$ 11.8 cm or oedema	15% weight gain or resolution of oedema	F-75 and F-100 for hospitalised patients and RUTF for out-patients	Recovery 88.3% and 89.6% of patients with MUAC < 11.5 cm and MUAC 11.6 - 11.8 cm recovered respectively. Death Death rate was 1.4% and 0.71% among the MUAC < 11.5 cm and MUAC 11.6 -11.8 cm respectively.
(Isanaka <i>et al.</i> , 2015)	6 - 59 months	Niger	2,399	Secondary data analysis	Out-patient care	MUAC < 11.5 cm or WHZ < -3 + MUAC $\geq$ 11.5 cm	WHZ $\geq$ -2 SD and MUAC > 11.5 cm on two consecutive visits	RUTF	There was no statistical difference in mortality, recovery and default rate and transfer to in-patient care between the two groups.
(Saaka <i>et al.</i> , 2015)	6 - 59 months	Ghana	348	Retrospective	Out-patient care	MUAC < 11.5 cm MUAC > 12.5 cm + oedema	MUAC < 12.5 cm	RUTF	Weight gain Patients admitted on the basis of oedema had a significantly greater weight gain on discharge compared with those with MUAC < 11.5 cm (9.9 kg vs 8.8 kg). Length of hospital stay LOS did not significantly differ between the two cohorts of patients
(Nielsen <i>et al.</i> , 2004)	6 - 59 months	Guinea Bissau	247	Case series	Out-patient care	MUAC < 13.0 cm	MUAC $\geq$ 13.0 cm	Supplementary feeding (millet gruel+ fresh bananas+ margarine+ fresh eggs + full strength milk +micronutrient tablets)	Recovery 5.9, 11.3 and 28.7 per 1000 persons per day with MUAC < 11.5 cm, 11.5 - 12.5 cm and 12.6 -13.0 cm recovered respectively

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Table 2.1 Studies reporting the treatment outcomes of children with SAM diagnosed by MUAC and/or WHZ (Cont.)

Reference	Age Group	Country	Sample Size	Study Design	Care Delivered	SAM Diagnostic Criteria	Discharge Criteria	Treatment	Outcome
(Burza <i>et al.</i> , 2015)	6 - 59 months	India	8542	Observational, retrospective cohort	In-patient and out-patient	Old criteria WHZ <-3 SD $\pm$ MUAC < 11.0 cm $\pm$ bilateral pitting oedema New criteria MUAC < 11.5 cm $\pm$ bilateral pitting oedema	Old criteria WHZ > -2SD and MUAC > 11.0 cm New criteria MUAC >12.0 cm	F-75 and F-100 for in-patient care RUTF for out-patients	Old criteria 1.1% died, 53.4% discharged as cured, and 38.3% defaulted Mean weight gain = 4.7 ± 3.1 g/kg/day Length of stay = 8.7 ± 6.1 days New criteria 0.8% died, 57.4% discharged as cured, 36.2% defaulted Mean weight gain = 5.1 ± 3.7 g/kg/day (p-value < 0.01) Length of stay = 7.3 ± 5.6 days (p-value < 0.01)
(Grijalva-Eternod <i>et al.</i> , 2016)	0 - 60 months	Burundi; DRC; Kenya; Liberia; Myanmar; Niger; Somalia; Sudan; Tajikistan; Uganda	< 6 months 2939 6 - 60 months 21106	Analysis of secondary datasets	Home treatment Stabilisation centre Therapeutic feeding centre Day centre	GAM WHZ <-2 $\pm$ oedema MAM WHZ < -2 but $\geq$ -3 SAM WHZ < -3 $\pm$ oedema	The Sphere Project 2011 definitions for Recovery; Default; Non-recovery and Death as well as missing data and admission error	Not Reported	Recovery 75% (< 6 months); 74.5% (6 - 60 months) Death 4.6%(< 6 months); 3.95% (6 - 60 months) Non-recovery 10.2% (< 6months); 10.(6 - 60 months) Default 6.43% (< 6 months); 7.75% (6 - 60 months) (p-value < 0.01) Admission error 0.37% (< 6mths); 0.50%(6 - 60 months) Missing values 2.69% (< 6 months); 3.24% (6 - 60 months) (p-value = 0.05)

MUAC: Mid upper arm circumference; WHZ: Weight-for-height z- score; GAM: Global acute malnutrition (WHZ <-2 and/or oedema); MAM: Moderate acute malnutrition; SAM: Severe acute malnutrition;
LOS: Length of hospital stay.

2.8.3 WHO guidelines for treatment of SAM

Recent guidelines recommend an integrated approach to SAM management that encompasses in-patient and community-based treatment, depending on the presence or absence of complications. Children diagnosed as severely malnourished, but who have appetite and are medically well and alert are treated as out-patients with ready-to-use therapeutic food (RUTF) and basic medical care with consistent follow-ups. On the other hand, children who present with medical complications, severe oedema, and poor appetite and/or one or more IMCI danger signs are treated as in-patients (WHO, 2013:3). It is quite clear that strategies for the diagnosis and management of SAM in older children (6 - 59 months) are well developed when compared with those for infants 0 - 5 months. There is still little evidence regarding the outcome of extrapolating SAM diagnosis and management guidelines for children 6 - 59 months to infants less than 6 months old as is currently done in practice (WHO, 2013:60-65).

Similar to the management guidelines for children 6 - 59 months, treatment of SAM in infants < 6 months is categorised into in-patient and out-patient care. Those with SAM in addition to one or more of the following conditions are to be admitted for in-patient care: serious medical complications; recent weight loss or failure to gain weight; presence of any pitting oedema; ineffective feeding or any medical or social concern that requires thorough assessment or intensive support (WHO, 2013:63). Infants < 6 months without medical complications or any of the above-listed conditions are to be treated as out-patients and receive a course of broad-spectrum antibiotics appropriate for their weight (WHO, 2013:64). Presently, RUTF is not recommended for infants < 6 months for the community management of SAM (Kerac *et al.*, 2012:12). The ultimate feeding approach is to re-establish exclusive breastfeeding (WHO, 2013:64).

2.8.4 Facility-based treatment

Owing to the profound metabolic and physiological alterations that occur with SAM, urgent and intensive care is essential. In an attempt to reduce mortality and standardise in-patient care of SAM, the WHO recommends the use of a 10-step standard treatment protocol which comprises an initial stabilisation and a longer rehabilitation phase for in-patient management (Ashworth *et al.*, 2003), as shown in **Table 2.2**. The stabilisation phase involves restoration of homeostasis and treatment of acute medical complications, which are the main causes of avoidable deaths in children with SAM (Ashworth, 2008:547). It involves the prevention or treatment of hypoglycaemia, hypothermia and dehydration; correction of electrolyte imbalance; and treatment or prevention of infections. Blood glucose level < 3 mmol/L is indicative of hypoglycaemia and

should be treated promptly by administering 50 ml bolus of 10% glucose or sucrose orally or by a nasogastric tube followed by initiation of starter feed in the case of a conscious child. Intravenous sterile 10% glucose is to be administered only if the child is unconscious, followed by 50 ml of 10% glucose administered by nasogastric tube and commencement of two-hourly starter feeds. In situations where testing blood glucose is not feasible, hypoglycaemia is to be presumed and treated accordingly. Hypoglycaemia and hypothermia occur concurrently and are signs of infection. Axillary temperature < 35°C is suggestive of hypothermia and must be managed with immediate feeding and active rewarming (Ashworth *et al.*, 2003).

Table 2.2: Outline of the WHO ten steps for in-patient management

Step	Stabilisation		Rehabilitation
	Days 1-2	Days 3-7	Weeks 2-6
1. Hypoglycaemia	→		
2. Hypothermia	→		
3. Dehydration	→		
4. Electrolytes	→	→	→
5. Infection	→	→	
6. Micronutrients		No iron	With Iron
7. Cautious feeding	→	→	
8. Catch-up growth			→
9. Sensory stimulation	→	→	→
10. Prepare for follow-up			→

Source: Ashworth *et al.* (2003).

Dehydration status in children with SAM may be difficult to interpret. Hence, all children with watery diarrhoea are assumed to be dehydrated and treated with enteral rehydration solution for malnutrition (ReSoMal). Intravenous rehydration is recommended only in the case of shock and must be done with caution to avoid fluid overload and heart failure. Imbalance in electrolytes is also corrected by administration of extra potassium and magnesium to allow renal excretion of sodium in order to dissipate existing oedema. Severely malnourished children are at an increased risk of nosocomial infections despite the fact that signs of infections may not be clinically evident. Therefore, ideally, children admitted for SAM are to be secluded from overcrowded wards and other infectious children on admission and treated routinely with broad spectrum antibiotics including intramuscular or intravenous ampicillin and gentamicin even in the absence of conspicuous clinical signs (Ashworth *et al.*, 2003; WHO, 2000:81)

Generally, all severely malnourished children suffer micronutrient deficiencies. Therefore, there is the need for replenishment of vitamin A, folic acid, zinc, copper and iron as part of the treatment.

Iron supplementation is withheld, however, during the stabilisation phase when infections and sepsis still persist to prevent, enteropathogenic proliferation (Cross *et al.*, 2015:1).

The rehabilitation phase commences the moment acute medical complications have been resolved and appetite has improved. It aims at rebuilding depleted body stores and promoting catch-up growth, providing sensory and emotional support and preparation for follow-up after discharge to ensure complete recovery (Ashworth *et al.*, 2003).

2.8.5 WHO guidelines for discharging SAM

According to the latest updates on the management of SAM, discharge of children with SAM from in-patient treatment to out-patient treatment, should be based only on resolution of medical complications, including oedema, return of appetite and clinical alertness, rather than anthropometric outcomes such as MUAC, WHZ or percentage weight gain (WHO, 2013:20). This recommendation, although considered strong, is based almost entirely on expert opinion (Tickell & Denno, 2016:646). However, research conducted by Goossens *et al.* (2012) and Nielsen *et al.* (2004) provide evidence to support the use of MUAC, rather than percentage weight gain for discharging children with SAM from treatment. The use of percentage weight gain as discharge criterion deprives patients who are more malnourished of sufficient time for full recovery, because patients with the lowest weight or MUAC measurements on admission meet the discharge criterion rapidly, thus benefiting less from nutritional rehabilitation (Goossens *et al.*, 2012). For infants < 6 months old, transfer from in-patient to out-patient care can be made when all clinical complications and oedema are resolved and the child has appetite and is alert and weight gain on either exclusive breastfeeding or replacement feeding is adequate (5 g/kg/day for 3 consecutive days). Prior to the discharge, structures must be put in place for community-based follow-up and support for the care-giver, and the child must be checked for all immunisations (WHO, 2013:64-65). **Table 2.3** provides a summary of the WHO guidelines for admission and discharge of children with SAM.

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Table 2.3: WHO guidelines for admission and discharge of children with SAM

Guideline	Age group	Recommendation	Grade of recommendation
Admission into in-patient care	6 - 59 months	Admit into in-patient care on the basis of MUAC < 11.5 cm or WHZ < -3 SD or severe oedema with underlying medical complications, lack of appetite and IMCI danger signs	Strong recommendation, low-quality evidence
	0 - 5 months	Infants with WHZ < -3 SD or bilateral pitting oedema in addition to serious medical complications, recent weight loss or failure to gain weight, ineffective feeding or any medical or social issue needing more detailed assessment or intensive support	Strong recommendation, very low-quality evidence
Discharge from in-patient care to outpatient treatment	6 - 59 months	Transfer from in-patient to outpatient care on the basis of resolution of medical complications, oedema and return of appetite and clinical alertness rather than anthropometry	Strong recommendation, low-quality evidence
	0 - 5 months	Resolution of medical complications, including oedema and good appetite and clinical wellness and alertness and satisfactory weight gain on either exclusive breastfeeding or replacement feeding above the median of the WHO growth velocity standards or more than 5 g/kg/day for at least 3 successive days	Strong recommendation, very low-quality evidence

MUAC: mid-upper arm circumference; WHZ: weight-for-height-z-score; IMCI: Integrated management of childhood illness; WHO: World Health Organisation. Source: (WHO, 2013)

2.8.6 Guidelines for diagnosing and discharging children with SAM in Ghana

The Ghana Health Service has adopted the community-based management of SAM (CMAM) approach, which is documented in the interim national guidelines for community-based management of severe acute malnutrition in Ghana. Hence, SAM management in Ghana follows the in-patient and out-patient treatment plan. Diagnostic criteria for SAM as stipulated in this guideline, are similar to the WHO guideline, except for the exclusion of WHZ as a diagnostic criterion. For children 6 - 59 months with bilateral pitting oedema (+++), any grade of oedema with severe wasting (MUAC < 11.5 cm), or SAM with medical complications, in-patient care is recommended. All infants (0 - 5 months) with SAM, defined as presence of bilateral oedema or visible wasting, are treated as in-patients. Again, children ≥ 6 months weighing < 4 kg are to be admitted for in-patient care (Ghana Health Service *et al.*, 2010:4). For children 6 - 59 months, discharge from in-patient care is based on resolution of medical complications, clinical alertness and wellness. Similarly, for infants < 6 months, discharge can be made when re-lactation has been successfully established and the child is gaining appropriate weight (20 g/day on breastfeeding alone for five days) (Ghana Health Service *et al.*, 2010:5).

2.9 Hospital practices and policies regarding SAM admission and discharge

The case fatality rates of SAM in health facilities have remained consistently high, ranging between 30% and 50% (WHO, 2016), despite the existence of the WHO treatment guideline. In sub-Saharan Africa, according to Picot *et al.* (2012), these unacceptably high fatality levels are attributable to inconsistency in the implementation of the WHO guidelines, especially in developing countries. Cases of SAM may not represent a high percentage of hospital admissions; however, they contribute disproportionately to hospital deaths. An instance is given of 11 hospitals in the Eastern Cape of South Africa where SAM accounted for 15% of paediatric admissions, but 33% of mortality (Karaolis *et al.*, 2007:202).

More often than not, severely malnourished children are admitted for in-patient care with primary diagnosis of common conditions such as pneumonia, gastroenteritis or tuberculosis, among others, which sometimes take precedence over SAM in terms of the treatment plan. Efforts are mistakenly directed towards the treatment of the primary illness first, rather than simultaneously addressing the physiological and metabolic alterations that occur with SAM. Failure on the part of physicians to identify, diagnose and manage children with SAM appropriately or those at risk who have been admitted for other acute ailments other than SAM leads to high mortality during the course of treatment (Ashworth, 2008:547). It is worth mentioning that malnutrition has been

insufficiently acknowledged as a major underlying cause of mortality associated with acute childhood diseases by primary healthcare providers owing to the failure of appropriate assessment of children who present at healthcare facilities with acute illness. Studies conducted in five health facilities in Uganda reveal that among children below the age of 5 who reported for treatment of acute childhood diseases, only 75.1% were weighed, whilst WHZ and MUAC were not assessed for 99.2% and 85.8% of the children, respectively. This resulted in 32.9% of treated children going unidentified and not treated for PEM (Akugizibwe *et al.*, 2013:463). In a similar study conducted in Ghana, only 5.9% of wasted children who had reported at the paediatric outpatient department were identified by the physician (Antwi, 2008:101). It can therefore be hypothesised that there are still lapses in the identification and diagnosis of SAM at the hospital level.

Curbing child mortality and morbidity associated with childhood illnesses and malnutrition demands the unimpaired functioning of health systems and the full implementation of effective interventions which emphasise proper case management and adherence to set guidelines and policies (Bryce *et al.*, 2003:163; English *et al.*, 2004:1950). Although there are national and international guidelines for the diagnosis and treatment of SAM and other paediatric illnesses, these guidelines, more often than not, are inadequately adhered to at the care delivery level. Quite a number of studies have provided evidence to partly justify this assertion (Biggs, 2013:175; Warfa *et al.*, 2014:1-4).

2.10 Conclusion

What this literature review sought to achieve was to provide a summary of available literature on the diagnostic and discharge criteria for SAM in infants and children between 0 and 59 months by the WHO and various nutrition rehabilitation programmes. It further reveals the research gap in the admission characteristics and treatment outcome that needs to be further investigated.

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CHAPTER 3 ARTICLE

3.1 Title page

Severe acute malnutrition diagnosis, admission and discharge protocols and practices of infants and children (0-59 months) in two Ghanaian hospitals.

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3.2 Article to be submitted to the journal *Maternal and Child Nutrition***Abstract**

Although the World Health Organisation (WHO) stipulates guidelines for the diagnosis of severe acute malnutrition (SAM) in children 0-59 months and their subsequent discharge, these are not based on strong evidence. Furthermore, knowledge of the relationship between admission anthropometry and length of hospital stay (LOS), mortality and weight gain is limited. This study aimed to assess the protocols of hospitals compared with clinical practices and the WHO guidelines with regard to diagnosis, admission and discharge of children with SAM in relation to treatment outcomes. Data on the hospitals' protocols were collected and compared with the WHO guidelines. A retrospective review of the medical record, of children 0-59 months diagnosed, admitted, treated and discharged for SAM, was conducted in two Ghanaian hospitals.

In the hospitals' protocols, MUAC is the only anthropometric tool recommended for SAM diagnosis, as opposed to the WHO's recommendation of MUAC or WHZ. In total, 289 records were included. MUAC was assessed in only 34.3% of the children at admission. Discharge, death and abscond rates were 77.7%, 17.7% and 3.8% respectively. Average LOS was 11.4 days with 5.8 g/kg/day weight gain. No significant changes in MUAC ($P=0.31$) and WHZ ($P=0.69$) were observed. Oedema and children aged 6-59 months with weight <4 kg were associated with longer LOS (14.1 days; 95% CI: 11.5; 17.2; $P=0.02$ and 17.7 days; 95% CI: 13.2; 23.8, $P<0.001$ respectively). There were differences between the hospitals' protocol, the WHO guideline and clinical practice. The level of mortality was higher than the accepted SPHERE minimum standard.

Key words (6): Severe acute malnutrition (SAM), medical complications, infants and children, admission criteria, treatment outcomes

Introduction

Malnutrition refers to all forms of clinical conditions resulting from imbalances, excesses and/or deficiencies of several nutrients, which lead to the compromising of the body's natural capacity to resist infection, heal and recover (UNICEF, 2006). It encompasses both undernutrition and overnutrition. However, in the context of this paper, it is used to refer to undernutrition, which may be categorised as chronic or acute, and is defined as the inadequate supply of energy and nutrients for optimum growth and maintenance of physiological function (UNICEF, 2006).

Malnutrition in children continues to be a formidable public health burden, accounting for nearly half of all under-five child deaths worldwide (United Nations Inter-agency group for child mortality estimation, 2015). Although significant progress has been made globally in the reduction of child malnutrition over the past few decades, overall reduction is unsatisfactory. Millions of children, especially in African and Asian sub-regions, still remain at risk (UNICEF, WHO & The World Bank, 2012). Globally, approximately 17 million children are affected by severe acute malnutrition (SAM), which accounts for over half a million deaths annually (UNICEF, WHO, & World Bank Group, 2017). Additionally, approximately 3.8 million infants <6 months are also affected by SAM (Kerac et al., 2011).

Malnutrition is considered the most important underlying factor in the development of severe infections and disease during infancy and early childhood, perpetuating the cycle of infection and deteriorating nutritional status (Fishman et al., 2004). The risk of death in severely malnourished children is over nine times higher than that of well-nourished children (Black et al., 2008). Moreover, this level of risk is relatively higher in infants <6 months in comparison with older children, considering their higher propensity for related pathologies and their vulnerability (Emergency Nutrition Network et al., 2009; Grijalva-Eternod et al., 2016; WHO, 2013). Beyond the loss of life caused by SAM, it is also associated with long-term developmental impairment, educational underachievement and an increased risk among survivors to develop chronic cardiovascular and metabolic diseases later in their lives (Lelijveld et al., 2016).

Severely malnourished children, who also have potentially life threatening illnesses (e.g. severe dehydration and lower respiratory tract infection), are said to have complicated SAM. In resource limited settings, children with complicated SAM require initial in-patient treatment. Once their condition has been stabilised, rehabilitation is completed at an outpatient facility (WHO, 2013).

In view of the profound health burden posed by SAM, the World Health Organisation (WHO), in its guidelines for the management of SAM, recommends early detection *via* the use of mid-upper arm circumference (MUAC) as a screening tool at the community level and the independent use of either MUAC or weight-for-height (WHZ) and the presence of bilateral pitting oedema for institutional diagnosis of SAM (WHO, 2013). However, recent studies have reported a gradual shift from the WHO's recommendation of WHZ <-3 standard deviation (SD) or MUAC <11.5 cm admission criteria to the use of MUAC alone for admission (Ali et al., 2013; Goossens et al., 2012). It therefore stands to reason that there may be differences regarding diagnosis and discharge of children with SAM in hospitals' protocols and actual clinical practices in comparison with WHO guidelines.

Notwithstanding the suspected inconsistencies that may exist in the diagnosis of SAM in various hospitals, there is also generally little evidence regarding the relationship between admission anthropometric indices and length of hospital stay (LOS), the risk of mortality and daily weight gain (WHO, 2013). Although the WHO considers its criteria for diagnosing SAM a strong recommendation, these are based on low-quality evidence (WHO, 2013). The more recently added recommendations for the management of SAM in infants <6 months are similarly based on very low-quality evidence owing to the paucity of research data in this age category (WHO, 2013). There is, therefore, an acknowledged obligation to develop the evidence base in order to advance care in this age group (Angood et al., 2015). Knowledge of the diagnostic criteria and treatment outcomes regarding SAM will add to the much needed evidence required for improved care.

Therefore, this study aimed to assess the hospitals' protocols in comparison with clinical practices and WHO recommendations with regard to the diagnosis, admission and discharge of children with SAM in relation to patient treatment outcomes.

Study methods

Study design, site and participants

A retrospective data collection was conducted in two referral hospitals in Ghana, a developing country in West Africa. Princess Marie Louise (PML) Children's Hospital, one of the sites located in the Greater Accra region, is known for pioneering the discovery of protein-malnutrition (Kwashiorkor) in children during the 1930s (Baumslag, 1993; Williams, 1935). As the main paediatric hospital in the country, it provides both primary and specialised paediatric services for the local community and serves as a referral centre for other health facilities across the country. It has both in-patient and out-patient nutrition rehabilitation clinics and specialises in the management of child malnutrition.

The second site, Komfo Anokye Teaching Hospital (KATH), in the Ashanti region, is a 1200-bed hospital with a nutrition rehabilitation unit serving as a referral unit for the three northern regions and the Brong Ahafo and Ashanti regions. These two study sites capture the scope of the southern and central sectors of the country. In both hospitals, severely malnourished children are preliminarily admitted through the out-patient department or the emergency ward and then transferred to the malnutrition ward.

Information on the hospitals' admission and discharge protocol for SAM was collected from the posters displayed in the malnutrition wards reflecting the current standard operating procedure.

Data from the medical records of infants and children of both genders between the ages of 0-59 months admitted and treated for SAM at PML and KATH between January 2013 and June 2017 were included, regardless of the diagnostic criteria. The medical records were screened using a screening tool (ANNEXURE B). Infants and children admitted for other medical conditions but

diagnosed with SAM during hospital stay were also eligible for inclusion. However, those diagnosed with additional metabolic, neurodevelopmental or any growth disorders or born premature or with a low birth weight (<2.5 kg) were excluded owing to their specialised nutritional needs. Those with incomplete medical information, whose treatment outcomes could thus not be ascertained, were also excluded.

Ethical approval was obtained from the North-West University Health Research Ethics Committee (HREC) (NWU-00063-17-S1) (ANNEXURE C), the Ghana Health Service (GHS-ERC: 09/06/17) (ANNEXURE D) and the Ethics Review Committee of the KATH (CHRPE/AP/374/17) (ANNEXURE E). The study was also approved by the management of both participating hospitals (ANNEXURE F). Data was extracted in privacy and patient as well as staff anonymity was ensured.

Data was collected by qualified dietitians after training to ensure a common understanding of the data to be extracted. The medical record numbers of children admitted for SAM were retrieved from the malnutrition ward register in reverse chronological order. The folder numbers from the ward registry were used to trace folders of all SAM cases from the hospital's main record system, with the assistance of the hospital record staff. The identification numbers of the medical records included were then entered into a registry to avoid duplicate capturing.

The data extraction was conducted using a pre-designed data extraction tool (ANNEXURE G) adapted from three WHO documents published on the WHO admission criteria and treatment guidelines to ensure content validity (WHO, 2010). Data collected included treatment hospital, gender, age, date and time of admission, anthropometric characteristics at admission (weight, height/length, MUAC and WHZ), date of SAM diagnosis, oedema grade, clinical signs, HIV and tuberculosis status and medical complications. Vital signs, including temperature and glucose levels, were recorded. In addition, data on treatment outcomes were collected. This included discharge anthropometry, resolution of medical complications, appetite or death. Treatment outcomes were categorised as "Discharged", "Died", "Absconded" and "Referred for further

treatment". Information on additional discharge protocols, such as referral to outpatient facilities and education of caregiver, were also collected. The supervising researcher cross-checked daily all extracted data against the medical records for correctness and completeness.

A total of 600 records were reviewed and 311 were eligible for inclusion. Twenty of these were multiple admissions and were thus excluded from the analysis. Two others were also excluded because of suspected measurement error. A total of 289 records was therefore included in the final analysis.

Data analysis

Data was first captured into Microsoft Access 2010 and cleaned and then exported into SAS version 9.4. LOS and time to death were determined by calculating the difference between admission and discharge date or date of death respectively. Admission and discharge WHZ, weight-for-age (WAZ) and length-for-age (LAZ) z-scores were calculated from weight, length or height, sex and age (in days) at admission and discharge, based on the WHO Anthro (version 3.2.2, January 2011), using the %igrowup_standard macro for SAS (WHO, 2017). The age of infants <1 month old was considered as zero months. Records of oedematous participants were excluded from the calculation of WHZ and WAZ. Average daily weight gain was calculated from the difference between mean weight at admission and discharge and the average LOS.

All variables were tested for normality using the Kolmogorov-Smirnov test. LOS and time to death were log transformed to take into account skewness and results were reported as geometric means. Chi-square was used to evaluate the association between categorical variables and Fisher's exact test was used when the expected cell counts in the contingency table were less than five. Descriptive statistics were presented as graphs and tables. The Spearman correlation coefficient was used to determine the association between continuous variables. Linear regression models taking into account unequal group sizes using the Tukey adjustment (Kramer, 1956), was used to determine the relationship between independent categorical variables and continuous outcomes. The Wilcoxon signed-rank test was used to compare anthropometric

characteristics on admission and discharge. Lastly, logistic regression models were used to identify independent predictors of mortality. Statistical significance was considered at a P-value of <0.05 .

Results

Admission and discharge protocols for SAM in children aged 0-59 months in both hospitals were the same and were consistent with the interim national guidelines for community-based SAM management in Ghana endorsed by the Ghana Health Service (GHS). **Table 1** provides a summary of the protocols of the hospitals compared with the WHO guidelines. There are a few disparities between the GHS Interim SAM management guidelines and the WHO guideline. No definitive anthropometric index is stipulated for the diagnosis of SAM in infants <6 months and all infants <6 months diagnosed with SAM, with or without medical complications, are treated as in-patients according to the GHS guideline.

An additional criterion unique to the GHS guideline is the diagnosis of children > 6 months weighing <4 kg as severely malnourished. The criteria for discharge from in-patient to out-patient care are quite similar in both guidelines.

Table 1. Summary of the comparison of hospitals' and WHO criteria for SAM in-patient admission and discharge

	Hospitals' Protocol	WHO Protocol
Admission criteria		
Children <6 months	a. Bilateral pitting oedema b. Visible wasting Either of the above with • infant too weak to suckle effectively • not gaining weight satisfactorily at home	a. WHZ <-3 SD or bilateral pitting oedema With • medical complications • recent weight loss or failure to gain weight • ineffective feeding • medical or social issues needing more detailed assessment or intensive support b. MUAC is not recommended as an admission tool
Children 6-59 months	a. Bilateral pitting oedema +++ b. Marasmic-Kwashiorkor: Any grade of bilateral pitting oedema with severe wasting (MUAC <11.5 cm) c. Any grade of oedema with any of the listed medical complications d. Severe wasting (MUAC <11.5 cm) with any of the listed medical complications. • Anorexia, no appetite • Intractable vomiting • Convulsions • Lethargy, not alert • Unconsciousness • Hypoglycaemia • High fever (>39 °C axillary and 38.5 °C for rectal) • Hypothermia (<35 °C axillary and 35.5 °C for rectal) • Severe dehydration • Lower respiratory tract infection • Severe anaemia • Eye signs of vitamin A deficiency • Skin lesion d. Children ≥6 months but weigh <4 kg	a. MUAC <11.5 cm or WHZ <-3 SD or severe oedema With • medical complications • lack of appetite • IMCI danger signs
Discharge criteria (Transfer from In-patient care to out-patient care)		
Children <6 months	a. Successful relaxation with effective suckling yielding a of minimum 20 g weight gain per day on breast milk alone for five days b. No bilateral pitting oedema for two weeks c. Clinically well and alert and has no other medical problem This discharge criteria apply also to children >6 months with weight <4 kg.	a. Resolution of medical complications and clinical wellness and alertness. b. Resolution of oedema c. Good appetite d. Satisfactory weight gain on either exclusive breastfeeding or replacement feeding above the median of the WHO growth velocity standards or >5 g/kg/day for at least 3 successive days.
Children 6-59 months	a. Passed appetite test for RUTF (child consumes >75% of daily ration of RUTF) and is beginning to gain weight. b. Medical complications resolving and clinically well and alert. c. Bilateral pitting oedema reducing	a. Resolving medical complications and are clinically well and alert b. Resolving oedema c. Return of appetite
Additional Discharge Recommendations	a. Mother has been adequately counselled b. Referred to an out-patient rehabilitation facility. b. Has received the required amounts of micronutrient supplements during the stay at the health facility and for use at home	a. Parent or caregiver educated on how to: feed frequently with energy- and nutrient-dense foods. Given structured play therapy b. Mother or caregiver linked to the needed community-based follow-up and support. c. Infant checked for immunisation and routine interventions.

The Admission and Discharge Criteria for SAM in the study hospitals is the same as the Ghana Health Service Interim National Guidelines for Community-Based Management of SAM in Ghana (GHS, 2010). WHO Protocol source: (WHO, 2013). WHZ: Weight-for-height/length; MUAC: Mid-upper arm circumference; RUTF: Ready-to-use therapeutic food; IMCI: Integrated management of childhood illness

Socio-demographic and anthropometric characteristics at admission

After careful screening, 289 records were included in the final analysis. Just over half (52.6%) of the children were female. The distribution of gender was similar in the <6 and 6-59 month age groups (52.8% versus 52.6% female respectively). Thirty-six (12.5%) were younger than six months. Median weight was 3.3 kg (IQR: 2.8; 4.0) and 5.9 kg (Interquartile range (IQR): 4.8; 7.0) for children <6 months and 6-59 months respectively. In 7.6% of those between 6-59 months, admission weight was <4 kg. Non-oedematous was the most common type of malnutrition presented by 82.0% of the children, of which 11.4% were infants <6 months (**Figure 1**). Even so, only 48.1% were reported as visibly wasted. **Table 2** presents the age and anthropometric features of the severely malnourished children at admission.

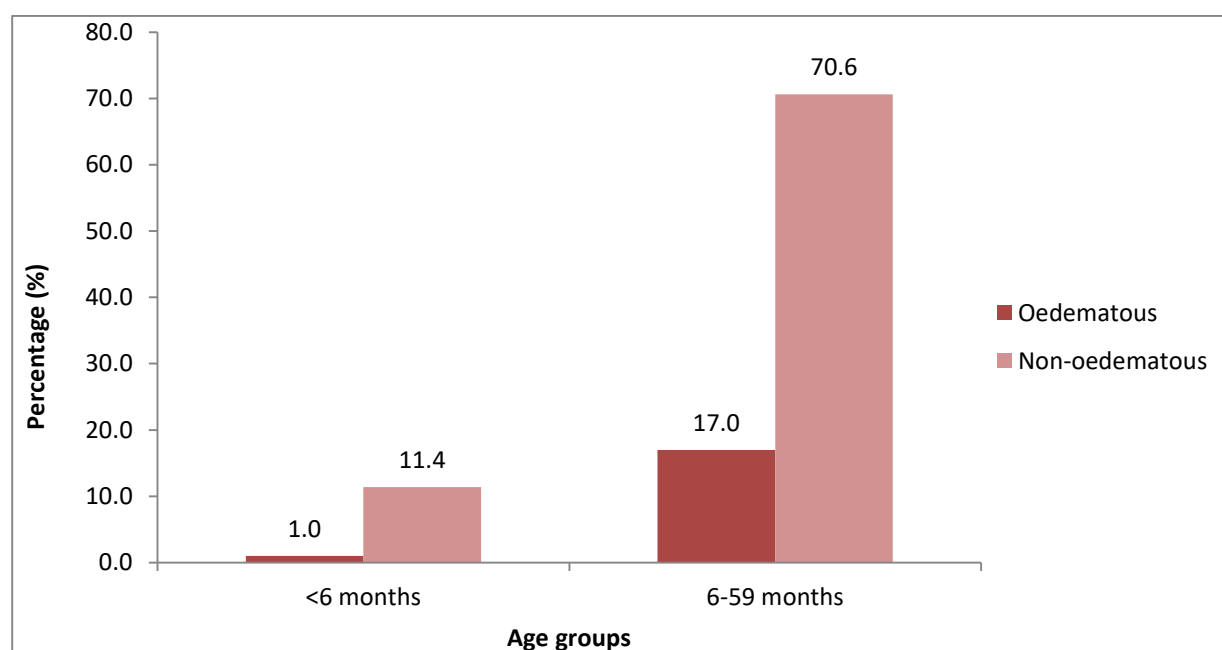


Figure 1. Distribution of the type of severe acute malnutrition stratified by age

Table 2. Age and anthropometric characteristics at admission n=289

Admission Characteristics	Median (IQR)	Minimum	Maximum
Age (Months)			
Total	12.0 (8.0; 18.0)	0.0	59.0
Oedematous	18.0 (9.5; 24.5)	3.0	51.0
Non-oedematous	11.0 (7.0; 17.0)	0.0	59.0
Weight (Kg)			
Total	5.6 (4.5; 6.9)	1.5	13.0
Oedematous	7.2 (5.7; 8.6)	2.3	13.0
Non-oedematous	5.2 (4.5; 6.5)	1.5	11.5
WHZ	-4.2 (-5.3; -3.5)	-9.7	0.8
WAZ	-4.4 (-5.1; -3.5)	-8.1	-0.6
LAZ	-2.2 (-3.2; -0.9)	-9.2	2.2
MUAC (cm)			
Total	10.8 (10.0; 11.5)	8.0	14.0
Oedematous	11.0(10.5; 11.8)	9.0	14.0
Non-oedematous	10.6 (10.0; 11.4)	8.0	13.0

WHZ: weight-for-height/length; WAZ: weight-for-age; LAZ: Length-for-age; MUAC: mid-upper arm circumference. Minimum age of 0.0 represents the age of infants <1 month old.

Clinical characteristics

Of the 289 children admitted, 4.5% and 0.7% were hypoglycaemic (random blood glucose <3 mmol/L) and hypothermic (axillary temperature <35 °C) respectively (**Table 3**). The majority (93.8%) of the children were conscious at admission, but 5.9% had features of shock (fast, weak or absent pulse, cold peripheries and decreased level of consciousness) and 7.3% presented with convulsions. Severe pallor was present in 22.8% of the children. Seventy (24.2%) of those who had diarrhoea were also severely dehydrated. Forty-two (14.5%) of the children were reactive to the HIV test, but for 82 (28.4%) HIV status was unknown. Tuberculosis (diagnosed using chest x-ray) was found in 24 (8.3%) of the children; however, in 143 of them (49.5%), tuberculosis status was unknown. In 66.7% of the children with HIV, there was also tuberculosis co-infection. Anaemia, sepsis and respiratory tract infection, primarily bronchopneumonia, were present in 10.8%, 15.4% and 27.2%, of the children, respectively.

Table 3. Demographic and anthropometric characteristics at admission stratified by treatment outcomes n=289

Admission Characteristics	Total n (%)	Discharged n (%)	Died n (%)	Absconded n (%)	Referred n (%)
Age (month)					
<6 months	36 (12.5)	28 (9.7)	8 (2.8)	0 (0.0)	0 (0.0)
6-59 months	253 (87.5)	196 (67.8)	43 (14.9)	11 (3.8)	3 (1.0)
Gender					
Female	152 (52.6)	120 (41.5)	26 (9.0)	6 (2.1)	0 (0.0)
Male	137 (47.4)	104 (36.0)	25 (8.7)	5 (1.7)	3 (1.0)
WHZ categories (SD)					
≥-3	18 (6.2)	15 (5.2)	2 (0.7)	1 (0.3)	0 (0.0)
<-3 and ≥-5	64 (22.1)	54 (18.7)	9 (3.1)	1 (0.3)	0 (0.0)
<-5	36 (12.5)	25 (8.7)	10 (3.5)	1 (0.3)	0 (0.0)
Missing	171 (59.2)	130 (45.0)	30 (10.4)	8 (2.8)	3 (1.0)
MUAC (cm)					
< 11.5	72 (24.9)	54 (18.7)	12 (4.2)	4 (1.4)	2 (0.7)
≥ 11.5	20 (6.9)	18 (6.3)	1 (0.3)	1 (0.3)	0 (0.0)
6 - 59 months, weight < 4kg	22 (7.6)	17 (5.9)	5 (1.7)	0 (0.0)	0 (0.0)
Type of malnutrition					
Oedematous	52 (18.0)	37 (12.8)	15 (5.2)	0 (0.0)	0 (0.0)
Non-oedematous	237 (82.0)	187 (64.7)	36 (12.5)	11 (3.8)	3 (1.0)

WHZ: weight-for-height/length; MUAC: mid-upper arm circumference; SD: Standard deviation; MUAC categorisation excludes children with oedematous malnutrition. The 'Missing' WHZ category includes those without WHZ scores reported at admission and those with oedematous SAM who were excluded from WHZ score calculation. All percentages are over the total sample of 289.

Assessment of actual clinical practices regarding admission and discharge

In 84.1% of the children, SAM diagnosis was reported at admission (within 24 hours of admission). MUAC and WHZ at admission, however, were reported in only 34.3% and 48.1% of the children respectively. Yet, in 30.9%, neither MUAC nor WHZ was reported. In 88.9% of the children admitted who were <6 months, MUAC was not reported; however, WHZ was measured in 36.1%. Among the 237 non-oedematous children, 32.5% were not assessed for either WHZ or MUAC. Among those aged 6-59 months with non-oedematous malnutrition, weighing >4 kg at admission, 19.5% had no assessment for either MUAC or WHZ and, yet, they were diagnosed with SAM. Furthermore, the basis for the diagnosis of SAM in four of the infants aged <6 months was not reported. **Table 4** displays the proportion of children assessed by various SAM indicators at admission. Fifty-two of the children were reported to have oedema at admission but 6 of these missed SAM diagnosis.

Table 4 Distribution of MUAC and WHZ assessment at admission

	<6 months n (%)	6-59 months n (%)	Total n (%)
Proportion of children assessed at admission (n=289)			
MUAC	4 (1.4)	95 (32.9)	99 (34.3)
WHZ	13 (4.5)	126 (43.6)	139 (48.1)
Both MUAC and WHZ	1 (0.3)	37 (12.8)	38 (13.1)
Oedema (Present)	3 (1.0)	49 (17.0)	52 (18.0)
Visible Wasting	18 (6.2)	121 (41.9)	139 (48.1)
Neither MUAC nor WHZ	20 (6.9)	69 (23.9)	89 (30.8)
6-59 months, weight <4kg	-	22 (7.6)	22 (7.6)
SAM Diagnosed at Admission (Within 24hrs of admission)	28 (9.7)	215 (74.4)	243 (84.1)
Proportion of children assessed and diagnosed with SAM at admission (n=243)			
SAM diagnostic indicators used in the hospitals			
MUAC	3 (1.2)	86 (35.4)	89 (36.6)
WHZ	13 (5.3)	120 (49.4)	133 (54.7)
Both MUAC and WHZ	0 (0.0)	36 (14.8)	36 (14.8)
Oedema (Present)	3 (1.2)	43 (17.7)	46 (18.9)
Visible Wasting	17 (7.0)	116 (47.7)	133 (54.7)
6-59 months, weight <4 kg	-	20 (8.2)	20 (8.2)
Proportion of Profile 1 & 2 children assessed at admission			
	Profile 1 (n=9)	Profile 2 (n=154)	
MUAC	1 (11.1)	67 (43.5)	
WHZ	4 (44.4)	84 (54.5)	
Both MUAC and WHZ	0 (0.0)	27 (17.5)	
Neither MUAC nor WHZ	4 (44.4)	30 (19.5)	

MUAC: mid-upper arm circumference; WHZ: weight-for-height/length z-score; Hrs: Hours; Profile1 = Children <6 months, non-oedematous, no signs of visible wasting, SAM diagnosed at Admission. Profile 2= Children 6-59 months old, Admission weight >4 kg, non-oedematous, SAM diagnosed at admission.

Discharge criteria

As illustrated in **Table 5**, of the 224 discharges, it was reported that 58.5% had infections and medical complications resolved and 74.1% had good appetite, while 99 (44.2%) had both good appetite and all infections effectively treated at the time of discharge. All oedematous infants <6 months old had a complete resolution of oedema at discharge while only 3 of the oedematous children in the 6–59 months group were discharged with mild oedema (grade+1).

Table 5. Discharge characteristics reported in the medical records of children diagnosed with SAM

Proportion of discharged children with:	<6 months (n=28)	6-59 months (n=196)
Medical complications resolved	21 (75.0)	110 (56.1)
Good appetite	21 (75.0)	145 (74.0)
Resolution of medical complications and good appetite	15 (53.6)	84 (42.9)

No oedema	28 (100.0)	193 (98.5)
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Of the 224 discharges, only 132 (58.9%) of the caregivers received nutrition education. However, a larger proportion, 211 (94.2%) of the discharged children was referred to an out-patient facility for continuous nutrition rehabilitation at the community level.

Treatment outcome

As shown in **Table 3**, of the 289 children included, 224 (77.5%) were discharged, 51 (17.7%) died, 11 (3.8%) absconded (refused complete treatment and left the malnutrition ward before official discharge) and 3 (1.0%) were referred for further treatment in other tertiary hospitals.

Length of hospital stay

The mean LOS was 11.4±1.9 days. There was no significant difference in LOS between the two age groups (12.1 days; 95% CI: 9.7; 15.4 for those <6 months and 11.3 days; 95% CI: 10.4; 12.3 for those aged 6-59 months, P=0.54) and the MUAC categorisations (11.4 days; 95% CI: 9.7; 13.3 for children with MUAC <11.5 cm and 10.7 days; 95% CI: 8.1; 14.2 for those with MUAC ≥11.5cm, P=0.94). For children 6-59 months with admission weight <4 kg, there was a higher LOS (17.7 days, 95% CI: 13.2; 23.8, P<0.001) compared with children aged between 6-59 months with admission weight >4 kg (10.8 days). Children with oedematous SAM recorded a significantly longer LOS (14.1 days; 95% CI: 11.5; 17.2; P=0.02) in comparison with those without oedema (10.9 days). A negative correlation of small magnitude was observed between admission WHZ ($r = -0.27$ 95% CI: -0.44; -0.07; P<0.001) and LOS. Those with admission WHZ <-5 SD had a significantly longer LOS (14.0; 95% CI: 11.1; 17.7; P=0.02) compared with those with WHZ ≥-3 SD (7.9 days) and WHZ <-3 SD and ≥ -5 SD (9.4 days). However, LOS was not significantly associated with admission MUAC (P=0.96), LAZ (P=0.07), age (P=0.15) and gender (P=0.23).

As illustrated in **Figure 2**, a quarter (25.2%) of the discharges occurred within 7 days of admission and, by the third week, a larger proportion (86.6%) had occurred. The average LOS for those discharged with good appetite and resolved infections was slightly higher (12.2 days, 95% CI: 10.9; 13.6) than for those discharged reportedly without good appetite and resolved infections (11.2 days, 95% CI: 10.3; 12.6), although this difference was statistically not significant (P=0.33).

There were no differences in the proportion of children discharged with good appetite and resolved infections between the various age ($P=0.29$) and WHZ score ($P=0.48$) groups and those aged between 6-59 months old with admission weight <4 kg ($P=0.56$).

Mortality

Of the 51 deaths, 15 (29.8%) occurred within the first 48 hours and 34 (66.0%) by the seventh day, as illustrated in **Figure 3**. The mean time to death was 4.8 ± 2.9 days. Children <6 months old significantly died earlier (1.5 days; 95% CI: 0.7; 3.2; $P=0.001$) compared with the 6-59 month group (5.9 days). There were no statistical differences in the time to death between oedematous and non-oedematous children ($P=0.90$), gender ($P=0.36$), MUAC groups ($P=1.00$) and WHZ categories. However, those aged 6-59 months weighing <4 kg, had a significantly longer time to death (10.5 days to death from admission, 95% CI: 4.5; 24.9; $P=0.003$) compared with those <6 months (1.5 days), but there was no significant difference when compared with those aged 6-59 months with admission weight >4 kg (5.4 days; $P=0.32$). Mortality was not significantly associated with admission MUAC ($P=0.46$), WHZ ($P=0.17$) and age ($P=0.62$).

Growth: weight gain and changes in z-scores and MUAC

A significant increase in weight ($P<0.001$) and WAZ ($P<0.001$) from admission to discharge was observed. The average weight gain was 5.8 g/kg/day (7.0 g/kg/day for the non-oedematous children and 1.0 g/kg/day for the children with oedematous malnutrition). Children aged <6 months recorded a higher, though not statistically significant ($P=0.66$), average weight gain of 11.2 g/kg/day compared with 5.4 g/kg/day in the 6-59 months age group. Likewise, children with admission WHZ <-5 SD had a higher average weight gain of 6.5 g/kg/day, although this was not significant when compared with those with admission WHZ ≥ -3 SD (4.4 g/kg/day; $P=0.73$) and WHZ <-3 SD and ≥ -5 SD (6.2 g/kg/day; $P=1.00$). No significant changes in MUAC ($P=0.31$) and WHZ ($P=0.69$) were observed.

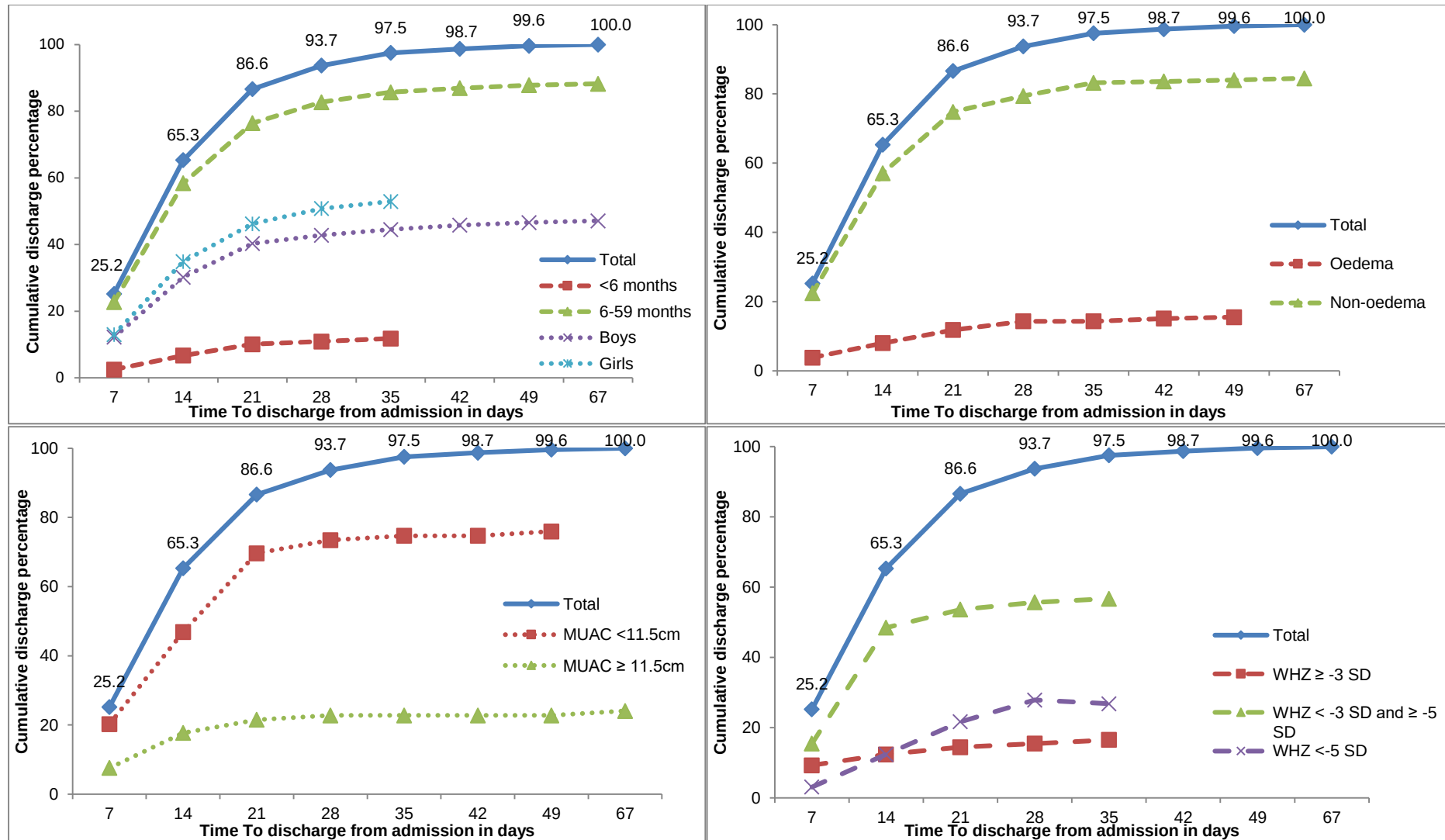


Figure 2. Time from admission to discharge by age groups, gender, type of malnutrition, MUAC and WHZ

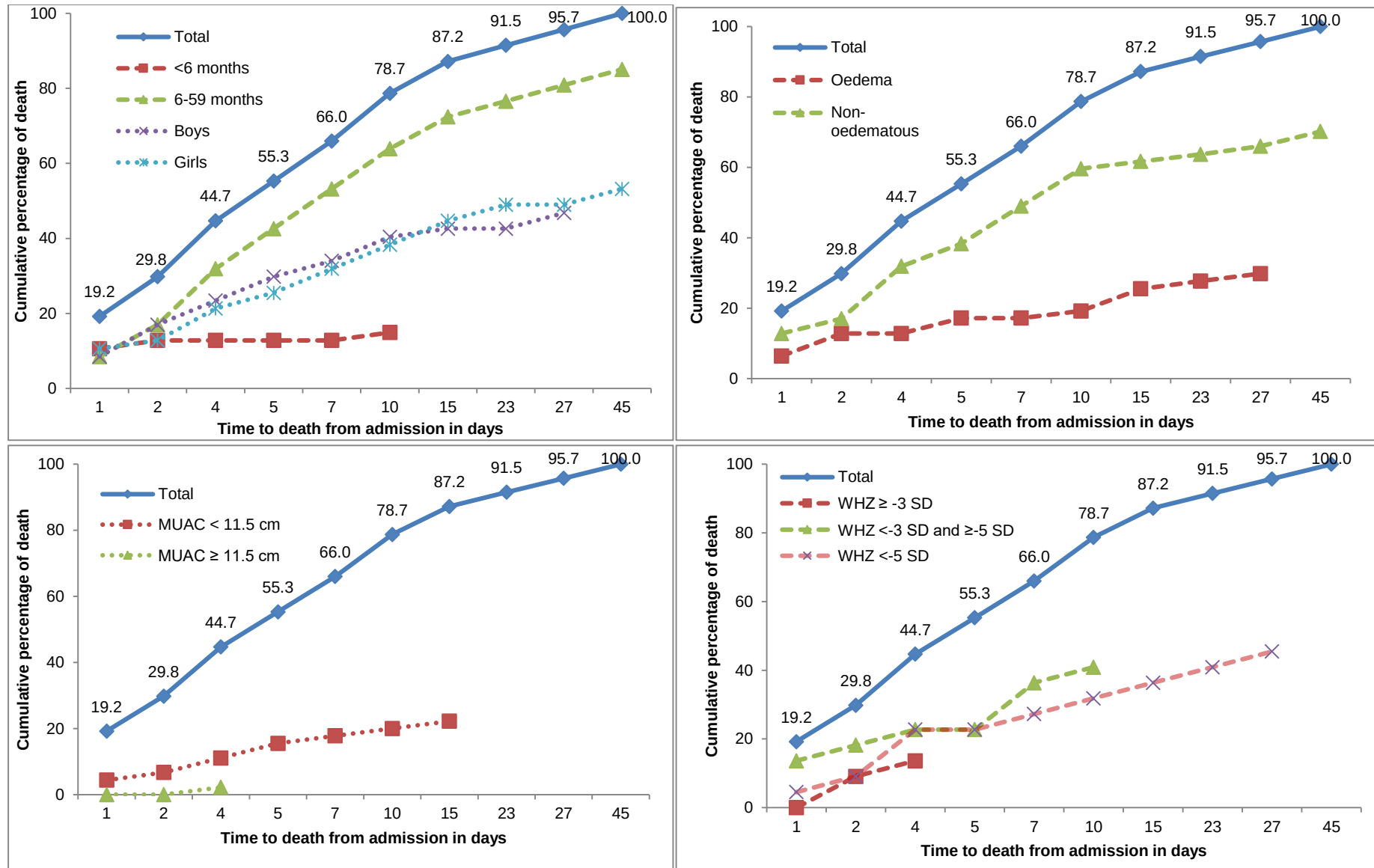


Figure 3. Time to death from admission by age groups, gender, MUAC, WHZ and type of malnutrition

Factors associated with mortality

Table 6 displays the association between demographic and anthropometric characteristics and type of malnutrition at admission and mortality. In the logistic regression model employed, children who were discharged or referred for further treatment, as well as those who absconded, were removed. Age and gender were considered the primary covariates in the model. Risk of death was 2.5 (95% CI: 1.2; 5.5; $P=0.02$) times higher in children with oedematous malnutrition. Similarly, shock, convulsion and severe pallor at admission were associated with a 7.1 (95% CI: 2.7; 20.5; $P<0.001$), 4.2 (95% CI: 1.6; 10.7; $P<0.001$) and 2.1 (95% CI: 1.1; 4.1; $P=0.03$) times increased risk of death respectively. Children who were reactive to the HIV test were found to be 3.1 (95% CI: 1.3; 7.2; $P=0.03$) times more likely to die than children who tested negative to HIV.

Table 6. Demographic and anthropometric characteristics associated with mortality in severely malnourished children

Admission Variables	Mortality n (%)	Adjusted Odds Ratio	95% CI	P- value
Age (month)				
<6 months (n=36)	8 (22.2)	1.3	0.6-3.1	0.54
6-59 months (n=253)	43 (17.0)	1 (ref)		
Gender				
Female (n =152)	26 (17.1)	0.9	0.5-1.7	0.74
Male (n =137)	25 (18.2)	1 (ref)		
WHZ categories (SD)				
<-3 (n=100)	19 (19.0)	1.7	0.3-8.0	0.53
≥-3 (n=18)	2 (11.1)	1 (ref)		
MUAC (cm)				
<11.5 (n=72)	12 (16.7)	3.9	0.5-32.2	0.38
≥11.5 (n=20)	1 (5.0)	1 (ref)		
6-59 months, weight <4 kg (n=22)	5 (22.7)	1.3	0.4-3.9	0.86
6-59 months, weight >4 kg (n=231)	38 (16.5)	1 (ref)		
Type of malnutrition				
Oedematous (n=52)	15 (28.8)	2.5	1.2-5.2	0.02
Non-oedematous (n=237)	36 (15.2)	1 (ref)		

Ref: reference; WHZ: weight-for-height z-score; MUAC: mid-upper arm circumference

Discussion

Although there are WHO guidelines for the diagnosis of SAM in children and their subsequent discharge, knowledge of the actual protocols and practices in this regard in hospitals remains limited. Furthermore, there is scant information on the relationship between admission anthropometric characteristics and treatment outcomes of children diagnosed with SAM. Therefore, this study aimed at comparing the hospitals' SAM diagnosis and discharge protocols with the actual clinical practices and WHO guidelines.

To the best of our knowledge, this is the first study of its kind to compare the protocol of hospitals in Ghana on SAM diagnosis, admission and discharge with actual clinical practice and WHO guidelines. An important finding of this study is the recommendation of MUAC as the only anthropometric diagnostic criterion for SAM in children aged 6-59 months in the hospitals' protocol. This observation simply adds to the evidence of the gradual shift from the WHO guidelines of the use of WHZ or MUAC to the use of MUAC alone. This drift is encouraged by studies conducted by various researchers, including Ali et al. (2013); Briend, Maire, Fontaine, and Garenne (2012) as well as Mogendi, De Steur, Gellynck, Saeed, and Makokha (2015), who demonstrate the superiority of MUAC over WHZ in the prediction of mortality and thus its appropriateness as a sole SAM diagnostic tool.

Another criterion that distinguishes the hospitals' protocol from the WHO guideline is the categorisation of children between 6-59 months and weighing <4 kg as severely malnourished requiring in-patient management. This criterion is similar to that stipulated in the national guidelines for in-patient management of SAM in infants and young children in Nigeria, where children in the mentioned age group weighing <3.5 kg are diagnosed with SAM and treated as in-patients (Federal Ministry of Health Nigeria, 2016).

Again, diagnosis of SAM in infants <6 months is based on parameters such as bipedal pitting oedema and visible wasting, which can be somewhat subjective. There is no anthropometric

definition of SAM in this age group, according to the provision of the hospitals' protocol. This does not correspond to the WHO guideline and National SAM management guidelines of South Africa and Nigeria, where WHZ <-3 SD is recommended (Federal Ministry of Health Nigeria, 2016; National Department of Health, 2015; WHO, 2013). While WHO recommends a weight increase of 5 g/kg/day for 3 successive days as part of the discharge criteria in infants <6 months, the hospitals' protocol recommends a 20 g increase per day for 5 consecutive days, a criterion which is the same as that recommended by the Federal Health Ministry of Nigeria (Federal Ministry of Health Nigeria, 2016) for the discharge of infants <6 months with SAM.

This study identified that the practice regarding the assessment and diagnosis of SAM in study hospitals was incommensurate with the hospitals' protocol. It was observed that over 50% of the children who were supposed to be assessed for MUAC were not. A similar finding was reported in a study conducted in five health facilities in Uganda, where 85.8% of the children admitted for acute illness were not measured for MUAC (Akugizibwe, Kasolo, Duncan, Makubuya, & Damani, 2013). After considering those children who could have been diagnosed based on the presence of oedema, or those > 6 months who weighed <4 kg in this study, 3 in every 25 children aged 6-59 months admitted were assessed for neither MUAC nor WHZ, yet were diagnosed with SAM at admission. Similarly, the basis for the diagnosis of SAM in four of the infants <6 months was not reported. This could be due to lack of proper assessment of the children at the time of admission. On the other hand, this observation could also potentially be attributed to inefficiency in documentation. The possibility of anthropometric assessment data taken but not recorded in the patient record cannot be ruled out. This could happen as a result of the overwhelming workload at the admission and discharge point and should be further explored. In a study conducted by Shihundla, Lebesse, and Maputle (2016), it was reported that the increased workload of nurses resulted in the unavailability of patient information.

This study was also conducted to assess the treatment outcomes of children aged 0-59 months diagnosed and admitted for SAM. Similar to reports from another study conducted in Ghana

(Walana et al., 2016), the majority of the children were between 6-59 months, owing to their increased risk of malnutrition during the complementary feeding phase. Nonetheless, our finding of a 12.5% SAM prevalence in infants <6 months also sheds more light on the growing occurrence of SAM in this age group (Kerac et al., 2011:1008). This observation is in line with reports from the Ghana demographic and health survey, in which the prevalence of SAM in this cohort has increased from 0.9% in 1999 to 1.4% in 2015 (Ghana Statistical Service, Ghana Health Service, & ICF International, 2015; Ghana Statistical Service & Macro International Incorporated, 1999).

In contrast to studies by Jarso, Workicho, and Alemseged (2015), Saaka et al. (2015) and Walana et al. (2016), SAM was more common in females in this study. Most (82.0%) of the children included in this study had non-oedematous SAM and this finding corresponds to those of some studies that suggest a high prevalence of severe wasting over oedematous SAM in Ghana (Minkah, 2010; Saaka et al., 2015). Among the infants <6 months old, only few were oedematous and this is congruent with observations made by Grijalva-Eternod et al. (2016). The reason for the lower occurrence of oedema in this age group is still unclear.

In this study, extremely low WHZ and WAZ were recorded, indicating the severity of malnutrition in children with additional medical complications. Similar WHZ scores were also reported in a study of children with complicated SAM (Attia et al., 2016). These extreme values suggest further room for improvement in the health system regarding early identification of children at risk before they are extremely wasted. This is confirmed by a study conducted in Ghana, in which 94.1% of wasted children who had reported to an out-patient clinic were not identified (Antwi, 2008).

The discharge rate observed in this study was 77.5% and is in agreement with results obtained in previous studies (Attia et al., 2016; Teferi et al., 2010). Although children with oedematous SAM and those aged 6-59 months with weight <4 kg recorded significantly higher LOS, the average LOS was within the internationally accepted maximum of 30 days (SPHERE project team, 2011). Longer LOS has been seen, however, in other studies (Gebremichael, 2015; Teferi et al., 2010). In contrast to the significantly longer time to recovery for children with oedema observed in this

study, Gebremichael (2015) reported otherwise. Our study failed to find any association between age, gender and LOS, which is similar to observations made by Gebremichael (2015). In contrast to the findings of Gebremichael (2015), admission MUAC for this study was not associated with LOS. Lower admission WHZ was however associated with longer hospital stay. This is an expected outcome, where those with the worst anthropometric deficits are likely to take a longer time to recover. The weak inverse association observed between admission WHZ and LOS could be attributed to the high number of missing WHZ readings at admission and the number of mortalities that were excluded from the LOS calculation.

The average daily weight gain of 5.8 g/kg reported in this study is below the SPHERE acceptable minimum of 8 g/kg/day (SPHERE project team, 2011). Additionally, it is also below 10.4 g/kg/day and 13.7 g/kg/day observed by Jarso et al. (2015) and Teferi et al. (2010). This difference could be due partly to the relatively shorter LOS of 11.4 days reported in our study compared with 17.4 days and 23 days respectively in the aforementioned studies. Although there was a significant increase in weight from admission to discharge, no significant increase in WHZ and MUAC were observed. This could be attributed to the large numbers of participants with unrecorded MUAC and WHZ at discharge.

The death rate of 17.7% (22.2% in children <6 months and 17.0% in those 6-59 months old) observed in the current study is unacceptably high Compared with the SPHERE acceptable standard of <10%. Likewise, high case fatality rates of 32%, 23%, 19% and 12.3% have also been recorded in South Africa, Malawi, Kenya and Ethiopia respectively (Attia et al., 2016; Berkley et al., 2005; Gebremichael, Bezabih, & Tsadik, 2014; Puoane et al., 2001). The finding that the majority of deaths occurred in the first 7 days of admission agrees with earlier studies (Bachou, Tumwine, Mwadime & Tylleskar, 2006; Gebremichael et al., 2014 and Jarso et al., 2015). These earlier deaths likely were more difficult to prevent and could be attributed to the severity of the complications presented on admission in addition to late presentation to the health facility. However, the later deaths, which accounted for approximately two-thirds of the deaths may

possibly have been preventable, although the exact causes of deaths were not reported. These high levels of SAM-related deaths could be due to late pursuit of medical care, the high patient load in resource-limited facilities and inadequate adherence to treatment protocols.

In this study, children <6 months died earlier than those aged 6-59 months. Similar results from a study by Jarso et al. (2015) reported that younger children were 1.9 times more likely to die earlier than their older counterparts. As in reports by Bachou et al. (2006), gender was not associated with death in this study. Oedema was associated with 2.5 times increased risk of mortality compared with those with severe wasting. In agreement, Collins et al. (2006) reported an increased risk of death in children with oedematous SAM due to the significant electrolyte imbalances that accompanies oedema. Similarly, our finding that the presence of shock at admission was associated with a 7.1 fold increase in the death rate has been found in other studies (De Maayer & Saloojee, 2011; Hossain, Chisti, Yoshimatsu, Yasmin, & Ahmed, 2015; Maitland et al., 2006). This could be attributed to the delicate nature of shock management in children with SAM and the possibility of fluid overload, which could lead to heart failure.

The high mortality rate observed in children in our study who presented with convulsions may either be due to severe electrolyte abnormalities or unrecognized central nervous system infections. Chisti et al. (2014) further found that children with SAM are predisposed to fatal convulsions caused by hypocalcaemia, which significantly limits their chances of survival. Unfortunately serum calcium was not determined in the patients included in our study. It can therefore be motivated that convulsions in severely malnourished children should prompt investigation for electrolyte abnormalities.

As has been reported in several other studies (Asafo-Agyei, Antwi, & Nguah, 2013; Munthali, Jacobs, Sitali, Dambe, & Michelo, 2015), HIV-positive status was also associated with a 3 times increased risk of death, which could be due to the extreme immune deficiency caused by both the HIV infection and SAM resulting in poor response to treatment and severity of secondary infections. Children with severe pallor were over 2 times more likely to die compared with those

without, an observation which is congruent with studies conducted in Ethiopia and South Africa (De Maayer & Saloojee, 2011; Jarso et al., 2015).

In this study, MUAC <11.5 cm was associated with a 3.9 times increased risk of death compared with children with MUAC ≥ 11.5 cm although the difference was not statistically significant. Similarly, the risk of death was marginally increased with a <-3 SD compared with WHZ ≥ -3 SD, although not statistically significantly so. This lack of statistical significance could possibly be due to the large numbers of unavailable MUAC and WHZ readings at admission.

A major strength of this study is that the data was taken from previously recorded information of patients who had been treated and discharged, therefore depicting the actual practices in the hospitals. This guarantees no form of alterations in the hospitals' practices owing to knowledge of the study. Furthermore, to the best of our knowledge, this is the first study in Ghana to compare the clinical practices of health workers with the hospitals' protocol and WHO guidelines for SAM admission and discharge, and the treatment outcomes.

Nonetheless, this study has a few limitations. First, there was no control over the quality of anthropometric measurements at admission and discharge. Second, the exclusion of children diagnosed with SAM with incomplete medical information could be a potential source of bias. Further, the large number of missing information in the medical records could also be a potential source of bias. This study was conducted in only two hospitals and a larger, more varied sample could have been advantageous.

Conclusion

There were differences between the hospitals' SAM protocols and the WHO SAM guideline. The only anthropometric indicator for SAM recommended in the hospitals' protocol was MUAC <11.5 cm and all infants <6 months diagnosed with SAM require in-patient SAM management. There was a difference between the actual clinical practices of the healthcare workers compared with the hospitals' protocol. MUAC was not assessed in a large proportion of the children although it

is the only anthropometric diagnostic indicator for SAM in the hospitals. The average weight gain was 5.8 g/kg/day over 11.4 days LOS period. Furthermore, the high death rate was beyond the SPHERE acceptable minimum standard. Shock, convulsion, HIV-positive status, oedema and severe pallor were associated with increased risk of death. These results emphasise the need for detailed health systems research and an in-depth investigation into additional factors contributing to the results found in this study in order to curb the high SAM mortality rates.

Key Messages

1. There are some differences between hospitals' SAM diagnosis and discharge protocol and the WHO guideline.
2. MUAC <11.5 cm is the only anthropometric indicator for SAM recommended in the hospitals' protocol and all infants <6 months diagnosed with SAM require in-patient SAM management.
3. Clinical practices regarding SAM diagnosis and discharge were not commensurate with the hospitals' protocol.
4. Shock, convulsion, HIV-positive status, oedema and severe pallor were associated with increased risk of death.
5. The level of SAM mortality in the hospitals was higher than the SPHERE minimum standard.

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CHAPTER 4 GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

4.1 Introduction

This concluding chapter provides a summary of the key findings of the study and how they address the aims and objectives of the study. It further provides a general conclusion and highlights some proposed recommendations for policy formulation and future research.

Research aim

The aim of this observational study was to assess and compare hospitals' protocols with actual clinical practices and the WHO recommendations regarding admission and discharge criteria for SAM in relation to treatment outcomes among Ghanaian children 0 - 59 months.

Research objectives

The objectives of this study were to:

- Assess hospitals' protocols for diagnosing, admitting and discharging children 0 - 59 months with SAM
- Compare hospitals' protocols with the WHO guidelines
- Assess hospitals' practices regarding diagnosis, in-patient admission and discharge of children with SAM
- Assess treatment outcomes in relation to actual practices, adherence to hospitals' protocol and/or the WHO guidelines.

These objectives were measured by the following treatment outcomes measurements:

- Length of hospital stay
- Mortality
- Growth: weight gain and z-scores
- MUAC

4.2 Hospitals' protocol for SAM diagnosis, admission and discharge and comparison with the WHO guidelines

Although the hospitals' protocols largely compare with the WHO guidelines, a few key differences were identified, such as the recommendation of MUAC as the only anthropometric tool for SAM, the diagnosis of SAM in children 6 – 59 months weighing < 4 kg and all infants < 6 months treated as in-patients in the hospitals.

The admission and discharge criteria for SAM in the study hospitals correspond to the GHS interim national guidelines for community-based management of SAM, which has adopted MUAC as the only anthropometric tool for SAM diagnosis in children aged 6 - 59 months (GHS, 2010:2), as compared with the recommendation of the use of MUAC or by the WHO (WHO, 2013:19). The lone use of MUAC in the diagnosis of SAM has been promoted by several studies that have reported it as a better tool than WHZ for identifying children at risk of death (Ali *et al.*, 2013:319; Briend *et al.*, 2012:130). Further, it is an uncomplicated tool, which is quick and convenient and requires less training. For these reasons, the use of MUAC has been recommended over WHZ. This study is a confirmation that, in Ghana, although the WHO recommends the use of MUAC and/or WHZ, MUAC is the primary anthropometric SAM indicator.

The protocols for the study hospitals also adopt the community-based management approach of SAM, where children (6 - 59 months) with SAM (MUAC < 11.5 cm or oedema) accompanied by additional medical complications are hospitalised and managed as in-patients. This criterion is in accordance with the WHO guideline. A criterion that distinguishes the hospitals' protocols from the WHO guideline is the diagnosis of SAM in children 6 - 59 months, weighing < 4 kg. Interestingly, national guidelines for in-patient management of SAM in infants and young children in Nigeria also have a similar criterion (Federal Ministry of Health Nigeria, 2016:6). Furthermore, *per* the protocols of the hospitals, all infants < 6 months diagnosed with SAM with or without medical complications are treated as in-patients. However, the WHO guideline recommends out-patient treatment for infants < 6 months diagnosed with SAM without medical complications.

Even though the WHO recommends the use of WHZ < -3 SD for diagnosing infants < 6 months old (WHO, 2013:63), the hospitals' protocol has no anthropometric indicator for diagnosing SAM in this age group (GHS, 2010:4). Another difference between the hospitals' protocols and the WHO guideline is that, while the WHO recommends a weight increase of 5 g/kg/day for 3 successive days as part of the discharge criteria for SAM in infants < 6 months (WHO, 2013:65), the hospitals' protocols recommend a 20 g increase per day for 5 consecutive days (GHS, 2010:58), a criterion which is the same as that recommended by the Federal Health Ministry of

Nigeria (Federal Ministry of Health Nigeria, 2016:61) for the discharge of SAM in infants < 6 months.

4.3 Hospital practices regarding diagnosis, in-patient admission and discharge of SAM

In view of the results obtained from this study, it is apparent that the actual clinical practices regarding SAM diagnosis do not correspond with the hospitals' protocols, which are comprised, in essence, of the interim SAM management guidelines of the GHS. Only 34.3% and 48.1% of the children were assessed for MUAC and WHZ respectively at admission. Some (18.0%) were diagnosed based on the presence of oedema. After taking into account those children and infants who were possibly diagnosed with SAM based on oedema, visible wasting and age 6-59 months with weight < 4 kg, the basis for the diagnosis of SAM was unknown for 11.9% and 11.1% of the children aged 6 - 59 months and < 6 months respectively. Among the children who were discharged, only 58.5% had their infections resolved and 74.1% had good appetite while only 44.2% had both good appetite and all infections treated at the time of discharge. Those discharged with persisting infections and/or poor appetite are at greater risk of relapse and mortality.

All infants < 6 months who had oedema at admission had a complete resolution of oedema at discharge while only 3 of those aged 6 - 59 months had oedema grade +1 at discharge. Contrary to the recommendations of the hospitals' protocol, only 58.9% of the caregivers received nutrition education at discharge. However, 94.2% were referred to an out-patient facility for continuous nutrition rehabilitation at the community level. Little or no nutrition education for the caregivers can also increase the risk of relapse. These observations report the differences in the practices compared with the hospitals' protocol. There is a need for constant training of healthcare providers and the strengthening of the healthcare system to bridge some of these gaps in order to optimise the quality of the care delivered, especially to vulnerable children who are at increased risk of death.

4.4 Treatment outcomes

In this study, a discharge rate of 77.5% was reported. Studies in Malawi and Ethiopia reported slightly higher discharge rates of 82.3% and 87.0% respectively compared with those reported in the present study (Attia *et al.*, 2016:1444; Teferi *et al.*, 2010:234). In another study conducted in Northern Ghana among children with SAM receiving out-patient care, a discharge from treatment rate of 33.6% was reported but was attributed to the large default rates (Saaka *et al.*, 2015:4). It can therefore be speculated that in-patient management of SAM, which addresses much more complicated cases, may potentially have more successes in terms of better outcomes, compared

CHAPTER 4 GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS

with the out-patient treatment, where compliance with treatment may be low. The reasons for the poor out-patient compliance with treatment need further investigation.

The treatment outcomes were measured by LOS, mortality, weight gain, changes in WHZ and MUAC. The average LOS of 11.4 days and weight gain of 5.8 g/kg/day in this study was lower than was reported in studies conducted in Ethiopia, which also recorded relatively longer LOS and higher average daily weight gain of 17.4 days with 10.4 g/kg/day weight gain and 25 days with 14 g/kg/day weight gain (Jarso *et al.*, 2015:4; Teferi *et al.*, 2010:234). The lower LOS and average daily weight gain observed in this study raises the concern of discharges that are made too early before full recovery, possibly because of lack of space in the hospitals and the possibility of nosocomial infections. This is demonstrated by the percentage of children who were discharged without good appetite and with unresolved medical complications in this study. The lack of adequate recovery before discharge into community management increases the risk of relapse and, consequently, death. This is confirmed in a follow-up study of post-discharge severely malnourished children in Malawi, where 25% of deaths occurred after normal discharge from the SAM management programme (Kerac *et al.*, 2014:1).

In the present study, it is observed that oedema is associated with significantly longer hospital stay. Similarly, children aged 6 - 59 months with admission weight < 4 kg also had a significantly higher LOS than their counterparts who weighed > 4 kg. It is further observed that LOS increases significantly with decreasing admission WHZ. Possibly due to the large numbers of missing MUAC readings at admission, there was no association found between MUAC and LOS. No significant changes in MUAC ($P = 0.31$) and WHZ ($P = 0.69$) from admission to discharge were observed.

This present study also adds to the records of high SAM mortality rates reported in hospitals in Africa. Considering that disturbingly higher mortality rates have also been reported in South Africa, Malawi and Kenya, it is imperative that health policy makers on the continent prioritise child health and strengthen interventions to reduce these preventable deaths. In this study, shock, convulsion, oedema, HIV-positive status and severe pallor were associated with increased risk of death. This draws attention to complications at admission that should be given priority during SAM management, especially in resource-limited facilities. MUAC < 11.5 cm and WHZ < -3 SD were associated with increased risk of mortality even though this increase did not attain statistical significance.

4.5 Conclusions and recommendations arising from the study

- The actual clinical practices regarding the diagnosis and discharge of SAM are not sufficiently commensurate with the hospitals' protocol. Therefore, it is recommended that the GHS

CHAPTER 4 GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS

embark on regular training for healthcare providers in order to improve the health system. Again, there is a need to enhance the healthcare system to optimise the quality of care delivered.

- A discharge rate of 77.5% observed in this study is a step in the right direction. However, improving the healthcare system and the quality of care delivered will likely augment the current treatment success treatment.
- Although the LOS recorded in this study is within the SPHERE acceptable maximum, patients should be allowed to recover appreciably before discharge.
- The average daily weight of 5.8 g/kg observed in this study is lower than the accepted SPHERE minimum of 8.0 g/kg/day.
- No significant changes in MUAC and WHZ were observed.
- According to the outcome of this study, admission MUAC, age and gender cannot be used to predict LOS.
- From this study, it can be concluded that the lower the WHZ at admission, the longer the LOS.
- The high mortality rate of 17.7% is a disturbing outcome which requires the GHS and the Ministry of Health to rise to the occasion and ensure that treatment guidelines are adequately adhered to at the facility level.
- From this study, it cannot be firmly concluded that MUAC < 11.5 cm and WHZ < -3 SD are associated with increased risk of death. More research involving large samples will be required.
- According to this study, the presence of complications such as shock, convulsion, HIV-positive status, oedema and severe pallor limit the chances of survival; therefore more priority should be given to severely malnourished children with these complications.

4.6 Limitation of the study

- First, there was no control over the quality of anthropometric measurements at admission and discharge.
- Second, the exclusion of children diagnosed with SAM with incomplete medical information could be a potential source of bias.

4.7 Strength of the study

A major strength of this study is that the data comprised of already recorded information of patients who had been treated and discharged, therefore depicting the actual practices in the hospitals, guaranteeing that there were no forms of alteration in their practices that may have been due to knowledge of the study.

This is the first study in Ghana to compare the hospitals' protocol with the actual practices of health workers and the WHO guidelines for SAM admission and discharge and the consequent outcomes. This research thus provides important information on how the healthcare system can enhance practice and policy to improve LOS and reduce SAM mortality in Ghana.

4.8 Future research

In this current study, it has been shown that practices regarding SAM diagnosis, admission and discharge do not adequately compare with the hospitals' protocol. Future research should therefore focus on:

- The challenges faced by healthcare providers in their line of duty and the lapses in the health system that impede the quality of care delivered.
- Assessing the hospitals' practices regarding the actual SAM treatment given in relation to the treatment outcomes. This should focus on the following areas:
 - a. Fluid management
 - b. Therapeutic feeding approaches
 - c. Antibiotics administration
 - d. Micronutrient supplementation
- Identifying factors associated with SAM mortalities in both hospitals and out-patient facilities.

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ANNEXURES

ANNEXURE A: Author's guidelines for the journal *Maternal and Child Nutrition*

The scope of Maternal & Child Nutrition includes pre-conceptual nutrition, antenatal and postnatal maternal nutrition, women's nutrition throughout their reproductive years, and fetal, neonatal, infant and child nutrition, up to and including adolescence. The Journal welcomes submission of

(1) Original Research Papers

(2) Systematic Reviews that provide original information on maternal and/or child nutrition and

(3) Letters to the Editor (Correspondence), usually commenting on a recent publication in the journal.

The journal also publishes Special Issues, which bring together collections of papers on a particular theme, usually edited by a Guest Editor, and subject to customary reviewing process.

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Maternal & Child Nutrition uses double-blinded review. Please do not include identifying information on any documents other than the Title page.

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Author names, affiliations, and a short running title. Twelve (12) words or less is the recommended length for a title. The word counts for the abstract and the main body of the text (excluding references and legends) should be clearly stated, along with the number of references, tables and figures. Also included on the Title Page should be the following information:

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The main text should be typed double-spaced, include continuous line numbers and structured as follows:

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Journal article: Phelps, L. (1996). Discriminative validity of the WRAML with ADHD and LD children. *Psychology in the Schools*, 33, 5-12.

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Serdula, M. K., Lundeen, E., Nichols, E. K., Imanalieva, C., Minbaev, M., Mamyrbaeva, T., ... Kyrgyz Republic Working Group. (2013). Effects of a large-scale micronutrient powder and young child feeding education program on the micronutrient status of children 6–24 months of age in the Kyrgyz Republic. *European Journal of Clinical Nutrition*, 67, 703–707.

Stevens, G. A., Bennett, J. E., Hennocq, Q., Lu, Y., De-Regil, L. M., Rogers, L., ... Ezzati, M. (2015). Trends and mortality effects of vitamin A deficiency in children in 138 low-income and

middle-income countries between 1991 and 2013: A pooled analysis of population-based surveys. *Lancet Global Health*, 3, e528–e536.

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High quality review articles should provide novel insights, analysis and interpretation of the published literature and offer a balanced critical appraisal of established or emerging issues related to maternal and child nutrition. Review Articles should not exceed 5,000 words and 100 references. Additional data (e.g. Tables) can be provided as a Supplementary Appendix. The handling Editor may relocate tables or figures into a Supplementary Appendix if the manuscript exceeds these specifications and/or 12 printed pages.

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ANNEXURES

ANNEXURE B: Screening form

SAMAC

Screening form: Ghana

For each file screened, the following questions should be considered to determine inclusion.

INCLUDED: All questions are answer YES (Y).

EXCLUDED: 1 of more questions are answered NO (N)

(Conditions or diseases related to SAM: recurring infections, malaria, dehydration, diarrhoea, TB, parasite infestations, cholera etc.)

(Medical problems NOT related to SAM: metabolic, neurodevelopmental or any other growth disorder)

Date	Hospital	File number	Criteria for inclusion:																	
			Age between 0 – 59 mo?		Diagnosis of SAM?		Diagnosis of condition or disease related to SAM?		Medical problems not related to SAM is <u>NOT</u> present?		Date of file ≥ 2013?		Born full term?		Normal birth weight?		Complete medical information?			
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED

ANNEXURE C: Ethical approval from North-West University Ethics Committee



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ETHICS APPROVAL CERTIFICATE OF STUDY

Based on approval by Health Research Ethics Committee (HREC) on 19/01/2018, the North-West University Research Ethics Regulatory Committee (NWU-RERC) hereby approves your study as indicated below. This implies that the NWU-RERC grants its permission that provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: Evaluation of admission criteria and treatment guidelines of African infants and children (0-59 months) diagnosed with severe acute malnutrition – the SAMAC-study																													
Study Leader/Supervisor: Dr MJ Lombard																													
Student:																													
Ethics number:	<table border="1"> <tr> <td>N</td><td>W</td><td>U</td><td>-</td><td>0</td><td>0</td><td>0</td><td>6</td><td>3</td><td>-</td><td>1</td><td>7</td><td>-</td><td>A</td><td>1</td> </tr> <tr> <td colspan="3">Institution</td> <td colspan="6">Study Number</td> <td colspan="2">Year</td> <td colspan="2">Status</td> </tr> </table> Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation	N	W	U	-	0	0	0	6	3	-	1	7	-	A	1	Institution			Study Number						Year		Status	
N	W	U	-	0	0	0	6	3	-	1	7	-	A	1															
Institution			Study Number						Year		Status																		
Application Type: Large Study																													
Commencement date: 2018-01-19																													
Risk: Minimal																													
Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.																													

Special conditions of the approval (if applicable):

This approval is provided for the study to be undertaken in Ghana. Before the study can commence in Botswana or South Africa, however, the researchers will have to:

1. Please provide the HREC with copies of the ethical approval letters from the Botswanan Ministry of Health indicating that the study can be conducted.
2. Please provide the HREC with copies of the approval letters from the South African provincial Department of Health for the different provinces to be included, indicating that the study can be conducted.
3. Please provide the HREC with copies of the goodwill permission letters from hospitals to be included in the study indicating that you can utilise their services/facilities.

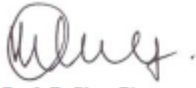
General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:

- The study leader (principal investigator) must report in the prescribed format to the NWU-RERC via HREC:
 - annually (or as otherwise requested) on the monitoring of the study, and upon completion of the study
 - without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.
- Annually a number of studies may be randomly selected for an external audit.
- The approval applies strictly to the proposal as stipulated in the application form. Should any changes to the proposal be deemed necessary during the course of the study, the study leader must apply for approval of these amendments at the HREC, prior to implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the study may be started.
- In the interest of ethical responsibility the NWU-RERC and HREC retains the right to:
 - request access to any information or data at any time during the course or after completion of the study;
 - to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process.
 - withdraw or postpone approval if:
 - any unethical principles or practices of the study are revealed or suspected,
 - it becomes apparent that any relevant information was withheld from the HREC or that information has been false or misrepresented,
 - the required amendments, annual (or otherwise stipulated) report and reporting of adverse events or incidents was not done in a timely manner and accurately,
 - new institutional rules, national legislation or international conventions deem it necessary.
- HREC can be contacted for further information or any report templates via Ethics-HREC@nwu.ac.za or 018 299 1206.

The RERC would like to remain at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the RERC or HREC for any further enquiries or requests for assistance.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Refilwe' followed by a stylized surname.

Prof. Refilwe Phaswana-Mafuya
Chair NWU Research Ethics Regulatory Committee (RERC)

ANNEXURE D: Ethical approval from Ghana Health Service

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this letter should be quoted



GHANA HEALTH SERVICE
You are Healthier than Others

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Tel: +233-302-681109
Fax: +233-302-685424
Email: ghsere@gmail.com

My Ref: GHS RDD ERC Admin App / 637
Your Ref No:

Dr. Martani Lombard
Centre of Excellence for Nutrition
School of Physiology, Nutrition and Consumer Sciences
North-West University, Potchefstroom Campus

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHIS-ERC Number	GHS-ERC: 09/06/17
Project Title	Evaluation of Admission Criteria and Treatment Guidelines of African Infant and Children (0-59 Months) Diagnosed with Severe Acute Malnutrition – The SAMAC-Study (Ghana Sub-study)
Approval Date	16 th July, 2017
Expiry Date	15 th July, 2018
GHIS-ERC Decision	Approved

This approval requires the following from the Principal Investigator

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months.
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and at implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol.

SIGNED.....
DR. CYNTHIA BANNERMAN
(GHS-ERC CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

*In case of reply the
number and date of this
Letter should be quoted.*



Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Tel: +233-302-681109
Fax + 233-302-685424
Email: ghserc@gmail.com

MyRef: GHS/RDD/ERC/Admin/App 15 611
Your Ref. No.

Janet Adele Carboo
North-West University
South Africa

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	GHS-ERC: 25/06/17
Project Title	Assessment and Evaluation of In-patient Diagnosis and Discharge Protocols in Ghanaian Infants and Children (0-59 Months) Diagnose with Severe Acute Malnutrition – The SAMAC – (Ghana Sub-Study)
Approval Date	27 th June, 2017
Expiry Date	26 th June, 2018
GHS-ERC Decision	Approved

This approval requires the following from the Principal Investigator

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report **after completion** of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....
DR. CYNTHIA BANNERMAN
(GHS-ERC CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

ANNEXURE E: Ethical approval from Ethics Review Committee of KATH



KWAME NKURUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF HEALTH SCIENCES

SCHOOL OF MEDICAL SCIENCES / KOMFO ANOKYE TEACHING HOSPITAL
COMMITTEE ON HUMAN RESEARCH, PUBLICATION AND ETHICS



Ref: CHRPE/AP/374/17

30th June, 2017.

Dr. Matani J. Lombard
Directorate of Child Health
KATH-KUMASI

Dear Sir,

LETTER OF APPROVAL

Protocol Title: *"Evaluation of Admission Criteria and Treatment Guideline of Sub-Saharan Africa and Children (0-59) Diagnosed with Severe Acute Malnutrition – the SAMAC Study."*

Proposed Site: *Chest Clinic, Directorate of Medicine, Komfo Anokye Teaching Hospital.*

Sponsor: *Cfar Grant.*

Your submission to the Committee on Human Research, Publications and Ethics on the above named protocol refers.

The Committee reviewed the following documents:

- A notification letter of 26th April, 2017 from the Komfo Anokye Teaching Hospital (study site) indicating approval for the conduct of the study in the Hospital.
- A Completed CHRPE Application Form.
- Participant Information Leaflet and Consent Form.
- Research Protocol.
- Questionnaire.

The Committee has considered the ethical merit of your submission and approved the protocol. The approval is for a fixed period of one year, beginning 30th June, 2017 to 29th June, 2018 renewable thereafter. The Committee may however, suspend or withdraw ethical approval at any time if your study is found to contravene the approved protocol.

Data gathered for the study should be used for the approved purposes only. Permission should be sought from the Committee if any amendment to the protocol or use, other than submitted, is made of your research data.

The Committee should be notified of the actual start date of the project and would expect a report on your study annually or at the close of the project, whichever one comes first. It should also be informed of any publication arising from the study.

Thank you Sir, for your application.

Yours faithfully,


Rev. Prof. John Appiah-Poku
Honorary Secretary
FOR: CHAIRMAN

Room 7 Block J, School of Medical Sciences, KNUST, University Post Office, Kumasi, Ghana
Phone: +233 3220 63248 Mobile: +233 20 5453785 Email: chrpe.knust.kath@gmail.com / chrpe@knust.edu.gh

ANNEXURE F: Approval from KATH and PML management

**KOMFO ANOKYE
TEACHING HOSPITAL**

DIRECTORATE OF CHILD HEALTH



P. O. Box 1934
KUMASI - GHANA
Tel: +233 - 3220-22301 - 4
Fax: +233 - 3220 - 24654/24621
Website: www.kathsp.org

Our Ref. No:.....

Your Ref. No:.....

12 MAY 2017

DR. MARTANI LOMBARD

Dear Sir/Madam

LETTER OF APPROVAL

RE: "EVALUATION OF ADMISSION CRITERIA AND TREATMENT GUIDELINES OF SUB-SAHARA AFRICAN INFANTS AND CHILDREN (0-59 MONTHS) DIAGNOSED WITH SEVERE ACUTE MALNUTRITION –THE SAMAC- STUDY AT KOMFO ANOKYE TEACHING HOSPITAL"

Approval is hereby given for you to conduct the study entitled "Evaluation of admission criteria and treatment guidelines of sub-Sahara African infants and children (0-59 months) diagnosed with severe acute malnutrition – the SAMAC- study at Komfo Anokye Teaching Hospital" subject to ethical approval.

It is required that any future revisions or amendments are duly communicated to the directorate.

Thank you.


PROF. E. O. D. ADDO-YOBO
HEAD OF DIRECTORATE

A Centre of Excellence

In case of reply the number and the date
of this letter should be quoted.

My Ref. No. GHS/PMLCH/RS/G-43

Your Ref. No.



PML CHILDREN'S HOSPITAL
GHANA HEALTH SERVICE
POST OFFICE BOX GP 122
ACCRA.

TEL. NO. 0302-664137/2673477
FAX #: 0302-673344

E-mail: pmlhosp@ghs.gov.gh
Website: www.pmlhosp.com.gh

September 9, 2017

DR. MARTANI LOMBARD
CENTRE OF EXCELLENCE FOR NUTRITION
SCHOOL OF PHYSIOLOGY, NUTRITION AND CONSUMER SCIENCES
NORTH-WEST UNIVERSITY, POTCHEFSTROOM CAMPUS

APPROVAL LETTER

This is to officially inform you that approval has been given for Ms. Janet Carboo to carry out her research on the Topic: *Evaluation of Admission Criteria and Treatment Guidelines of African Infants and Children (0-59 Months) Diagnosed with Severe Acute Malnutrition – The SAMAC-Study (Ghana Sub-study)* in the Princess Marie Louise Children's Hospital having seen the Ethical Clearance from the Ghana Health Service.

Thank you

DR. ISAAC KOBINA ABBAN
(MEDICAL SUPERINTENDENT (AG))

ANNEXURES

ANNEXURE G: Data extraction form

SAMAC

DATA EXTRACTION FORM

1. DEMOGRAPHIC INFORMATION										
1.1. Participant number					1.2. Country				1.3. Hospital	
1.4. Town					1.5. Province/District					
1.6. Data collected by (Name of field worker):					1.7. Date of data collection					
1.8. Was patient referred from a clinic or hospital?			Yes		No		1.9. If YES, name of hospital or clinic			

2. ADMISSION DATA (Status of child at admission)																				
2.1. Admission information documented by			Paediatrician			GP			House officer/ Intern			Dietitian			Nutrition officer			Nurse		
			Others (Specify)																	
2.2. Date of admission		20	Y	M	D	2.3. Time of admission		2.4. Date of birth		20	Y	M	D	2.5. Current Age (months)						
2.6. Gender		Boy		Girl		2.7. When was SAM diagnosed		At admission				While admitted								
2.8. Date of SAM diagnosis while on admission		20	Y	M	D	2.9. New admission for SAM		Yes		No		2.10. Readmission for SAM		Yes		No				
2.11. Weight on admission (kg)		Kg			2.12. Height/length measurement (cm)		cm					Not recorded								
		Not recorded																		
2.13. Which of the following was measured:					Height				Length				Not indicated							
2.14. MUAC (mm)					2.15. Recorded weight for height/ length Z score							Not Recorded								
		Not recorded																		
2.16. Oedema grade		0		+ (mild)			++ (moderate)			+++ (severe)										

Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

2.17. Clinical Signs	Irritability		Wasting		Eye signs		Diarrhoea						
	Dermatitis		Severe pallor		Shock		Vomiting						
	Convulsions		Irregular heart beat		Weak pulse								
	Slow capillary fill (> 3 seconds)		Cold hands / feet		Fast pulse								
2.18. HIV/RVD status at admission	Positive		Negative		Unknown								
2.19. ARV/RVD treatment at admission	No		Yes, Prior to admission		Unknown								
2.20. List ARV/RVD medications at admission	Medication	Dosage	Medication	Dosage	Medication	Dosage							
2.21. TB status at admission	Positive		Negative		Unknown								
2.22. TB treatment at admission	No		Yes, Prior to admission		Unknown								
2.23. List TB medications at admission	Medication	Dosage	Medication	Dosage	Medication	Dosage							
2.24. Other medications at admission	Medication	Dosage	Medication	Dosage	Medication	Dosage							
	Medication	Dosage	Medication	Dosage	Medication	Dosage							
2.25. Medical complication/diagnosis at admission													
Conscious	Not reported		Yes		No		Hypoglycaemia (< 3 mmol/L)	Not reported		Yes		No	
Dehydration	Not reported		Yes		No		Hypothermia (< 35 °C)	Not reported		Yes		No	
Respiratory tract infection	Not reported		Yes		No		Urinary tract infection	Not reported		Yes		No	
Meningitis	Not reported		Yes		No		Malaria	Not reported		Yes		No	

Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

2.26. List other diagnosis at admission												
2.27. Did the patient receive any IV at admission/Casualty/Emergency								Yes		No		
2.28. If yes, Type of IV fluid received			Rate	___/___hrly	Total volume		Duration (no of hrs):					
If yes, Type of IV fluid received			Rate	___/___hrly	Total volume		Duration (no of hrs):					
If yes, Type of IV fluid received			Rate	___/___hrly	Total volume		Duration (no of hrs):					
2.29. Did patient receive 10% glucose or sucrose solution within 30 minutes of admission								Yes		No		
Route	NGT		Oral		IV		Rate	___/___hrly	Total volume		Duration (no of hrs)	
2.30. Did the patient receive ReSoMal?								Yes		No		
Route	NGT		Oral				Rate	___/___hrly	Total volume		Duration (no of hrs)	
2.31. Did the patient receive other oral rehydration solutions at admission?								Yes		No		
Route	NGT		Oral				Rate	___/___hrly	Total volume		Duration (no of hrs)	
2.32 Did patient received any feed (s) within 30 minutes of admission								Yes		No		
2.33. What feed was given at admission												
Route	NGT		Oral				Rate	___/___hrly	Total volume		Duration (no of hrs)	

Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

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Participant Number:

ANNEXURES

SAMAC

DATA EXTRACTION FORM

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Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

4. BIOCHEMICAL INFORMATION (Information during hospital stay)									
Blood Tests	Unit	Date	Result	Date	Result	Date	Result	Date	Result
S-Na									
S-K									
S-Cl									
S-urea									
S-Creatinine									
S-Albumin									
S-CRP									
Red Blood Count									
Hb									
Haematocrit									
MCV									
MCH									
MCHC									
Platelet Count									
White Blood Count									
S-Fe									

Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

5. FEEDING (During hospital stay)													
5.1. Feeds prescribed by		Paediatrician		GP		House officer/Intern		Dietitian		Nutrition Officer		Nurse	
		Others (Specify)											
5.2. When were feeds initiated		Date					Time			Not Recorded			
5.3. STARTER FEEDS													
Date	Feed (F75, Infant formula, Breast milk, others.)	Name of Product	Pre-mixed	Self-mixed	Route		Rate	Nr of feeds/day	Total volume prescribed /day (ml)	Total volume consumed/day(ml)	Ward diet or solids given while on starter feeds		If Yes, which ward diet or solid feed was given
					NGT	Oral					Yes	No	
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						

Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

5. FEEDING (During hospital stay)													
5.3. STARTER FEEDS Continued													
Date	Feed (F75, Infant formula, Breast milk, others.)	Name of Product	Pre-mixed	Self-mixed	Route		Rate	Nr of feeds/day	Total volume prescribed /day (ml)	Total volume consumed/ day(ml)	Ward diet or solids given while on starter feeds		If Yes, which ward diet or solid feed was given
					NGT	Oral					Yes	No	
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
5.4. For self-mixed recipes feeds record recipe													

Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

5. FEEDING (During hospital Stay)													
5.5. Feeds prescribed by		Paediatrician		GP		House officer/Intern			Dietitian		Nutrition Officer		Nurse
		Others (Specify)											
5.6. When were feeds transitioned		Date				Time				Not Recorded			
5.7. TRANSITION FEEDS													
Date	Feed (F100, Infant formula, Breast milk, RUTF, others.)	Name of Product	Pre-mixed	Self-mixed	Route		Rate	Nr of feeds/day	Total volume prescribed /day (ml)	Total volume consumed/day(ml)	Ward diet or solids given while on transition feeds		If Yes, which ward diet or solid feed was given
					NGT	Oral					Yes	No	
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						
							___/___hrly						

Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

5. FEEDING (During hospital Stay)													
5.7. TRANSITION FEEDS continued													
Date	Feed (FI00, Infant formula, Breast milk, RUTF, others.)	Name of Product	Pre-mixed	Self-mixed	Route		Rate	Nr of feeds/day	Total volume prescribed /day (ml)	Total volume consumed/ day(ml)	Ward diet or solids given while on transition feeds		If Yes, which ward diet or solid feed was given
					NGT	Oral					Yes	No	
							___/___ hrly						
							___/___ hrly						
							___/___ hrly						
							___/___ hrly						
							___/___ hrly						
							___/___ hrly						
							___/___ hrly						
							___/___ hrly						
5.8. For self-mixed recipes feeds record recipe													

Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

6. ELECTROLYTE AND TRACE ELEMENTS PRESCRIPTIONS																			
6.1. Prescribed by			Paediatrician		GP		House officer/Intern			Dietician			Nutrition officer			Nurse			
			Others (Specify)																
6.2. Electrolyte and trace elements given during hospital stay																			
Date	Potassium Chloride sol			Trace element mix (MgSO ₄ 280mg, Zn SO ₄ 36mg, CuSO ₄ 0.1mg/1ml oral sol)			Oral Magnesium			MgSO ₄ IM			Zinc (zinc sulphate, gluconate acetate, picolinate)			Others		Others	
	Yes	No	Dosage	Yes	No	Dosage	Yes	No	Dosage	Yes	No	Dosage	Yes	No	Dosage	Dosage	Dosage		

Participant Number:

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SAMAC

DATA EXTRACTION FORM

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Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

8. MEDICAL TREATMENT											
Did the patient receive any of the following:											
8.1 Prescribed by		Paediatrician		GP		House officer		Dietitian		Nutrition officer	
		Others (Specify)									
8.2. Medications given during hospital stay											
Name of medication	Indication	Route				Date started	Date stopped	Dosage	Freq/day		
		IM	IV	NG	Oral						
		IM	IV	NG	Oral						
		IM	IV	NG	Oral						
		IM	IV	NG	Oral						
		IM	IV	NG	Oral						
		IM	IV	NG	Oral						
		IM	IV	NG	Oral						
		IM	IV	NG	Oral						
		IM	IV	NG	Oral						
		IM	IV	NG	Oral						
		IM	IV	NG	Oral						
		IM	IV	NG	Oral						

Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

9A. ADDITIONAL PROGRESS NOTES (Anthropometry and Clinical Signs)															
Date	Anthropometry		Clinical Signs												
	Weight (Kg)	MUAC (mm)	Oedema	Appetite	Dermatitis		Pallor		Convulsion		Irritability		Shock		Others
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	

Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

9A. ADDITIONAL PROGRESS NOTES (Anthropometry and Clinical Signs)															
Date	Anthropometry		Clinical Signs												
	Weight (Kg)	MUAC (mm)	Oedema	Appetite	Dermatitis		Pallor		Convulsion		Irritability		Shock		Others
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	

Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

9B. ADDITIONAL PROGRESS NOTES (Oral rehydration and IV fluids)												
Date	ReSoMal				Other Oral Rehydration Solutions					IV Fluids		
	Route		Rate ____/____hrly	Total Vol/day	Name of product	Route		Rate ____/____hrly	Total Vol/day	Type	Rate ____/____hrly	Total Vol/day
	NGT	Oral				NGT	Oral					
			____/____hrly					____/____hrly			____/____hrly	
			____/____hrly					____/____hrly			____/____hrly	
			____/____hrly					____/____hrly			____/____hrly	
			____/____hrly					____/____hrly			____/____hrly	
			____/____hrly					____/____hrly			____/____hrly	
			____/____hrly					____/____hrly			____/____hrly	
			____/____hrly					____/____hrly			____/____hrly	
			____/____hrly					____/____hrly			____/____hrly	
			____/____hrly					____/____hrly			____/____hrly	
			____/____hrly					____/____hrly			____/____hrly	

Participant Number:

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ANNEXURES

SAMAC

DATA EXTRACTION FORM

10. DISCHARGE DATA (Status of child on date of discharge to home)														
10.1. Date of discharge	20	Y	M	D	10.2. Date of Death	20	Y	M	D	10.3. Cause of death				
10.4. Weight (kg)	Kg				10.5. Height/length measurement (cm)	cm				Not indicated				
10.6. Which of the following was measured:					Height					Length				
10.7. MUAC (mm)					10.8. Weight for height Z score	Not Reported								
10.9. Oedema grade	0				+	(mild)				++	(moderate)	+++	(Severe)	
10.10. Tested for TB	Yes								10.11. Tested for HIV	Yes				
	No									No				
	Unknown									Unknown				
10.13. TB status	Positive								10.14. HIV status	Positive				
	Negative									Negative				
	Unknown									Unknown				
10.15. Good appetite	Yes								10.16. Infections resolved	Yes				
	No									No				
	Unknown									Unknown				
10.18. Other clinical information noted on Discharge														
10.19. Caregiver given nutrition and health education	Yes								No					
										If Yes, By whom				
10.20. Number of different health professionals who cared for patient during hospital stay	Paediatrician								GP					
	House officer/ Intern								Nutrition officer				Others	

Participant Number:

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