Associations of admission- and transfer criteria with clinical outcomes of children (24 – 59 months) treated for severe acute malnutrition in Ghanaian referral hospitals – the SAMAC study

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- Knowledge without Action is Wasteful and Action without Knowledge is Foolish -

Al - Ghazali

PREFACE

This mini-dissertation consists of six chapters and is written in a chapter format. Chapter One is an introductory chapter which provides the aims, objectives and outputs of this study. Chapter Two is a comprehensive review of literature on the topic. Chapter Three gives the methods used to conduct the study plus describes the statistical analysis applied to obtain answers to the research question. The results are given in Chapter Four. Finally, Chapter Five provides an overall discussion and Chapter Six the conclusions of the study. The references are acknowledged in the references list after the conclusion.

I, Christel Nel, hereby declare that with the exemption of the acknowledged references, i did the research to write this dissertation at the centre of excellence for nutrition at the North-West University under the supervision and guidance of Mrs. Cornelia Conradie together with Dr. Martani Lombard.

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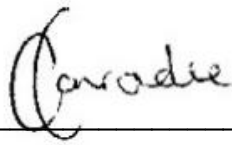
CHRISTEL NEL (M.SC. STUDENT)



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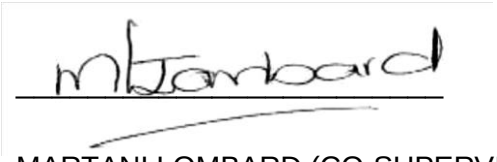

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ABSTRACT

Introduction: Severe acute malnutrition (SAM) affects more than 50 million children worldwide of which more than a quarter resides in Africa. A patient presenting with indices of SAM who experiences medical complications requires admission to in-patient treatment as their mortality risk is increased by almost 12 times in comparison to non-wasted children. Thus, the World Health Organisation (WHO) developed a guideline for the treatment of in-patients, which includes the criteria for admission and transfer of SAM patients. SAM is diagnosed in children aged 6 - 59 months as a weight-for-length/height (WLZ/WHZ) below the -3 standard deviation (SD) of the WHO child growth standards or a mid-upper arm circumference (MUAC) of less than 115mm and/or the presence of bilateral pitting oedema. The transfer from in-patient to community-based management is not recommended to be based on anthropometric assessments, but rather on clinical improvement. The WHO guideline is however based on low or very low-quality evidence, as research remains limited. The WHO identified the admission- and transfer criteria as an area that requires significant evaluation to improve clinical outcomes, especially in different age groups. Further, the implementation of the criterion used to diagnose and transfer Ghanaian patients remains, as yet, unknown. It is envisaged that this study will contribute to a better understanding of the clinical practices in terms of whether Ghanaian children are admitted early enough and transferred timeously to Community-based Management of Acute Malnutrition (CMAM).

Methods: Secondary data of the Severe Acute Malnutrition in African Children (SAMAC) larger study was used for this mini-dissertation. The SAMAC study is a multi-country, multi-hospital study which is based on a retrospective case-control design, and data are collected from medical records only. Data collection for the purpose of this sub-study took place at three referral hospitals in Ghana and included records of children aged 24 - 59 months, admitted for SAM between January 2013 and June 2018. Data was captured into Microsoft Access and analysed using version 9.4 of Statistical Analysis System (SAS).

Results: Medical records of 135 children aged 24 - 59 months were included for analysis. The age group 24 – 35 months presented 70% of the study sample. Tamale Teaching Hospital (TTH) had almost three times the amount of admissions compared to Komfo Anokye Teaching Hospital (KATH) and Princess Marie Louise (PML) Children's Hospital. Weight is the most reported anthropometry measurement on admission. The results will also be discussed as per hospital. Considering the indices of SAM, MUAC were reported in 48% (n=65) of medical records (median = 110mm and interquartile range (IQR): 103.0; 120.0), while WHZ was reported in 12.5% (n=17) of medical records with a median of -4.14 (IQR: -5.37; -2.53). Visible

signs of emaciation and oedema occurred in 56% and 46% of patients, respectively. The median length of hospital stay (LOS) was 11 days with an IQR between 8 and 18, while a median weight gain of 0.03kg (IQR: -0.02; 0.08) was observed. Seventy-five percent (n=103) of patients were discharged from in-patient treatment, while 1% (n=2) were referred to CMAM. A 19% (n=25) mortality rate was observed of which TTH had the highest rate (24%; n=21).

Discussion: The occurrence of malnutrition differs from region to region in Ghana as TTH remains burden with higher malnutrition rates than KATH and PML. The majority of MUAC and WHZ were unreported at admission, while visible signs of emaciation remain the diagnostic criteria for diagnosis of SAM. The high percentage of oedema occurring, as well as the low MUAC and WHZ values on admission indicates the severity of SAM within our study sample. No other association could be found between anthropometric measurements on admission and clinical outcomes. Since no readmissions occurred, associations between transfer criteria and clinical outcomes could not be evaluated.

Conclusion: The practice for admitting a SAM patient is not occurring as per WHO protocol. Further research is thus required to understand poor compliance of these guidelines in Ghanaian hospitals. Furthermore, more focus is required on CMAM to ensure children are admitted early enough to prevent complications, as well as transferred for follow-up treatment.

Keywords: Severe acute malnutrition, in-patient management, admission- and transfer criteria

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Thank you Lord for the passion You light up in my heart, the patience You have instilled in my veins and the ability to pursue my dreams. Your grace embraces me every day and oh, how blessed am I that You are my Saviour and King!

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- To all my family members: the Smitte, Joubert's, and Nel's, especially Ouma Jo - thank you for the motivation and prayers.

To my loving and caring parents: thank you for the countless sacrifices. You taught me to persevere. Without your support and love, I would not have been able to accomplish all that I have. God gave me a great gift, and that is to call you mom and dad.

Finally, I dedicate this work to my loving husband whose encouraging words are never-ending. You supported me, dried up my tears and motivated me throughout. Thank you for always believing in me.

▪ Me and You, Just us Two ▪

ABBREVIATIONS

CI	Confidence interval
CMAM	Community-based Management of Acute Malnutrition
GDP	Gross domestic product
HIV	Human immunodeficiency virus
IMCI	Integrated Management of Childhood Illness
IQR	Interquartile range
LAZ/HAZ	Length/Height-for-age z-score
LOS	Length of hospital stay
MAM	Moderate acute malnutrition
MIYC	Maternal Infant and Young Child
MUAC	Mid-upper arm circumference
NCD's	Non-communicable diseases
NCHS	The National Centre for Health Statics
NWU	North-West University
OR	Odd ration
PI	Principal investigator
ReSoMal	Oral rehydration salts
RUTF	Ready-to-use therapeutic food
SAM	Severe acute malnutrition
SAS	Statistical Analysis System
SD	Standard deviation
SDG	Sustainable Development Goals
SOP	Standard operations procedure
TB	Tuberculosis
UNICEF	United Nations International Children's Emergency Fund
UTI	Urinary tract infection
WAZ	Weight-for-age z-score

WHO	World Health Organisation
WLZ/WHZ	Weight-for-length/height z-score

MEDICAL TERMS

Stunting	Stunting is indicative of short stature for age on the WHO HAZ growth standards. Below the median, and between the -2 Z score and -3 Z score, are interpreted as moderate stunting, while the Z score below -3 indicates severe stunting (De Onis, 2006).
Wasting	Thinness is measured by the WHO WLZ/WHZ growth standards. Below the median and between the -2 Z score and -3 Z score are interpreted as moderate wasting, while the Z score below -3 indicates severe wasting .
Underweight	A low WAZ according to the WHO growth standards. Below the median, and between the -2 Z score and -3 Z score are interpreted as moderately underweight, while the Z score below -3 indicates severely underweight (De Onis, 2006).

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CHAPTER 1 INTRODUCTION

1.1 Background

Optimal nutrition empowers children to grow, develop, learn and play, and to participate and contribute to society (UNICEF, 2018). Conversely, malnutrition impedes optimal brain development and physical work capacity in adulthood, thus influencing the potential of economic growth, and as a result perpetuating a cycle of poverty and malnutrition which withholds human development (Development Initiatives, 2018). Therefore, to eradicate poverty as aimed by the Sustainable Development Goals (SDG), malnutrition in all its forms needs to be addressed.

The SDG are global targets which aim to achieve a better and more sustainable future for all (Development Initiatives, 2017). Nutrition is intertwined in most of the SDG and therefore, without nutrition interventions to prevent and treat malnutrition, the SDG will not be achieved (Development Initiatives, 2017). The second SDG, more specifically, entails ending all forms of malnutrition by 2030 (UN, 2016, Development Initiatives, 2017). The Maternal Infant and Young Child (MIYC) Nutrition Targets of 2025, aims to reduce childhood stunting by 40% while reducing and maintaining wasting at less than 5% (WHO, 2014). In a recent discussion paper published by the World Health Organisation (WHO) (2018), it is recommended that to ensure alignment with the SDG, the MIYC nutrition targets are adjusted to reduce stunting with 50%, and to attain a wasting rate of less than 3% by 2030 (WHO, 2018). As emphasised by the 2018 Global Nutrition Report, the adjustments in the nutrition targets are to account for the relatively slow progress in meeting these targets (Development Initiatives, 2018, WHO, 2018), as well as to take into account the projected population growth (WHO, 2018). As for stunting, the average annual rate of reduction (AARR) required to meet the current 2025 goal (AARR >= 3.8) was considered, and extended to 2030. The targets for wasting, however, was adjusted to a level where wasting is regarded as of 'no concern'. Urgent attention on a global scale is thus required for the development and improvement of policies and programmes to address malnutrition, as well as for their implementation (Development Initiatives, 2018). In Ghana, this has been found to be no different (Aheto *et al*., 2015).

Sub-Saharan Africa has one of the highest mortality rates associated with undernutrition; approximately one in 13 children die before their fifth birthday (UNIGME, 2018). In Ghana, specifically, about 19% of children younger than the age of five years are stunted, and almost 5% are wasted (Ghana Statistical Service, 2015). Although substantial progress has been made in the past decade to reduce the prevalence of undernutrition in Ghana, wasting remains

a major health problem with unacceptably high rates (Aheto *et al*., 2015, Ghana Statistical Service, 2015). Child survival rates, both globally and in Ghana, are, though, unlikely to improve without addressing wasting – that is preventing wasting, improving care with regards to timely and appropriate treatment, plus regular follow-ups to prevent reoccurrence (WHO, 2018).

Severe acute malnutrition (SAM) is the result of severe nutrient deficiency over a relatively short period of time and can be complicated by concurrent infectious diseases (UNICEF, 2015). The altered physiological and metabolic state of a SAM child can consequently manifest in the clinical appearance of severe wasting, presenting with or without oedema (Rodríguez *et al*., 2011, WHO, 2013). According to Black *at al*. (2008b), the mortality rates of children diagnosed with SAM are nine times higher compared to non-wasted children. The diagnostic criteria recommended for SAM in children aged 6 - 59 months are: a weight-for-length/height (WLZ/WHZ) below the -3 standard deviation (SD) of the WHO child growth standards, a mid-upper arm circumference (MUAC) of less than 115mm, and/or the presence of bilateral pitting oedema of nutritional origin (WHO, 2013).

Treatment of SAM can be categorised into in-patient treatment and community-based management, depending on the medical and physical status of the child (WHO, 2007, WHO, 2013). Children experiencing any medical complications, insufficient appetite and/or one or more Integrated Management of Childhood Illness (IMCI), danger signs (including intractable vomiting, convulsions, hypoglycaemia, fever, hypothermia, dehydration, diarrhoea, anaemia, skin lesions, bleeding or oedema), are referred to as SAM presenting with complications (WHO, 2013). Owing to the increased mortality risk of SAM children with complications, these patients need to be admitted for in-patient or facility-based treatment. The WHO developed a multi-step treatment guideline (also known as 'the 10-steps') for treating SAM patients admitted to health care facilities (Ashworth *et al*., 2003, WHO, 2013). The 10-steps include treatment of hypoglycaemia, hypothermia, dehydration and infection, and correcting electrolytes imbalances, micronutrient deficiencies, nutritional support, sensory stimulation and emotional support. In-patient treatment is accomplished in two phases. Phase one, also known as the stabilisation phase, usually occur during the first week of admission when severe complications are managed. The second phase, known as the rehabilitation phase, covers an extended period to enable the patient to recover and to prevent relapse (Ashworth *et al*., 2003). During the rehabilitation phase when patients present with signs of recovery such as a reduction in oedema, resolution of medical complications, and sufficient appetite they can be transferred into Community-based Management of Acute Malnutrition (CMAM) (WHO, 2013). Discharge criteria from both treatment programmes (in-patient and community-based management) are based on the WLZ/WHZ above the -2 SD or a MUAC above 125mm without the presence of oedema for

at least two weeks (WHO, 2013). The WHO recommends that the anthropometric indicator used to diagnose SAM, be used to assess whether the child has reached nutritional recovery (WHO, 2013). Regular monitoring of children discharged from the treatment programmes is strongly recommended to avoid recurrence of SAM (WHO, 2013). Early discharge from the treatment programmes can result in recurring SAM, precipitating the risk of irreversible stunting (WHO, 2013).

1.2 Rational

Together with the necessary programmes and interventions, the correct identification and treatment of SAM could significantly decrease wasting (Bhutta *et al*., 2013). Using the WLZ/WHZ indicator to diagnose SAM could pose challenge in developing countries due to the lack of equipment (scales, stadiometers and length mats) and the skills required (correct methods of using the equipment and interpretation of the WHO growth chart) (Myatt *et al*., 2006). MUAC, conversely, is a quick and easy nutritional screening tool which is measured by using an armband marked in millimetres (mm) and colour coded for easy detection of acute malnutrition. Due to the cost-effectiveness and simple technique that MUAC requires, it is recommended to be used in the community as a screening tool (by trained health care workers and community members) (WHO, 2007). Although MUAC is used to screen for SAM within communities, both MUAC and WLZ/WHZ are indicators of nutritional status, and the recommendation is, therefore, to use both to ensure proper diagnosis for in-patient treatment (Myatt *et al*., 2006, WHO, 2013). Both MUAC and WLZ/WHZ are however criticised for misdiagnosing a percentage of children with SAM (Laillou *et al*., 2014, Grellety *et al*., 2015). An analysis conducted by Laillou *et al*. (2014) indicated that by using the current MUAC criterion of <115mm to diagnose SAM, over 90% of children with a WLZ/WHZ below -3 SD was missed; whereas a WLZ/WHZ below -3 SD missed 80% of children with a MUAC of <115mm. Furthermore, the median MUAC of a healthy child at one year of age is 155mm and 158mm, and at five years of age 174mm and 175mm for girls and boys, respectively (Hossain *et al*., 2017b). As there is a linear increase in MUAC with age during childhood, using only one MUAC cut-off point for the entire age group of 0 - 59 months is questionable (De Onis *et al*., 1997, Hossain *et al*., 2017b). Thus, investigating suitable cut-off values for different age groups could improve the diagnostic criteria for SAM, especially in children older than 24 months. The WHO also urges for further research to refine the MUAC cut-off values to identify SAM in children aged 24 - 59 months through the assessment of clinical outcomes (WHO, 2013).

The probability of stunting is increased with a child's age (Aheto *et al*., 2015, UNIGME, 2018). This is congruent with 2015 data from Ghana which indicated that stunting peaks between the ages of 24 - 35 months (Ghana Statistical Service, 2015). While stunted children are more likely to have previously experienced wasting (Saaka and Galaa, 2016, UNIGME, 2018), stunting also increases the risk of wasting (Dasgupta *et al*., 2015, Development Initiatives, 2018). Reoccurrence or relapse of acute malnutrition after complete recovery has been reported to be as high as 27.5% at 9 months follow-up (O'Sullivan *et al*., 2018). Wasting and stunting are both associated with an increase in mortality - especially when it occurs simultaneously in a child (UNIGME, 2018). Since these two conditions can occur concurrently (Saaka and Galaa, 2016), accurate diagnostic criteria for SAM in children older than 24 months is critical as the management of chronic and acute malnutrition differs (Bergeron and Castleman, 2012).

To improve the guideline for treating SAM children with complications, the WHO published a document '*Updates on the Management of Severe Acute Malnutrition in Infants and Children*' in 2013 (WHO, 2013). This WHO document provides updated evidence regarding key interventions on which the current guideline is based. However, many of the recommendations, including the admission- and transfer of SAM children, which are strongly recommended, in the document, are based on low and very low quality evidence. Mainly due to limited research available to formulate recommendations, the WHO made a call for further research in the management of children with SAM (WHO, 2013, Tickell and Denno, 2016). A planned review of the guideline is scheduled for 2020 (WHO, 2013), and it is envisaged that the larger SAMAC (Severe Acute Malnutrition in African Children) study of which this sub-study forms part, will contribute to best practices in SAM management.

The implementation and outcome of the new WHO guideline are as yet unknown. In-hospital management practises, especially of Ghanaian children diagnosed with SAM, have also not been well investigated (Saaka *et al*., 2015). Relatively little is known about the clinical outcomes and factors associated with the recovery rate of Ghanaian children treated as in-patients for SAM (Saaka *et al*., 2015). According to the most recent Global Nutrition Report, only certain parts of Ghana have shown significant improvement with regards to child growth (UNIGME, 2018). The United Nations International Children's Emergency Fund (UNICEF), together with the government of Ghana are, however, working to address these disparities (UNICEF, 2013a). Currently, wasting and severe wasting effects about 4.7% and 0.7% of Ghanaian children, respectively (Ghana Statistical Service, 2015). Hence, to address SAM which remains a major health threat in mortality and morbidity rates, urgent attention needs to

be paid to the development and improvement of policies, as well as the implementation thereof (Aheto *et al*., 2015).

The larger SAMAC study aims to evaluate and compare different practices, hospital protocols, and WHO recommendations regarding admission criteria and treatment protocols of SAM in Sub-Saharan Africa. SAMAC is a multi-country, multi-hospital, retrospective case-control study which uses data collected in various Sub-Saharan African countries (to date South Africa, Ghana, Botswana, Kenya and Malawi). The data is collected in reverse chronological order and stratified according to predetermined age groups per country. As for this sub-study, secondary data obtained from medical records of children (24 – 59 months) admitted and treated for SAM (between 2013 to June 2018) from three referral hospitals in Ghana was used. It is envisaged that this study will contribute to a better understanding of the clinical practices in terms of admission and discharge criteria. Furthermore, we hypothesise that children admitted for SAM between the ages of 24 and 59 months who have a lower MUAC (<110mm) will have a poorer clinical outcome in comparison to those with a higher MUAC (>111mm).

1.3 Aims and Objectives

The aim of this sub-study is to determine the association of admission- and transfer criteria with the clinical outcomes in children (24 to 59 months) treated for SAM in three referral hospitals in Ghana.

The following objectives have been set and will be discussed as per hospital:

- To determine hospital clinical practices regarding admission- and transfer criteria (in terms of MUAC and WLZ/WHZ score) for children aged 24 – 59 months diagnosed with SAM;
- To determine clinical outcomes including but not limited to the length of hospital stay (LOS), mortality, weight gain during treatment, and secondary infections;
- To determine the associations of admission- and transfer criteria with clinical outcomes in children (24 – 59 months) treated for SAM.

We will be discussing the results as per hospital as it is an outcome of the larger SAMAC study.

1.4 Ethical Approval

Ethical clearance (Annexure 1 and 2) was firstly obtained by the North-West University (NWU) Human Research Ethics Committee (HREC) for the SAMAC larger study (NWU-00063-17-S1) plus this sub-study (NWU-00063-17-A1-02). After the HREC ethical approval was approved, ethical approval was obtained from each of the relevant Departments/Ministries of Health in Ghana (Annexure 3). Permission was also obtained from each of the included study hospitals (Annexure 5, 6 and 7).

1.5 Dissertation Structure

The NWU style guidelines were strictly adhered to in this dissertation regarding language usage, quotations and references. The dissertation comprises of six chapters. The first introductory chapter provides the aims, objectives and outputs of this study. The second chapter gives a literature review to provide background and current knowledge about SAM admission- and transfer criteria. Chapter Three encapsulates gives the methods used to conduct the study plus describes the statistical analysis applied to obtain answers to the research question. The results are given in Chapter Four. Finally, Chapter Five provides an overall discussion and the sixth chapter concluded the study. Attached are the references used and annexures adding context to the methodology.

1.6 Research Team

For this study the MSc. candidate designed the protocol which was submitted for ethical approval from the HREC. The candidate assisted in the development of the data extraction form. Furthermore, capturing and cleaning the data was done by the candidate with assistance from the rest of the team members. Together with the main study leader, the candidate did a proposal of the data analysis that needed to be made. Dr Cristian Ricci performed the statistical analysis with inputs from the candidate. The candidate herself then interpreted and presented the results in this mini-dissertation. **Table 1-1** lists the research team and the contributions of each researcher in the completion of this sub-study.

Table 1-1: Research Contributions

Team member	Training and experience
Mrs Christel Nel	Mrs Nel is a registered dietitian who works at Witbank Hospital, mainly focusing on paediatrics. She is a Masters student at NWU and is the main author of this mini-dissertation.
Mrs Cornelia Conradie	Mrs Conradie is a registered dietitian. She has experience as a registered dietitian working in paediatric wards in South Africa and is the main study leader for this study. She is a primary investigator (PI) in the SAMAC study and aids in the overall management such as data capturing, funding, resources, ethical application and well as post-graduate supervision.
Dr Tani Lombard	Dr Lombard is a registered dietitian. She has extensive research experience in infant and children chronic and acute malnutrition and is the co-study leader for this study. Dr Lombard is the PI who is responsible for the overall management of the SAMAC study.
Dr Cristian Ricci	Dr Ricci is currently employed as a post-doctorate fellow at the NWU. He is a qualified biostatistician and assisted with the statistical analysis and interpretation of the results. Dr Ricci is also a PI who manages statistical analysis for the SAMAC study.

1.7 Research Outputs

The data will also form part of the final report which will be provided to the relevant health care centres at the end of the larger SAMAC study, and if required, also to the relevant Departments/Ministries of Health in Ghana.

An article will be drafted after submission of this mini-dissertation and submitted for publication in a relevant international peer-reviewed journal. The outcomes of this study will also be presented at a national and/or international conference.

CHAPTER 2 LITERATURE REVIEW

2.1 Background of Malnutrition

According to the WHO, malnutrition is an imbalance between the combination of nutrients in the body and the body's nutritional demands to ensure growth, maintenance and specific functions (WHO, 1999). Malnutrition occurs as a result of excessive and/or deficient consumption of macro- and micronutrients (WHO, 2016, Development Initiatives, 2018). Malnutrition, therefore, comprises over- and undernutrition, this being obesity, non-communicable diseases (NCDs), wasting, stunting, as well as vitamin and mineral deficiencies. Worldwide, 88% of countries are experiencing 'double burden' malnutrition (WHO, 2016) which is the concurrence of undernutrition alongside overnutrition or diet-related NCDs - a multiplex nutrition paradigm (Development Initiatives, 2018). Globally, 19.9 billion adults are overweight and obese, while 462 million are underweight (WHO, 2016). This condition as also affects children: 38 million under the age of five are overweight and obese, while 202 million are underweight (UNICEF, 2018). A double burden of malnutrition can exist at individual levels, for instance when an obese child has a micronutrient deficiency, or in a household when the mother is overweight and the child presents with a form of underweight (WHO, 2016). It also occurs at population levels when there is a prevalence of undernutrition and obesity in the same population (WHO, 2016). Rapid economic development and urbanisation have given rise to nutrition transition diets becoming energy dense and nutrient poor, a decline in physical activity, and inadequate access to healthy food choices and healthcare facilities (Tzioumis and Adair, 2014, WHO, 2016).

In this study, the term 'malnutrition' refers to 'undernutrition', defined as an inadequate supply of energy and nutrients for optimum growth and development which results in poor development and dysfunction of the body's natural capacity to resist infection, to heal and to recover from illnesses (WHO, 2016). Child undernutrition is seen as an urgent global health issue likely to negatively influence productivity, economic growth and poverty rates (WHO, 2016, Development Initiatives, 2018).

2.2 Prevalence of Undernutrition

Globally, 150.8 million children younger than 5 years are stunted and 50.5 million suffer from wasting (Development Initiatives, 2018). It is critical to understand that depending on the time during which the survey took place, these estimates may under-represent current incidents of

wasting (Khara, 2016). However, it is estimated that undernutrition is responsible for approximately 45% of all deaths in children under the age of five (Development Initiatives, 2018). According to reports, 15 000 children died every day from mostly preventable causes or treatable diseases in 2017 (UNIGME, 2018). If the current trend continues, 56 million children under the age of five will die between 2018 and 2030 (UNIGME, 2018).

Significant progress has however been made over the past decade to reduce undernutrition, and the number of children dying under the age of five has declined globally with 57% (from 34 000 in 1990 to less than 15 000 in 2017) (UNIGME, 2018). In Sub-Saharan Africa, a 28% decrease was observed in the mortality rate of children under the age of five (from 10,500 in 1990 to less than 7500 in 2017) (UNIGME, 2018). According to an article published by UNICEF in the early 2010s, *Improving Child Nutrition, the achievable imperative for global progress*, programmes and protocols (including promotion of good sanitation practices, safe introduction of solids, the prevention of micronutrient deficiencies, early initiation of breastfeeding and continuous exclusive breastfeeding up to the age of six months, plus in-patient treatment of SAM and CMAM), which were implemented to prevent and treat undernutrition, were the main contributing factors in this reduction (UNICEF, 2013b).

Nevertheless, this decrease is not equally distributed since more than 95% of all underweight children reside in South East Asia and Sub-Saharan Africa (UNICEF, 2018). Moreover, in Sub-Saharan Africa distribution is also not equal; asymmetrical distributions of undernutrition was geometrically observed by Ricci *et al*. (2018). This data suggests that despite global progress, undernutrition remains unresolved and unacceptably high in Sub-Saharan Africa (Development Initiatives, 2018). According to the data published in 2018, Africa has one of the highest mortality rates associated with undernutrition; approximately one in 13 children die before their fifth birthdays which is 20 times higher compared to Australia and New Zealand (UNIGME, 2018). More than a quarter of children under five who are wasted live in Africa (UNICEF, 2018). In Sub-Saharan Africa, 7.5% of children are wasted while 2.2% are severely wasted (UNICEF, 2018).

In Ghana, substantial improvements have been made and a reduction in the prevalence of under-five wasting was observed from 9.5% in 1998 to 4.7% in 2014 (Ghana Statistical Service, 2015). However, 19% of all under-five Ghanaian children remain chronically undernourished while more than 5% are affected by a form of acute malnutrition (Ghana Statistical Service, 2015).

Although the number of children under the age of five who are chronically or acutely malnourished may have fallen, the data indicate that the decrease is not rapid enough to meet the SDGs in 2030 (Development Initiatives, 2018, WHO, 2018). In Africa, a decreased percentage is seen in malnourished children, but due to the growth in population, the actual number of malnourished children has risen (UNIGME, 2018). As mentioned in Chapter One, internationally agreed upon target levels have been adjusted to reach a target of less than 3% for wasted children by 2030 (Development Initiatives, 2017, WHO, 2018).

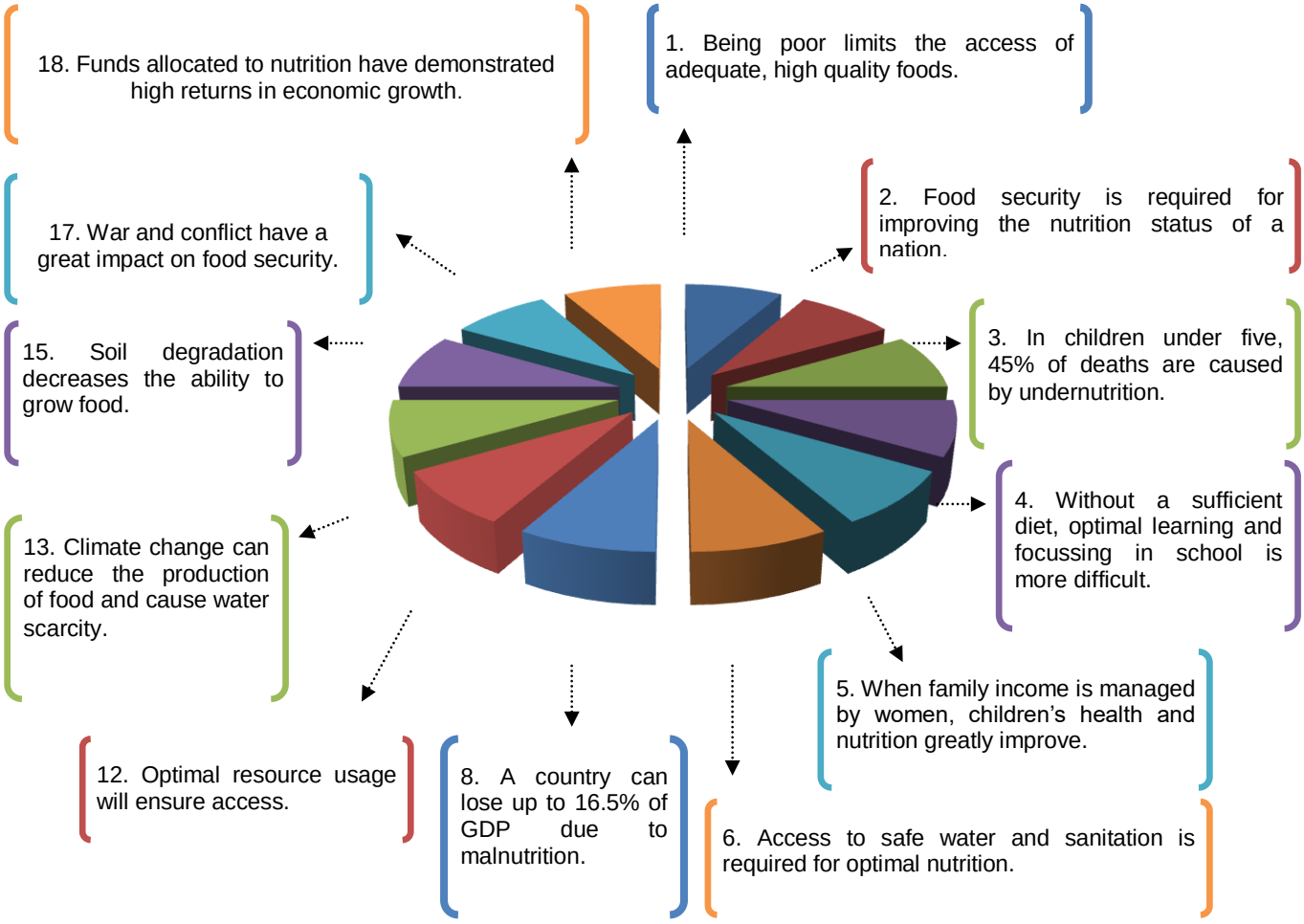


Figure 2-1: How the SDG's integrate with nutrition, adapted from UNDP, 2016.

In September 2015, more than 150 world leaders attended the United Nations (UN) Sustainable Development Summit to develop new goals, known as SDGs, to transform our world by 2030 (UNDP, 2016). The SDGs were adopted in January 2016, guiding the United Nations Development Programme (UNDP) and funding until 2030 (UNDP, 2016). These goals aim for

universal action to end poverty, protect the planet and ensure that all people can enjoy peace and achieve success (UNDP, 2016). At the summit held in 2015, it was stated that nutrition is both a maker and a marker of development within a country. Improving nutrition furthermore promotes key aspects such as health, education, employment, the empowerment of women, and the eradication of poverty and inequality (UN, 2016, Development Initiatives, 2018). Nutrition is essential to successfully achieve the SDGs by 2030 (Development Initiatives, 2018). The 17 goals specifically aim to eliminate poverty; achieve zero hunger and good health; implement quality education and access to clean water and sanitation; attain gender equality; promote economic growth and maintain responsible food production (UNDP, 2016). Although the objective of the second SDG is to achieve zero hunger, several of the goals contain indicators which are highly relevant to nutrition as presented in **Figure 2-1**. A multi-sectoral nutrition security approach is, therefore, necessary to reach optimal nutrition status in children (UNDP, 2016).

2.3 The Causes of Childhood Undernutrition

Optimal nutrition promotes growth in children as well as stimulates development, learning, play, participation while contributing to society (UNICEF, 2018). Furthermore, children who do not develop optimally are likely to become less productive adults with lower income potential, generally adding to an intergenerational cycle of poverty (UNICEF, 2013b). Malnutrition also increases the risk of disease during adulthood (including infectious lifestyle- and chronic diseases) and contributes to higher mortality and morbidity rates (Rodríguez *et al*., 2011, Black *et al*., 2013, WHO, 2016). The economic growth of a country is measured by the per-head gross domestic product (GDP) which is also the basis of all developmental policies (Vollmer *et al*., 2014). A country's economy can, therefore, be greatly influenced by malnutrition since up to 16.5% of annual GDP can be lost because of mortality, absenteeism, chronic illness and loss in productivity (Akombi *et al*., 2017, Development Initiatives, 2017). Thus, to eradicate poverty and to end all forms of malnutrition the causes of undernutrition need to be understood.

2.3.1 Determinants of Undernutrition

Undernutrition generally occurs in children when their nutritional needs and increased nutritional requirements are continuously not met, when their dietary intake is inadequate, or when a combination of these two aspects exist (Rodríguez *et al*., 2011). Developed in the early 1990s, the UNICEF framework has become the most important aid guiding and explaining the multiple

factors associated with undernutrition (UNICEF, 1990). It presents a general understanding of both micro and macro levels and can be adopted for all nutrition-related assessments and analyses. It associates the availability of nutrients with various determinants such as generic, environmental, and socio-economic status. According to the framework, the causes of malnutrition are classified into three hierarchical domains, namely basic, underlying and immediate causes (UNICEF, 1990). The framework highlights the interdependency of the determinants as each level influences the next domain as seen in **Figure 2-2** (UNICEF, 1990).

2.3.1.1 Immediate Causes

The immediate domain, as referred to in **Figure 2-2,** is influenced by the basic and underlying causes manifesting at the individual level through inadequate food intake and/or disease (Akombi *et al*., 2017). Acute infections are likely to induce malnutrition or exacerbate pre-existing malnutrition by increasing catabolism and malabsorption, and by decreasing appetite (Rodríguez *et al*., 2011). A vicious cycle (**Figure 2-3**) can occur as undernutrition, yet again, increases the risk for infectious disease due to decreased immune functions, and increased susceptibility to other infections and ultimately mortality (Black *et al*., 2013).

Malnutrition and infection often occur at the same time (Rodríguez *et al*., 2011, Black *et al*., 2013, Akombi *et al*., 2017). It is estimated that about half the deaths of children under the age of five years are caused by infectious diseases, especially in Sub-Saharan Africa, including pneumonia (16%), diarrhoea (8%) sepsis (7%) and malaria (5%) (UNIGME, 2018). In Ghana, malaria is the leading cause of death in children under the age of five (UNICEF, 2013a). Depending on the severity, infectious diseases lead to wasting which is detrimental to linear growth (WHO, 2014).

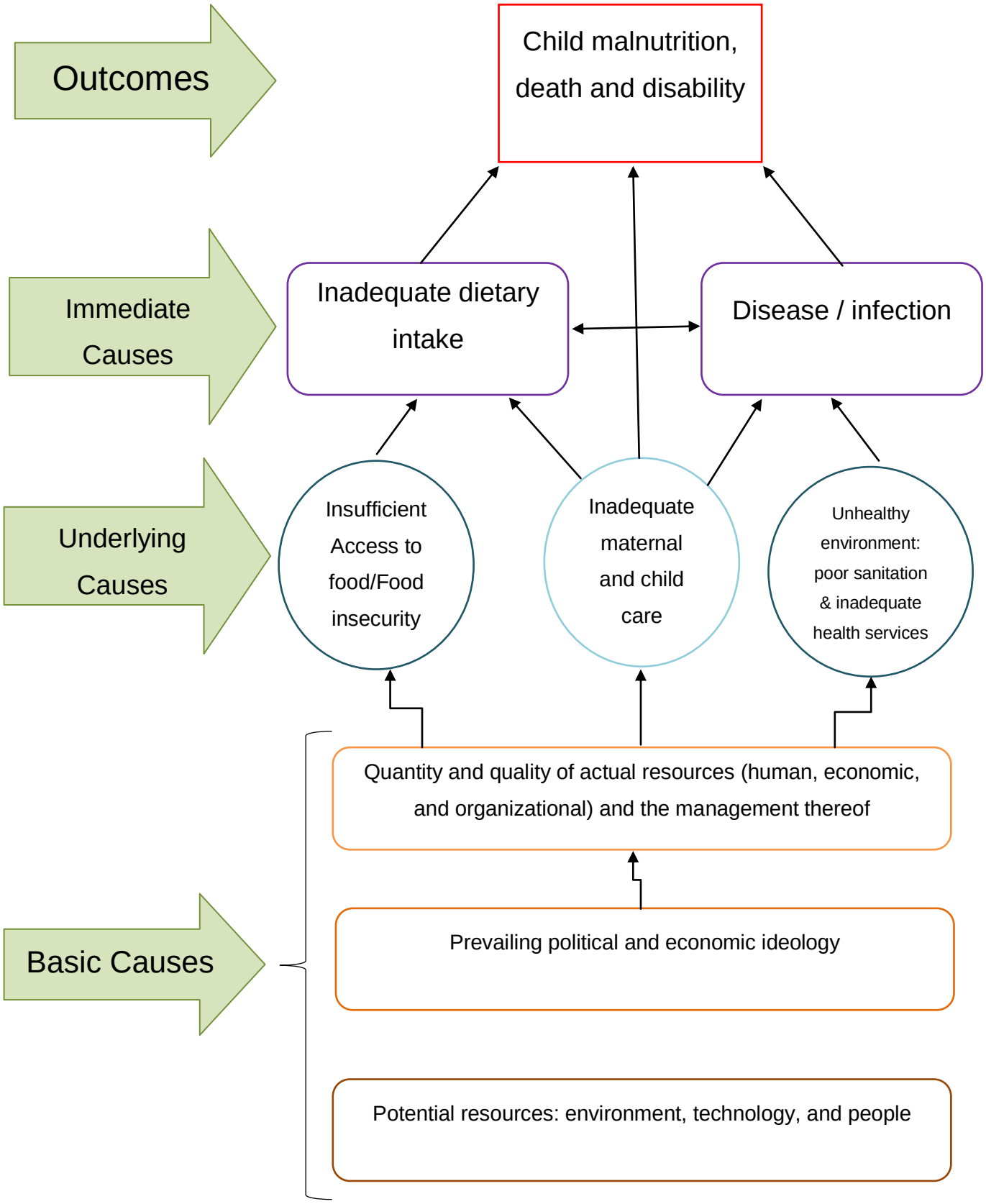


Figure 2-2: The UNICEF framework, adapted from UNICEF (1990)

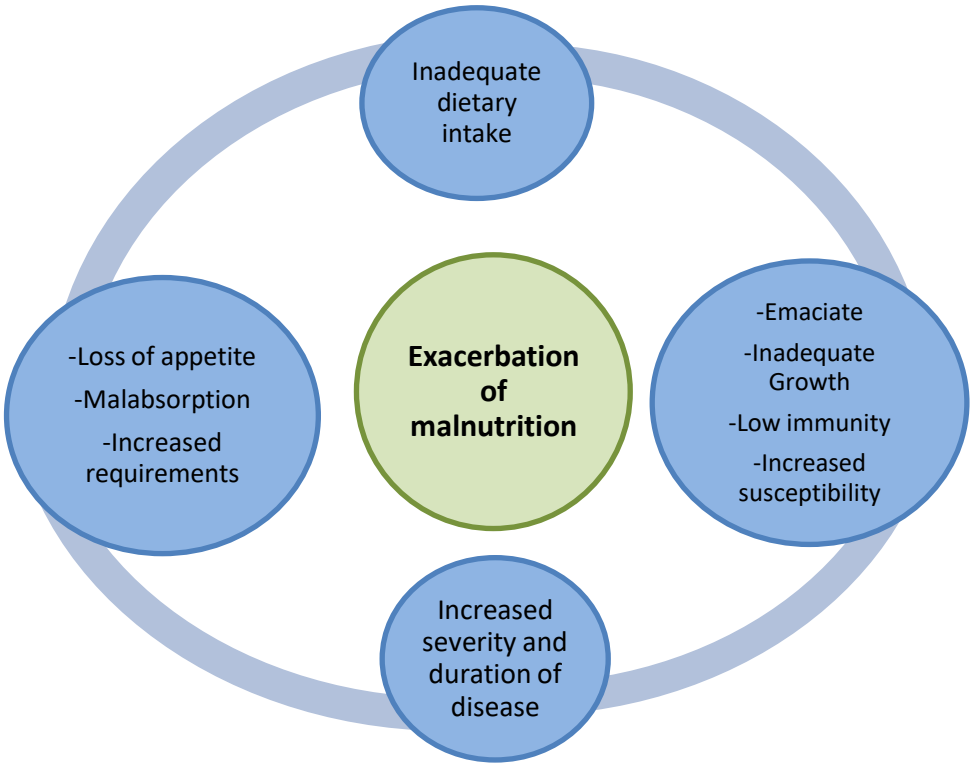


Figure 2-3: Relation between disease and malnutrition, adapted from Rodríguez *et al*. (2011)

After birth, establishing optimal infant feeding practices is the most cost-effective intervention for the prevention of any form of malnutrition (Arabi *et al*., 2012, Akombi *et al*., 2017). In infants and young children, inadequate nutrient intake is often caused by suboptimal breastfeeding practices and/or improper introduction of complementary foods (Arabi *et al*., 2012). In the early 2000s, the WHO and UNICEF jointly launched a global strategy for infant and young child feeding practices to improve the nutritional status, development and survival rate of children (WHO, 2003). The strategy states that all babies should be breastfed within one hour after birth, exclusively breastfed for the first six months of life, and continue to be breastfed up to two years (WHO, 2003). These guidelines are recommended to ensure positive impacts on length and weight gain during infancy (Adair *et al*., 2013). Having said this, the global strategy does not pay much attention to feeding practices for children after two years. It is however recommended that a variety of local foods should be offered to children to promote optimal health (WHO, 2003). The guidelines also promote food fortification for older infants and young children to ensure that they receive adequate amounts of micronutrients (WHO, 2003) which reduce the risk of undernourishment in childhood.

2.3.1.2 Underlying Causes

The immediate causes of malnutrition are influenced by underlying determinants, this being household food insecurity, unhealthy household environments and inadequate maternal and child care (**Figure 2-2**). Mother and child health remain a focus area which will ensure healthy lives and promote optimal wellbeing at all ages (Development Initiatives, 2018) as maternal and early life nutrition influence health outcomes later in life (Black *et al*., 2013, WHO, 2016, Akombi *et al*., 2017).

The third SDG aims to achieve overall good health and wellbeing. It is though estimated that 400 million people do not have basic health care services (UNDP, 2016), this impeding optimal care for children. A combination of unsanitary environments without proper healthcare facilities increases the risk of infection which in turn increases the risk of malnutrition (Rodríguez *et al*., 2011). Consequently, the capacity for adults to work and earn income is reduced, and the time and money required caring for other members of the family, greatly increased (Rodríguez *et al*., 2011). Ghana recognises the need to implement national initiatives to promote maternal and child health issues as it remains the main underlying cause of malnutrition (Ghana Statistical Service, 2015).

2.3.1.3 Basic Causes

The underlying causes of malnutrition are influenced by basic determinants, this being the availability and governance of natural resources in communities and in countries. This may affect child nutrition directly or indirectly (Akombi *et al*., 2017). The resources available in a country are determined by the natural environment, access to technology, and the quality of human resources (Akombi *et al*., 2017). Furthermore, political, economic and social factors generally determine how resources are used and how this influences underlying factors (UNICEF, 1990). It is known that undernutrition is most common in underprivileged household settings (Black *et al*., 2008, Ricci *et al*., 2018). A general review published in 2007 emphasises that underprivileged households buy less food, invest little or none of their income in education, and carry credit loans at higher interest rates. These factors influence their knowledge, health and nutrition status which in turn influences income, not only at household- but also at national level (Banerjee and Duflo, 2007).

2.3.2 Contributing Factors in Sub-Saharan Africa

In Sub-Saharan Africa, undernutrition remains a public health concern as it affects 23% of children under the age of 59 months. Ricci *et al*. (2018) conducted an ecological study to determine the factors associated with undernutrition in children between 0 – 59 months residing in Sub-Saharan Africa. It was concluded that Human Immunodeficiency Virus (HIV) prevalence, the number of doctors, household income, and hygiene conditions influence the prevalence of undernutrition. The results of the latter study indicate that an increase of one doctor per 1000 people can reduce the occurrence of chronic malnutrition by 2.6%. Furthermore, it is estimated that a 1% decrease in HIV prevalence would translate into a 1.5% decline in underweight. A positive association was also found between undernutrition and policies aimed to improve health-care (Ricci *et al*., 2018).

A systematic review to assess the cause of undernutrition in Sub-Saharan Africa concluded that low parental education is the most consistent factor associated with undernutrition (Akombi *et al*., 2017). Similar results were found in a study conducted in Ghana. A demographic health survey indicated that Ghanaian children show decreased risks of malnutrition when maternal education levels are higher (Aheto *et al*., 2015). Improved health-related decisions, increased household income, and food security were observed when parents had higher education status, consequently decreasing the risk for malnutrition (Dasgupta *et al*., 2015, Akombi *et al*., 2017). Factors associated with undernutrition in Ghana moreover include the mother's age and BMI (<20 years, <18.5kg/m^2), low birth weight, lack of immunisation, and environmental factors such as sanitation, hygiene, housing and clean drinking water (Aheto *et al*., 2015).

Water scarcity was another determinant found by Ricci *at al*. (2018) to negatively influence undernutrition since a 10% increase in water accessibility will decrease underweight by 1.7%. A child's age was also found to relate to undernutrition as sub-optimal growth was noticed with an increase in age (Dasgupta *et al*., 2015, Akombi *et al*., 2017). This could possibly be due to the increased interaction of older children with the environment which makes them more susceptible to childhood diseases through the consumption of contaminated food and/or water and poor sanitation (Akombi *et al*., 2017).

2.4 Classifying Undernutrition

2.4.1 Identifying Growth Faltering

In the 1970s, physical growth experts, paediatricians and clinical nutritionists identified the need for growth references in children. The National Centre for Health Statistics (NCHS) then generated percentiles curves for assessing the physical growth in children (Hamill *et al*., 1979). Although these percentile curves were based on large representative samples of children living in the United States, it improved the general accuracy in assessing children's growth (Hamill *et al*., 1979). However, during the 1990s the validity of these references was questioned since healthy breastfed infants living in healthy environments grew less rapidly and deviated greatly from the references (WHO, 2006). To address the limitations of the NCHS's growth percentiles, the WHO developed growth charts based on a multi-centre growth reference study conducted between 1997 and 2003 in the USA, Oman, Norway, Brazil, and certain parts of Ghana and India (WHO, 2006). Data for this study was derived from children who lived in environments which reduced constraints to growth such as poor diet and infection (WHO, 2006). The updated growth charts were published in April 2006 and are now widely used to monitor and describe the growth of children (WHO, 2006). These charts refer to both the growth standards for infants and young children from birth to the age of 59 months and to the growth references available for children between 5 to 19 years (WHO, 2006). Growth charts are important in both public health sectors and in clinical practices. In public health, these charts can identify populations which are at risk for malnutrition, and in clinical settings to evaluate and identify growth abnormalities. The charts are also useful in distinguishing between chronic and acute malnutrition (Collins *et al*., 2006a, WHO, 2006). This is critical since the causes, management and consequences of acute and chronic malnutrition are different (Collins *et al*., 2006b, Bergeron and Castleman, 2012, WHO, 2013, Khara, 2016).

Given the different assessment indices of acute and chronic malnutrition, it may seem that they are mutually exclusive. A deficit in nutrients during early childhood increases the risk of a decline in linear growth, which may not be completely averted by subsequent adequate nutrient intake which supports normal growth, resulting in stunting without wasting (WHO, 2014). However, it is found that stunting and wasting can occur concurrently as the majority of children who are treated for SAM are also stunted (Bergeron and Castleman, 2012, Khara, 2016). One child may present with a combination of wasting, stunting, and underweight, while another may present with a combination of wasting with either underweight or stunting (WHO, 2014). While the relationship and associations of stunting and wasting remain poorly understood, much information about the causes and effects are available (Khara, 2016). When inadequate

nutrients intake/absorption is present, multiple or single micronutrient deficiencies may occur increasing the consequences of malnutrition (Bailey *et al*., 2015). Micronutrient deficiency frequently, but not always, occurs as part of a malnutrition cycle and can be coupled with stunting or wasting (Khara, 2016).

2.4.1.1 Micronutrient Deficiency

Micronutrient deficiency, which is less noticeable, is also referred to as "hidden hunger" (USAID, 2009, Bailey *et al*., 2015). At the basic level, it is caused by insufficient intake of nutrient-rich foods and is worsened by insufficient absorption, poor sanitation, infection, and/ or lack of education and healthcare (USAID, 2009). Micronutrient deficiencies have short- and long-term effects and are the most common contributor to poor health. Consequently, micronutrient deficiencies have a deleterious effect on the development of a young child (Bailey et al., 2015). Therefore, the updated WHO guidelines discuss micronutrient deficiencies as a frequent complication encountered amongst SAM children. In comparison with their well-nourished peers, even mild to moderate micronutrient deficiencies increase a child's susceptibility to infections and consequent death (Black *et al*., 2013, Bailey *et al*., 2015). Micronutrient interventions are amongst the most cost-effective interventions to improve global health in low- and middle-income countries. The benefits include a reduced prevalence in low birth weight, increased child survival rates, and an increase in cognitive development (Adair *et al*., 2013, Bhutta *et al*., 2013)

Globally, more than 2 billion people are at risk of vitamin A, zinc and iron deficiencies (Bhutta *et al*., 2013). Vitamin A is a fat-soluble vitamin required for adequate immune function, vision, and optimal development in a child (Bailey *et al*., 2015). Vitamin A deficiency is associated with increased infection and is the leading cause of eye damage in children (otherwise known as eye signs of Vitamin A deficiency), causing inter alia xerophthalmia, Bitots spots, corneal ulcerations and lesions (Bailey *et al*., 2015). Evidence indicates that where Vitamin A deficiency exists in a country, supplementation can reduce mortality rates up to 23% (USAID, 2009). To the knowledge of the author, no data exists on the prevalence of vitamin A deficiency in Ghanaian children. However, supplementation of vitamin A has been found to be highest in the central region of Ghana, while the lowest is observed in the northern region (Ghana Statistical Service, 2015).

While 33% of children worldwide under the age of five years are vitamin A deficient, 47% are anaemic (WHO, 2009). In Ghana anaemia is the most prevalent micronutrient deficiency which affects approximately 66% of children (Ghana Statistical Service, 2015). Reports have also

shown that between 80-95% of malnourished patients present with severe anaemia of which iron deficiency anaemia are the most prevalent (Masoga, 2018). This statistic is similar in Ghana where iron anaemia is the most prevalent type of anaemia in children under the age of five (Ghana Statistical Service, 2015). Iron deficiency anaemia is mostly caused by inadequate dietary intake, malaria and/or intestinal worm infestation (WHO, 2011, Ghana Statistical Service, 2015). Iron is important for the production of haemoglobin which is the oxygen-carrying component of red blood cells. These cells carry oxygen to the muscles and brain which make iron critical for motor and cognitive development during childhood (USAID, 2009). If iron levels are too low, the body produces too few red blood cells, and individuals develop anaemia. Iron deficiency anaemia is most accurately diagnosed by low serum ferritin (WHO, 2011). Ferritin is a sensitive indicator of iron deficiency since iron is primarily stored in the form of ferritin. A low serum level of ferritin, therefore, reflects depleted iron stores (WHO, 2011). Iron deficiency is a microcytic anaemia, which impairs work capacity and decreases immune and endocrine functions (Bailey *et al*., 2015).

2.4.2 Acute and Chronic and Malnutrition

Chronic malnutrition, commonly known as stunting, affects over 19% of children in Ghana (Ghana Statistical Service, 2015). Child stunting is indicative of insufficient nutrient intake over a longer period, leading to linear growth failure or stunting (Khara, 2016). It is characterised by length/height-for-age (LAZ/HAZ) of two or more SD below the WHO child growth standards' median (Black *et al*., 2013). Severely stunted children have more than five-fold increased risk of mortality (Black *et al*., 2008, Khara, 2016).

Factors that contribute to stunting include maternal health and nutrition, inadequate infant and young child feeding practices, and infection (WHO, 2014). Maternal undernutrition accounts for 20% of childhood stunting (WHO, 2014). Stunting can be initiated *in utero* if maternal undernutrition occurs and if it continues during early childhood (Bhutta *et al*., 2013). Chronic malnutrition is usually not noticeable as it may be shrouded by normal appearance and does not present an immediate threat to life (Black *et al*., 2008, Khara, 2016). This, however, does not make stunting less of a risk to the growth and development of a child in the long term. Stunting is an impediment to human and economic development because these children have diminished cognitive and physical development, reduced productive capacity and ill health - thus influencing economic or income potential (Khara, 2016). A 1% loss in adult height due to childhood stunting is associated with a 1.4% loss in economic productivity (WHO, 2014). It is further estimated that stunted children earn 20% less as adults compared to non-stunted individuals, consequently perpetuating the cycle of poverty and malnutrition (WHO, 2014).

Chronic malnutrition is mostly irreversible as it cannot be completely averted by adequate nutrient intake (Dasgupta *et al*., 2015, Khara, 2016). The management of chronic malnutrition, therefore, focuses on prevention which includes optimal maternal nutrition, exclusive breastfeeding during the first six months of life and adequate feeding practises (Bergeron and Castleman, 2012, WHO, 2014). Conversely, children who are chronically malnourished having increased risks of becoming overweight or obese later in life should they experience rapid weight gain after the age of two years. Such weight gain is associated with NCDs – including coronary heart disease, stroke, hypertension and type two diabetes (WHO, 2014).

The probability of stunting increases as a child's age increases, whereas the probability of wasting decreases with an increasd age (Aheto *et al*., 2015, UNIGME, 2018). This is congruent with data from Ghana which indicated in 2015 that stunting peaks between 24 - 35 months (Ghana Statistical Service, 2015). The data, though, indicates that children who are wasted are more likely to become stunted, while stunting increases the risk of wasting (Dasgupta *et al*., 2015, Development Initiatives, 2018, UNIGME, 2018). There are no clear mechanisms that indicate wasting can lead directly to stunting (Saaka and Galaa, 2016, Khara, 2016). Wasting, however, a consequent of fat and muscle depletion, is a state where linear growth is reduced since the body can only have linear growth while energy reserves are available (Saaka and Galaa, 2016, Khara, 2016).

Wasting and stunting are both associated with an increase in mortality (UNIGME, 2018). When both stunting and wasting occur, a 12-fold increase in mortality is observed (Khara, 2016). As these two conditions can occur concurrently (Saaka and Galaa, 2016), accurate diagnostic criteria for SAM in children older than 24 months is critical since the management for chronic and acute malnutrition differs (Bergeron and Castleman, 2012). Acute malnutrition, as suggested by the name, reflects recent weight loss (Collins *et al*., 2006a). However, the time period which refers to acute or chronic malnutrition is not well defined (Khara, 2016). According to the WHO, acute malnutrition can be classified as moderate or severe depending on anthropometry and medical complications (WHO, 2013). Moderate acute malnutrition (MAM) is defined as a WLZ/WHZ between the -2 and -3 SD of the WHO child growth standards, and/or a MUAC between 115mm and 125mm (WHO, 2013). Globally, MAM affects approximately 34 million children under the age of five (UNICEF, 2018).

2.5 Severe Acute Malnutrition

SAM is characterised by a rapid deterioration in nutritional status over a short period of time (UNICEF, 2015). This acute phase leads to loss of body fat and deterioration of muscle, known as wasting (UNICEF, 2015). It is important to note that 'wasting' can refer to visible signs of emaciation (i.e. bone structure and loss of subcutaneous fat) or can be indicated anthropometrically on the WHZ. Initially, in the absence of anthropometric measurements, visible signs of wasting or emaciation were used to diagnose SAM (WHO, 2007). However, more recent data indicated that using visible signs of emaciation as an indicator can lead to misdiagnosis of approximately half of SAM patients (Mogeni *et al*., 2011). Thus, current evidence does not support visible signs of emaciation as a stand-alone criterion for SAM in children under five years old (Mogeni *et al*., 2011, WHO, 2013). The guideline recommends that wasting rather be diagnosed with anthropometry (WHO, 2013). SAM is consequently defined as a WLZ/WHZ below the -3 SD of the WHO child growth standards, with a MUAC of less than 115mm, and/or the presence of bilateral pitting oedema of nutritional origin (WHO, 2013).

Using the WLZ/WHZ indicator to diagnose SAM could however prove to be challenging in developing countries due to lack of equipment (scales, stadiometers and length mats) and the required skills (correct method of using the equipment and interpretation of the WHO growth chart). Conversely, MUAC is a quick an easy nutritional screening tool which is measured by using an armband marked in millimetres and colour-coded for easy detection of acute malnutrition (WHO, 2007). Due to the cost-effectiveness and the simple technique that MUAC requires, it is recommended to be used in communities (by trained healthcare workers and community members) (WHO, 2013, USAID, 2017). As mortality risks are directly related to the severity of SAM, early identification could decrease the mortality rate drastically (Collins *et al*., 2006a, Picot *et al*., 2012, WHO, 2013).

Children have lower muscle mass than adults and therefore measurement procedures require reliability since it directly influences both the admission and discharge criteria in these patients (Masoga, 2018). According to Black *et al*. (2013) diagnosing acute malnutrition correctly, can prevent over 400 000 deaths. Individual studies, therefore, focus on evaluating the efficacy of MUAC and WLZ/WHZ as criteria to diagnose SAM. Evidence indicates that MUAC and WLZ/WHZ are both indicators of nutritional status; however, each is criticised for misdiagnosing a percentage of children with SAM (Laillou *et al*., 2014, Aguayo *et al*., 2015, Grellety *et al*., 2015, Hossain *et al*., 2017b). An analysis conducted by Laillou *at al*. (2014) indicated that by using the current MUAC criterion of <115mm to diagnose SAM, over 90% of children with a

WLZ/WHZ below -3 SD was missed; whereas a WLZ/WHZ below -3 SD missed 80% of children with a MUAC of <115mm. Both indicators have a high specificity (>95%) to detect children at risk of dying, but a low sensitivity (<10%) to predict death (Briend *et al*., 2012). In community studies, MUAC has been found to be more accurate than WHZ/WLZ to identify children at risk of dying (Briend *et al*., 2012). Aguayo *et al*. (2015) concluded that a MUAC of <115mm is an acceptable diagnostic criterion for SAM, although the current recommended cut-off values are more reliable in children between 6 and 23 months. Another study suggested that an upward adjustment of the MUAC cut-off value of <125mm could prevent almost 30% more deaths (in all age groups) than the current criteria (Grellety *et al*., 2015). Further, the median MUAC of a healthy child at one year is 155mm and 158mm, and at five years 174mm and 175mm for girls and boys respectively (Hossain *et al*., 2017b). During childhood an increase in MUAC is observed with an increase in age; uncertainties, therefore, arise when a single MUAC cut-off value is used to diagnose SAM in older children (>24months) (De Onis *et al*., 1997, Hossain *et al*., 2017b). Furthermore, there are important physiological differences between younger infants and older children. As stated by the WHO, these differences could justify separate considerations for the management of SAM in different age groups (WHO, 2013).

2.5.1 Management of Severe Acute Malnutrition

2.5.1.1 Community-Based Management of Severe Acute Malnutrition

The median case fatality rate for children under the age of five with SAM ranges from 30 - 50% (Collins *et al*., 2006a, Hossain *et al*., 2017a). This number, however, reduces if SAM children do not experience any complications (UNICEF, 2009, Aguayo *et al*., 2015, Hossain *et al*., 2017a). The WHO therefore developed the CMAM guidelines based on the evidence that a large number of children can effectively be managed within the community (Myatt *et al*., 2006, WHO, 2007, Ghana Health Services, 2010, USAID, 2017). CMAM is an approach proven to manage SAM (without complication) and MAM in children under the age of five as out-patients. CMAM is currently implemented in 70 countries, of which Ghana is one (Ghana Health Services, 2010, USAID, 2017). CMAM aims to reach large scale coverage of children suffering from SAM, more specifically to allow the majority (approximately 80%) of children to be managed within the community. CMAM is also implemented to provide access to services and quality management with therapeutic foods to ensure optimal recovery for children who do not present with medical complications (WHO, 2007).

Prior to CMAM, SAM treatment was restricted to healthcare facilities alone. This meant that all SAM patients, with or without medical complications, had to stay in hospital until fully recovered.

This treatment plan was challenging for both patients and the healthcare system (WHO, 2007). Patients were treated for long recovery periods (up to six weeks), leading to overcrowding which not only made it difficult for families to remain in treatment care but increased the risk of cross-infection. The treatment care plan also increased costs because of the need for intensive medical and nutritional protocols administrated by trained healthcare practitioners. Consequently, the impact and coverage of SAM treatment were limited (WHO, 2013). In developing countries such as Ghana, resources are restricted and not all SAM patients can be admitted for management (Ghana Health Services, 2010). A recent systematic review indicated that most African countries lack adequate human recourses and equipment to manage SAM (Hossain *et al*., 2017a). In alignment with the WHO guideline, Ghana developed a national guideline, "*Interim National Guidelines for Community-based Management of Severe Acute Malnutrition in Ghana*" to aid in the management of out-patient (Ghana Health Services, 2010).

Community healthcare workers in Ghana screen children for acute malnutrition using MUAC and oedematous malnutrition (Ghana Health Services, 2010). This aligns with the WHO which suggests the use of MUAC for screening SAM in communities (WHO, 2013). Children identified with SAM or MAM are then referred to nearest health centres (USAID, 2017). A caretaker will take the child to the healthcare centre where healthcare workers will conduct anthropometric measurements, asses for nutritional oedema and medical complications, and do an appetite test according to the established protocol as shown in **Table 2-1** (Ghana Health Services, 2010). In contrast to the WHO guideline, the Ghanaian guideline suggests that only children with severe oedema be admitted for in-patient treatment (Ghana Health Services, 2010). Children with mild or moderate oedema can be treated as out-patients. The appetite test is done with ready-to-use therapeutic food (RUTF) to establish whether the child will have sufficient nutritional intake when treated as an out-patient (UNICEF, 2015). The child passes the appetite test if he/she can ingest the prescribed amount of RUTF per kilogram body weight (WHO, 2013, USAID, 2017).

RUTF is composed of a lipid-based high-energy protein plus micronutrients which enable a child to gain adequate weight (UNICEF, 2015). As the RUTF isn't water-based it minimises bacterial growth and does not require cooking - making them safe for home use (USAID, 2017). Children presenting with indices of SAM who are clinically well, without medical complications, and who have an adequate appetite, qualify for out-patient management (Collins *et al*., 2006b, WHO, 2013).

Table 2-1: Classification of SAM in Ghanaian children (Ghana Health Services, 2010)

Management approach classification	**IN-PATIENT TREATMENT** **SAM with medical complication**	**OUT-PATIENT CARE** **SAM without medical complication**
Anthropometric and clinical measures	Children 6 - 59 months: Bilateral pitting oedema (+++) or any grade of bilateral pitting oedema with severe wasting (MUAC < 115 mm) or SAM with medical complications. Infants 0 - 6 months: Any bilateral pitting oedema or visible wasting. Infants ≥6 months who weigh <4.0kg.	Children 6 - 59 months: Either bilateral pitting oedema (++) or (+) or severe wasting (MUAC < 115 mm).
Appetite test	Failed	Passed
Clinical evaluation	SAM with any of the following medical complications: Clinically well and alert Anorexia, no appetite Intractable vomiting Convulsions Lethargy, not alert Unconsciousness Hypoglycaemia High fever Hypothermia Severe dehydration Lower respiratory tract infection Severe anaemia Skin lesion Eye signs of vitamin A deficiency	Clinically well and alert.

These children are managed at home with weekly follow-ups at a nearby facility on the condition that RUTF is provided to the caretaker as an essential aid in the treatment plan (Ghana Health Services, 2010). Should a child fail the appetite test or present with one or more danger signs

(unable to drink/breastfeed, intractable vomiting, lethargy, lower respiratory infections, high fever, severe dehydration, severe anaemia, hypoglycaemia, hypothermia, eye signs of vitamin A deficiency, skin lesions, convulsions or unconsciousness), it is strongly recommended that the child be treated at an appropriate healthcare facility (a hospital or stabilisation centre) (WHO, 2007, Ghana Health Services, 2010, WHO, 2013, USAID, 2017).

2.5.1.2 In-Patient Management of Severe Acute Malnutrition

Children presenting with SAM with complications account for 10 - 20% of all SAM cases (WHO, 2007). SAM refers to an acute decline inadequate energy to sustain metabolism, resulting in profound derangements in normal physiology (UNICEF, 2015, Khara, 2016). These physiological adjustments occur when glycogen stores become depleted and the body shifts to an energy-sparing mode (Khara, 2016), which allows key organs to maintain their functions by using ketones (diverted from fat) and amino acids (diverted from muscle) as main energy sources (Masoga, 2018). There is also a decrease in blood perfusion to the gastrointestinal tract to ensure perfusion to other more important organs (Masoga, 2018). This results in a decrease in gastrointestinal motility causing impaired digestion and absorption which alters the insulin levels. During this process, the gut barrier function is sub-optimal, increasing susceptibility to pathogens (Masoga, 2018). Due to the alterations in physiological and metabolic states, as well as the increased risk of mortality, multi-step treatment guideline for treating SAM patients admitted to healthcare facilities were developed by the WHO (Ashworth *et al*., 2003, WHO, 2013, UNICEF, 2015). This guideline (also known as the 10-steps), take these changes into consideration and serves as an aid to healthcare workers to achieve optimal SAM management (**Table 2-2**) (Ashworth *et al*., 2003, WHO, 2013).

Table 2-2: Steps for in-patients treatment of SAM (Ghana Health Services, 2010)

Guideline	Indicator and Action	Monitoring
1. Treat Hypoglycaemia	A child with a serum glucose < 3 mmol/L should be treated with glucose immediately. Start 2 hourly feeding immediately. Shock must first be resolved before feeding.	Monitor blood glucose 2 hourly. Monitor rectal temperature and level of consciousness. Repeat glucose test if there is a decline in consciousness and temperature to < 35.5°C.
2. Treat hypothermia	Axillary and rectal temperature of < 35.0°C and < 35.5°C are indicative of hypothermia: 1. Feed immediately or start rehydration where necessary; 2. Give antibiotics.	Check body temperature 2 hourly until it rises to > 36.5°C. Ensure proper covering and clothing of the child throughout the night. Monitor blood glucose as well. Encourage Kangaroo Mother Care for warmth at night especially.
3. Treat dehydration	Intravenous rehydration is not recommended except in cases of shock. Assume all children with watery diarrhoea are dehydrated and administer ReSoMal.	Observe pulse rate, respiratory rate, urine frequency and stool/ vomit frequency. Signs of overhydration include increased respiratory and pulse rate increased oedema and puffy eyelids.
4. Correct electrolyte imbalance	Treatment of oedema with a diuretic is not recommended. Give: 1. Extra potassium 3-4 mmol/kg/d; 2. Extra magnesium 0.4-0.6 mmol/kg/d; 3. Use ReSoMal in rehydrating.	Monitor oedema. Low sodium diet.
5. Treat infection	Signs of infection may not be evident, therefore give routinely on admission: 1. Broad-spectrum antibiotics; 2. Measles vaccine if child is > 6 months and not immunized (delay if the child is in shock).	Monitor anorexia. If anorexia persists, reassess child fully, looking out for sites of infection and potentially resistant organisms. Ensure that vitamin and mineral supplements have been administered correctly.
6. Correct micronutrient deficiency	Avoid iron supplementation until child has a good appetite 1. Give vitamin A orally on day 1 (for age > 12 months, 6-12 months and 0-5 months give 200,000 IU; 100,000 IU; and	Monitor resolution of physical signs of micronutrient deficiency.

Guideline	Indicator and Action	Monitoring
	50,000 IU respectively. 2. Give a daily multivitamin supplement.	
7. Start cautious feeding	Feeding should commence immediately after admission and should be: 1. Small, frequent feeds of low osmolarity and low lactose provided 2. Orally or by nasogastric tube; 3. Encourage breastfeeding in addition to prescribed starter feed if the child is breastfed; 4. F 75 is a suitable starter feed for most children.	Observe and record: Quantities of feed given and left over Daily body weight Frequency of watery stool Vomiting.
8. Achieve catch-up growth	This phase is a vigorous approach to feeding to achieve high intakes and rapid weight gain of > 10 g/kg/d: Replace F-75 with the same amount F-100 for 48 hours and increase each successive feed by 10 ml intakes.	Monitor: Gastro-intestinal symptoms Signs of heart failure Respiratory rate Pulse rate.
9. Provide sensory stimulation and emotional support	Severely malnourished children may suffer delayed mental and behavioural development, thus provide: 1. Tender loving care; 2. A cheerful, stimulating environment; 3. Structured play therapy 15-30 min/d; 4. Physical activity as soon as the child has recovered enough; 5. Maternal involvement.	
10. Prepare for follow-up after recovery	Teach parent or caregiver how to: 1. Prepare and feed frequently with energy- and nutrient-dense foods; 2. Give structured play therapy.	Encourage caregiver to: Bring child for follow-up Ensure immunizations are given Ensure vitamin A is given every six months.

A systematic review, including nine studies published between 1996 and 2008 from low- and middle-income countries based in Africa, Asia and Latin America, assessed the effectiveness of the WHO treatment guideline on SAM mortality reduction (Hossain *et al*., 2017a). It concluded that when using the WHO guideline rather than conventional methods, a 41% reduction in SAM mortality was observed (Hossain *et al*., 2017a). This is congruent with Ashworth who indicated in 2003 that strict adherence to the guideline is likely to decrease case-fatality rates to less than 5% (Ashworth *et al*., 2003). As previously mentioned, case-fatality rates remain unacceptably high (Collins *et al*., 2006a, Hossain *et al*., 2017a), especially because cost-effective and evidence-based nutrition interventions exist.

The '10-steps' include treatment of hypoglycaemia, hypothermia, dehydration, and infection; correcting electrolytes imbalances, micronutrient deficiencies; and providing nutritional and emotional support plus stimulation. A short overview of the treatment practices is given in **Table 2-2**. The treatment of in-patients is divided into two phases: phase one, also known as the stabilisation phase, occurs during the first week of admission when severe complications are managed (WHO, 2013). The second phase, known as the rehabilitation phase, requires an extended time period to recover as seen in **Figure 2-4** to prevent relapse (Ashworth *et al*., 2003). However, between these two phases, there is also a transition period (WHO, 2013).

During the stabilisation phase, nutrition is a key aspect of successful treatment. Caution is needed when initiating feeds in the stabilisation phase since a malnourished child's physiological state is compromised and the haemostatic state is reduced (Cloete, 2015, Masoga, 2018). Almost all children suffering from acute malnutrition have impaired liver, kidney and gastrointestinal functions (Cloete, 2015). Thus, a feed low in protein, fat and sodium is required to stabilise the child. The WHO recommends using F-75 as the first therapeutic milk as it is low in protein and fat, but relatively high in carbohydrates (WHO, 2013). It is also recommended for feeding to start immediately after admission except when a child is in shock; shock should be resolved before starting bolus feeds (WHO, 2013). When feeding is commenced, it should be done in small volumes to decrease the risk of developing refeeding syndrome (WHO, 2013, Cloete, 2015). Refeeding syndrome is defined as the shift in fluid and electrolytes in malnourished patients with metabolic abnormalities once feeding is administrated (WHO, 2013). When refeeding syndrome is present, cardiac arrhythmia and failure, respiratory distress and acute renal failure may occur which could result in sudden death (WHO, 2013). These signs are easily misinterpreted by health care practitioners as being related to sepsis (WHO, 2013).

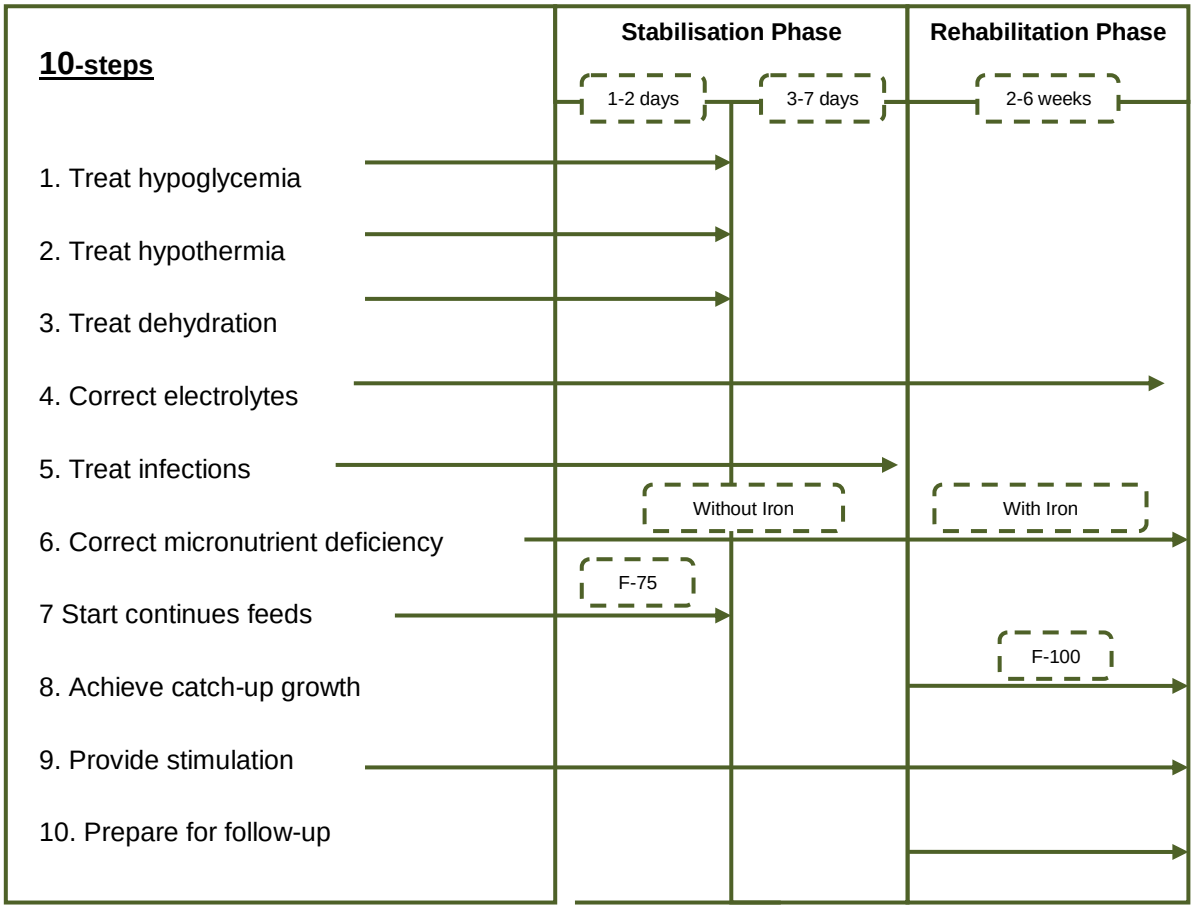


Figure 2-4: Time frame for the in-patient treatment of SAM, adapted from Ashworth *et al*. (2003)

A transition period was first suggested during the early 1990s when clinical trials observed diarrhoea, weight loss and refeeding syndrome during the initiation of large amounts of feeds, ultimately increasing mortality (WHO, 2013). Transitioning to the rehabilitation phase will usually occur within a week from admission (**Figure 2-4**) when medical complications such as oedema and sepsis are resolved and the child's appetite has returned (WHO, 2013). A gradual transition from F-75 to F-100 is required, with F-100 replacing F-75 at an equal amount for two days, before increasing the therapeutic food (WHO, 2013). When the child is stable, F-100 or RUTF is recommended by the WHO as it contains more protein and energy which will ensure the recovery of lean body mass and provide catch-up growth (WHO, 2013, Cloete, 2015). In the rehabilitation phase, nutritional rehab is vigorous and will achieve a rapid weight gain of 10g/kg/day (Cloete, 2015). In Ghana, few children remain in in-patient treatment until full recovery (which can take up to 6 weeks) as patients are transferred to CMAM with appropriate amounts of RUTF and follow-up visits (Ghana Health Services, 2010).

2.5.2 Transfer and Discharge from In-patient treatment

As mentioned in the previous section, SAM patients are generally discharged from hospital/ in-patient treatment during the rehabilitation phase, and thus before full recovery is achieved (WHO, 2013). As in Ghana, the WHO recommends that children who haven't reached full recovery on discharge from in-patient treatment, should be transferred to CMAM (Ghana Health Services, 2010, WHO, 2013). The WHO uses the term 'transfer' to refer to a child who is discharged from in-patient treatment and transitioning to CMAM. The term 'discharge' is used when a child exits both the in-patient and community-based treatment programme (WHO, 2013). It is, however, important to note that this terminology is not consistent in all documentation, guidelines and policies; in Ghana, for example, the term 'referral' is used instead of 'transfer' (Ghana Health Services, 2010). For the purpose of reporting on the data in this mini-dissertation (Chapters 3 to 6), though, the term 'discharge from in-patient treatment' is used to refer to dismissal from hospital – regardless whether the child was referred to CMAM or not. The number of children, though, referred to CMAM will be reported on separately.

The WHO recommends transferring patients from in-patient treatment to CMAM when they are clinically well and alert, when medical complications including oedema are resolved, and they present with a good appetite (WHO, 2013). Transfer is not recommended on the basis of anthropometric assessments, but rather clinical improvement (WHO, 2013). The WHO acknowledges that this recommendation is based on low quality evidence since little evidence is available regarding the most appropriate transfer criteria (WHO, 2013).

As far as discharge from the entire SAM treatment programme is concerned, previous WHO guidelines (WHO, 1999) recommended that the percentage of weight gain be used to monitor nutritional recovery. This was recommended to eliminate the need for height measurements. However, in the updated guideline published in 2013 ('*Updates on the Management of Severe Acute Malnutrition in Infants and Children*'), the WHO emphasises that percentage of weight gain should not be used as either transfer or discharge criterion as it does not indicate nutritional recovery (WHO, 2013). The change in the guideline is based on evidence indicating that the discharge criterion of 15% weight gain is not appropriate. Evidence found that by using percentage weight gain as a discharge criterion has the disadvantage of requiring a smaller absolute weight gain to meet discharge criteria for children with the lowest initial weight (Bekele *et al*., 2010, Dale *et al*., 2013). This resulted in a shorter period of treatment for the more severely malnourished children as not only the absolute weight gain required is less but also in the most wasted children receiving appropriate care, weight gain is higher (Bekele *et al*., 2010, Dale *et al*., 2013). Furthermore, the median weight of a healthy child at one year of age is less than a child who is five years of age. As there is a linear increase in weight, it is expected that

older children (with a greater weight but still SAM) will have an unnecessarily long stay in hospitals which increases their risk for secondary infection, while the more vulnerable children with lower weight being discharged before they have achieved full recovery (Dale *et al*., 2013, WHO, 2013).

The current recommendations are thus as follows: a SAM patient can be discharged from the entire treatment programme when he/she has been without oedema for at least two weeks, or the WLZ/WHZ is above -2 SD, or when the MUAC is above 125mm (WHO, 2013). However, it is critical that the same anthropometric indicator used to diagnose SAM is used to discharge a patient from the treatment programme. Dale *at al*. (2013) and Aguayo *at al*. (2015a) assessed the effectiveness of the current criteria in comparison to the previous criteria. Both studies found that the current criteria will increase the impact because the most vulnerable children will spend more time in the programme. This will prevent early discharge, reducing the recurrence of SAM and consequently decreasing the risk of irreversible stunting (Development Initiatives, 2018). The WHO also suggests regular monitoring of children who are discharged from the treatment programme to avoid relapse. However, no clear definition is given on relapse or on how often follow-ups should be conducted. O'Sullivan *at al*. (2018) conducted a recent review which included children aged 6 - 59 months who were diagnosed and treated for SAM, discharged and subsequently followed up on between 6 and 24 months thereafter. It was concluded that lack of follow-up was as high as 45% and more common among children who had been treated as inpatients. This could be due to caregivers losing daily wages or having insufficient funds to travel to health facilities (O'Sullivan *et al*., 2018). More research is needed on best practice to prevent relapse.

2.6 Conclusion

Acute malnutrition, which affects more than 50 million children globally, is seen when rapid deterioration in nutritional status over a short period of time disturbs the normal physiological and metabolic state of children (UNICEF, 2017, Masoga, 2018). Acute malnutrition can be complicated by concurrent infectious diseases which increase its severity (Rodríguez *et al*., 2011). Since mortality risk is directly related to the severity of acute malnutrition, early identification could prevent the onset of complications and decrease the mortality rate (Collins *et al*., 2006a, Picot *et al*., 2012, WHO, 2013). The WHO, thus, developed a treatment guideline for in-patient treatment of children diagnosed with SAM presenting with complications (WHO, 2013). The guideline is however based on low or very low quality evidence which is greatly due to the limited research available (WHO, 2013, Tickell and Denno, 2016). The WHO has also identified the admission- and transfer criteria as an area that requires significant evaluation to

improve clinical outcomes, especially in different age groups (WHO, 2013). There are important physiological differences between younger infants and older children which could justify separate considerations for the management of SAM in these age groups (WHO, 2013). In-hospital treatment practices, especially of Ghanaian children diagnosed with SAM, have also not been sufficiently investigated. Relatively little is known about the clinical outcomes and factors associated with the recovery rate of Ghanaian children treated as in-patients for SAM. Furthermore, recurring acute malnutrition precipitates the risk of irreversible stunting (Development Initiatives, 2018), and therefore accurate transfer criteria, as well as follow-up management, is imperative.

CHAPTER 3 METHODOLOGY

3.1 Study Design, Population and Setting

This study forms part of the SAMAC larger study. The SAMAC study is a multi-country, multi-hospital study based on a retrospective case-control study design with a quantitative, descriptive-comparative approach. To date, data has been collected in Ghana and Botswana, and data collection is still ongoing in South Africa. Dr Lombard, PI of the larger study, is currently obtaining ethical approval for data collection in Kenya and Malawi.

For the SAMAC study, the M.Sc. candidate assisted in obtaining ethical approval from hospitals surrounding Mpumalanga, South-Africa. As for this sub-study, the candidate planned the protocol which was submitted for this sub-study. The candidate did not participate in the data collection due to time and financial constraints, and therefore, secondary data collected in Ghana was used to address the aim and objective. The candidate did, however, assist in the development of the data extraction form, and in cleaning of the data captured into Microsoft Access. The candidate planned together with the main study leader the analysis that needed to be made. Dr Ricci performed the statistical analysis with inputs from the candidate. The candidate herself interpreted the results. Since the collection is still ongoing, this mini-dissertation only represents a subset of the SAMAC study data. It is envisaged that the complete SAMAC study will report on the different practices in the management of SAM in various Sub-Saharan Africa countries.

This chapter presents the methodology used in the SAMAC larger study protocol which is relevant to the sub-study. In short, three data collection sites were randomly selected in Ghana. After seeking the necessary ethical approval and obtaining permission, the data were retrospectively collected from the medical records (no human participants were enrolled in this study) of patients aged 24 – 59 months diagnosed with SAM.

A brief description of the study sites, inclusion and exclusion criteria, the data collection process, statistical analysis of data, and the ethical considerations are given below.

3.1.1 Study Site and Sampling Method

As per the SAMAC larger study protocol, all the hospitals in Ghana which treat patients for SAM were placed on a list (per region). A computer-generated system was used to randomly select the hospitals for inclusion. Once the selected hospitals were identified, the manager of each hospital was contacted to ensure that all ethics applications and permissions were in place

before the onset of the data extraction. This entailed the PIs of the study inviting the manager of each hospital to participate in the study via a letter requesting permission to collect data at their facility (Annexure 4). If it was not possible for the PI to personally invite the managers, the hospital managers were contacted via e-mail. Once permission was obtained from the hospital manager, hospital-specific ethics applications were obtained (Annexure 5, 6 and 7). If for any reason the hospital could not be included in the study, the next hospital on the random numbers table was contacted. This was done until the required number of hospitals was achieved. Subsequently, the relevant people (administrators and dietitians) were contacted for a meeting where the process and purpose of the study were explained.

The selected hospitals were (1) Komfo Anokye Teaching Hospital (KATH) situated in Kumasi in the Ashanti region, (2) Princess Marie Louise (PML) Children's Hospital in the Greater Accra region, and (3) Tamale Teaching Hospital (TTH) in Tamale in the Northern region of Ghana. **Figure 3-1** shows where the hospitals are situated in Ghana.

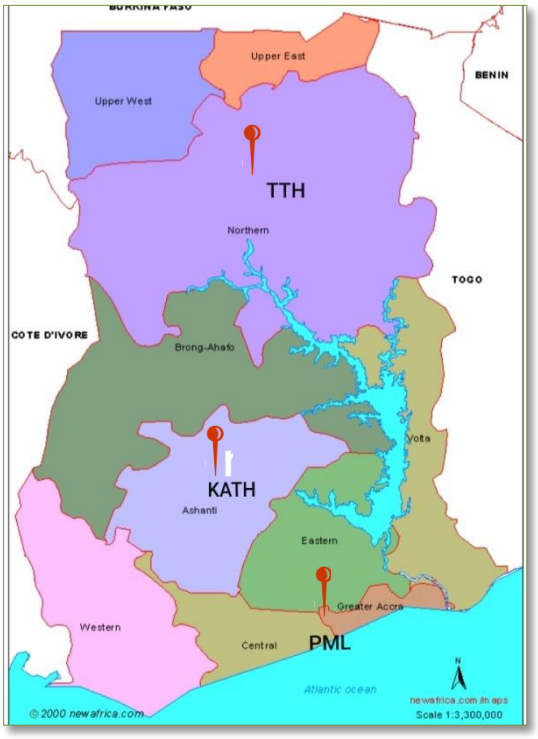


Figure 3-1: Map of Ghana presenting where the three hospitals are situated

Following is a short overview of the hospitals:

- KATH: KATH is the second largest hospital in Ghana and is a 1000-bed referral hospital. It provides postgraduate teaching to the West Africa College of Surgeons. KATH is well connected by road networks and receive referrals from parts of the Volta region, Brong-Ahafo, Central, Western, Eastern and the three Northern regions of Ghana. KATH also provides specialist services in child health, obstetrics and gynaecology, dentistry, oncology, surgery and medicine.
- PML: PML Children's Hospital has a 74-bed capacity and serves as a referral centre for other health facilities across Ghana. It is one of the few specialist children's hospitals in Western Africa. It is also the first hospital in Ghana to describe oedematous (kwashiorkor) and non-oedematous (marasmus) malnutrition (Williams, 1993), and is well-known for its in- and out-patient nutrition rehabilitation clinics. PML works in collaboration with UNICEF to combat the high level of child malnutrition in communities in Ghana.
- TTH: TTH is a referral hospital located in the city of Tamale in the Northern region of Ghana. It was commissioned in 1974 as a regional hospital and now a fully accredited tertiary level healthcare provider for all three northern regions of Ghana (Northern, Upper East and Upper West). This 380-bed capacity hospital provides specialist services in child health, surgery, trauma, internal medicine, anaesthesia and intensive care units, and gynaecology.

3.1.1.1 Inclusion and Exclusion Criteria of Study Sites

When compiling the list of hospitals from which the study sites were randomly selected, all hospitals treating infants and children (0 - 59 months) diagnosed with SAM were eligible for inclusion. The following hospitals, on the basis that they do not have paediatric services, were, however, excluded: orthopaedic hospitals, Tuberculosis (TB) hospitals, frail care centres, rehabilitation centres, psychiatric hospitals, oral and dental hospitals, reproductive health centre, midwife obstetrics units, wellness centres and hospitals that only treat adults.

3.1.2 Study Sample: Medical Records

As already mentioned, data for the larger SAMAC study was collected from medical records. For the larger study, data of infants and children (0 – 59 months) were collected; however, data of children aged 24 to 59 months were included for the purpose of the sub-study. Since the

updated WHO guideline for the in-patient treatment of SAM was published in 2013, only the records of patients admitted after 2013 were included.

A screening tool (Annexure 8) was used to assess medical records for inclusion according to the inclusion and exclusion criteria mentioned in section 3.1.2.1. The screening tool includes the file number, age, diagnosis of SAM, diagnosis of conditions related to SAM, the presence of other medical problems, and the date of admission.

3.1.2.1 Inclusion and Exclusion Criteria of Medical Records

Medical records of patients diagnosed with medical problems not related to SAM were excluded. Furthermore, the data of patients diagnosed with additional metabolic, neuro-developmental or other growth disorders were excluded since such disorders may alter their nutritional needs which would differ from patients diagnosed with SAM. The data collected includes both genders admitted for the treatment of SAM regardless of severity, the presence or absence of appetite and oedema and/or any other infectious diseases (such as recurring infections, malaria, dehydration, diarrhoea, HIV, TB, parasite infestations, cholera etc.) secondary to SAM. If the child was admitted for something other than SAM and SAM was identified during his/her hospital stay, the file was included.

3.1.3 Sample Size Calculation and Missing Data Handling

The sample size for the larger SAMAC study was defined by centre performing simulations considering the odd ration (OR) of death which is the primary outcome, ranging between 1.25 and 2.00 from a multivariate-adjusted model having at least 10 covariates and a rate of death ranging between 10% and 15%. Under these conditions 1000 medical records with a number of death cases ranging between 50 and 225 are sufficient to achieve a probability of type II error lower than 20% ($1-\beta \geq 0.80$) in case of statistically significant result of an OR greater than 1.5 (type I error lower than 5% or $\alpha < 0.05$). Dr Ricci at the NWU Faculty of Health Sciences is responsible for the above-mentioned power analysis.

However, the sample size calculation for the first annum in Ghana is based on at least 400 hospital records. This sample size is sufficient to detect consistent differences comparing continuous outcomes such as weight improvements at discharge or LOS, among groups of equal sizes (~100 hospital records). Specifically, given a type-I error of 5% ($\alpha = 0.05$) and two groups of equal sizes, medium mean differences (effect size index [$d_z = \Delta mean/S_{pooled}$] greater to 0.4) (Cohen, 1988) can be detected with a power greater than 80% ($\beta < 0.2$) (**Figure 3-2**). When considering dichotomous outcomes such as mortality, a number of observed outcomes

have been considered for a power calculation performed in a logistic regression setting. This number is sufficient to detect an 80% increased risk of the outcome using a logistic regression model adjusted for up to 5 covariates in a 1:4 matched case-control study as seen in Figure 3-3 (type II error rate < 10%, type-I error = 5%). After screening, 606 records were thus eligible for inclusion at age 0 - 59 months. Of this number, 135 medical records were that of children aged 24 – 59 months and were included for analysis to ensure that the objectives for this sub-study were achieved. All results were evaluated for post hoc statistical power before dissemination. Power analysis was performed using the power procedure of Statistical Analysis System (SAS) software version 9.4. Spearman's correlation and linear regression were used to determine the association between admission characteristics and clinical outcomes.

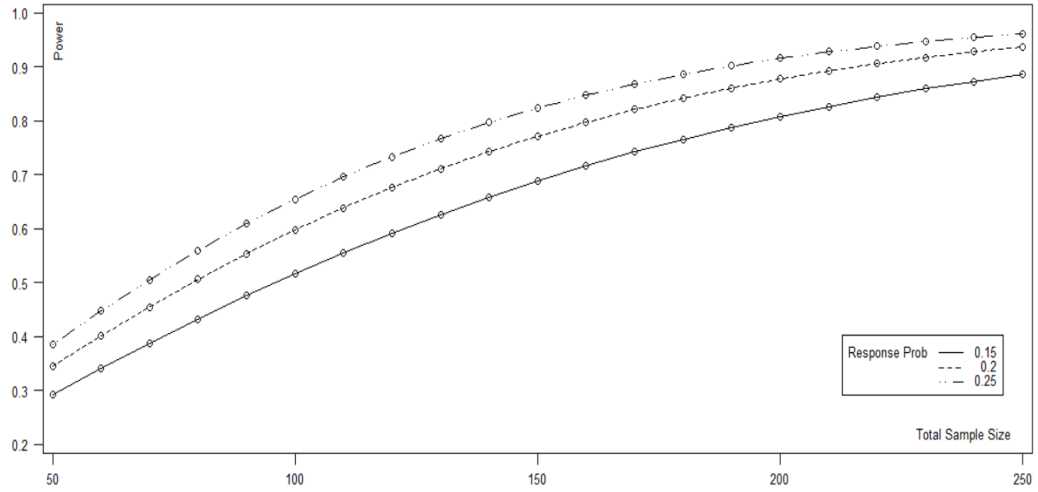


Figure 3-2: Multivariable logistic regression for covariates

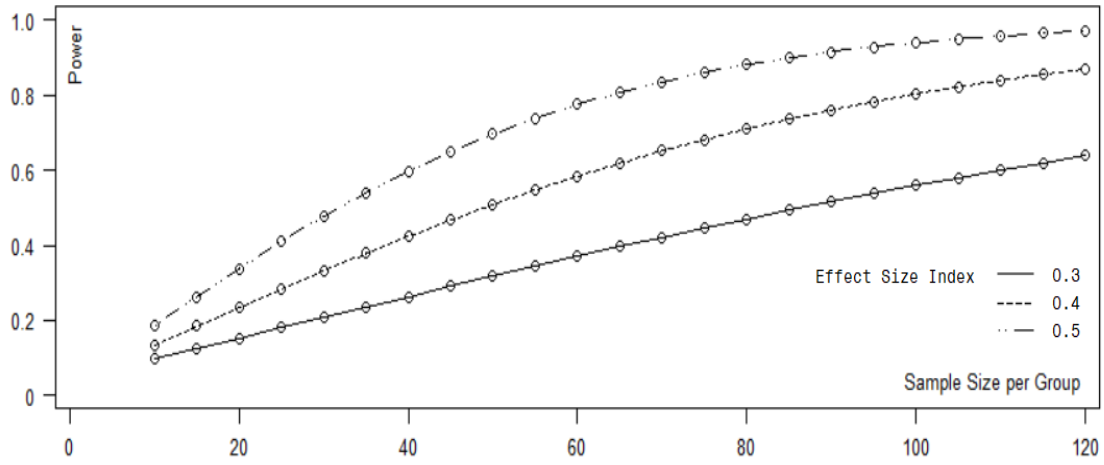


Figure 3-3: T-test evaluating significant differences between groups

3.2 Research Procedure and Data Collection

3.2.1 Data Collection

Since secondary data was used, all the data collection procedures used in this sub-study is the same as for the larger study. Three teams consisting of two people each extracted the data from medical records at the selected hospitals. Mrs Conradie, Dr Dolman and Dr Lombard provided detailed training in the completion of the data extraction form. To ensure quality control, at least 10% of all the data extraction forms collected during any given week was double-checked by another data collector. All decisions regarding inclusion of information from the medical record which were unclear to the fieldworker (such as handwriting illegibility) were discussed with the researcher, and a final decision was made by the researcher about the inclusion of the data.

Records were initially screened for inclusion according to the criteria specified in section 3.1.2.1 using the screening tool (Annexure 8). Once the record was identified as eligible, the data extraction register (Annexure 9) was filled in. The data extraction register includes information on the unique study data extraction form number, hospital, hospital medical record number and date of extraction. This was used to prevent duplication of medical records. Children who were readmitted for SAM were also included. Children who were readmitted at facilities other than PML, TTH and KATH would not be included in our analysis as we gathered data from these three hospitals.

Subsequently, data were extracted using the data extraction form (Annexure 10). This form was adapted from three WHO documents published in the admission criteria and treatment guideline of the WHO. The extraction form included basic demographic information such as country of residence, treatment hospital, gender and age, as well as admission and discharge criteria, anthropometric and clinical evaluations. The clinical signs and medical conditions occurring during admission were reported according to health care provider assessment. The clinical signs or diagnosis made on admission, including but not limited to the grade of oedema, irritability, the presence of appetite, emaciation, diarrhoea, severe pallor and slow capillary refill were, thus, defined according to the health care provider and not necessarily according to the definition of the WHO. With regards to the grading of oedema, the SAM treatment protocol in Ghana "*Interim National Guidelines for Community-based Management of Severe Acute Malnutrition in Ghana*" categorises oedema as follows: mild oedema (grade +) is diagnosed when it presents itself in both feet or ankles; moderate oedema (grade ++) presents in both feet plus the lower legs, hands or lower arms, and severe oedema (grade +++) presents as generalised bilateral pitting oedema in both feet, legs, arms and face (Ghana Health Services,

2010). Since the data was extracted from medical records, the techniques used and the accuracy of the anthropometric measurements could not be determined. Also, it is unsure how anaemia, a common diagnosis on admission, was determined. If TB and HIV were diagnosed on admission, this was reported to the health care provider by the child's caregiver. If the diagnosis was reported at discharge, this is indicative that the patient underwent diagnostic testing for these chronic infections which concluded the diagnosis. However, hypoglycaemia and hypothermia were diagnosed when the HGT was lower than 3.0mmol/L and axillary temperature lower than 35°C (Ghana Health Services, 2010). For the purpose of reporting on the data in this mini-dissertation (Chapters 3 to 6), the term 'discharge from in-patient treatment' is used to refer to dismissal from hospital – regardless of whether the child had been referred to CMAM or not. The number of patients referred to CMAM will be reported on separately.

The data collectors and researchers worked in a closed rooms or offices at the hospitals. None of the medical records was removed from these rooms and once the collection was completed, the records were refilled according to the hospital's procedures. The information was anonymously captured and not discussed outside the research team. No information, such as names, addresses, telephone numbers or names of health care practitioners, was captured. During periods when data were not extracted, the extraction register was kept in a locked office at NWU. Only fieldworkers and researchers have access to the data extraction forms, and only researchers and PIs have access to the captured electronic data

3.2.2 Quality Control

The data collectors completed the data extraction form by recording the required information from the medical records. Once the data extraction was completed (for each medical record) the researchers examined the data to ensure quality control. Data absent from the medical records was noted on the extraction form. As previously mentioned, data extractors double checked at least 10% of the medical records every week, and only research team members had access to the registers. During periods when data was not extracted, the data extraction register was kept in a locked office at NWU.

3.2.3 Data Analysis

The data was captured into Microsoft Access Software. After capturing, 10% of the data was double checked to ensure accuracy. The data was then exported into a SAS software package version 9.4 for analysis. This analysis was performed by Dr Ricci.

A non-parametric test (Kolmogorov-Smirnov) was performed on all variables to test for normality, and a histogram to test for outliers. Continuous variables are described using median and interquartile range, and categorical data using frequencies and percentages. Anthropometric data was converted into age- and gender-specific Z-scores using the igrowup_standard SAS macro derived from WHO anthropometry software version 3.2.2. (available at http://www.who.int/childgrowth/software/en/).

LOS was determined by calculating the difference between admission and discharge day. The age (in months) was determined by calculating the difference between the date of birth and admission date, while the average daily weight gain was calculated from the difference between median weight on admission and discharge and the average LOS. Data from the deceased patients was not taken into consideration when determining the LOS or weight gain.

Comparisons among the groups were performed using a linear model analysis adjusted for potential confounders. A multivariable-adjusted logistic regression was used to estimate the OR for clinical outcomes (death, LOS, weight gain, infection and appetite resolved). Sequential modelling was applied to take into account potential confounders. An adjusted model for age and gender was first considered, and thereafter more complex models adjusted for supplementary potential confounders (oedema) were considered. The level of significance is identified by a p-value of less than 0.05.

3.3 Research Expertise

The research team is fully trained to do this study. A summary of the training and experience of the research team is provided in **Table 3-1**.

3.4 Ethical Aspects

3.4.1 Legal Authorisation, Permissions, Goodwill Permissions and Insurance

Ethical approval (Annexure 1 and 2) was obtained from the HREC of NWU, South Africa, for the SAMAC larger study (NWU-00063-17-S1), as well as for this sub-study (NWU-00063-17-A1-02). Additional ethical approval was obtained from Ghana's Health Service Ethics Review Committee (Annexure 3). As previously stated permission letters were personally given by the

PIs to the management of the relevant hospitals. If the PIs could not personally deliver the letters due to time or budget constraints, the letters were emailed. Approval from the hospital was obtained before data capturing commenced (Annexure 5, 6 and 7). No insurance was required for this sub-study as there was no human handling/contact.

Table 3-1: Training and experience of the individual researchers

Team member	Training and experience
Dr Martani Lombard	Dr Lombard is a registered dietitian. She is currently teaching the SAM module in NUTT322 (Therapeutic paediatric nutrition). She also has extensive research experiences in terms of infants and children with chronic and acute malnutrition.
Dr Robin Claire Dolman	Dr Dolman is a registered dietitian and worked for nine years in the paediatric wards of a tertiary hospital in Gauteng, South Africa.
Mrs Cornelia Conradie	Mrs Conradie is a registered dietitian. She is currently teaching the introduction to the classification and treatment of SAM in the NUTC221 module. She has experience as a dietitian working in paediatric wards in South Africa.
Dr Cristian Ricci	Dr Ricci is currently employed as post-doctorate fellow at the Centre of Excellence for Nutrition at the North West University. He is a qualified biostatistician. He also has extensive research experience in the field of statistical methodology applied to nutritional epidemiology.
Data extractors	Two junior registered dietitians were appointed (with help from the rest of the SAMAC team) as data extractors who had in-hospital SAM treatment experience. These data extractors were trained together with the rest of the team (Dr Lombard, Dr Dolman, Mrs Conradie and Dr Ricci provided the training). A training manual together with a standard operating procedure was developed and provided to the whole research team.

3.4.2 Participants: Written Informed Consent

Since the data was collected from medical records only, informed consent was not required. However, the data was rendered anonymous by allocating data extraction numbers and by not recording the names, addresses or telephone numbers of patients or healthcare professionals. All the data was recorded in the hospital in a pre-allocated office to ensure that other individuals could not gain access to medical records and data.

3.4.3 Privacy and Confidentiality

The data collectors captured the data in private offices at the relevant hospitals. The research team did not discuss any of the information written in the medical records with any other person during the study or at any other stage. The paper data sheets are filed and kept in a locked cupboard in a locked office of the PIs at the NWU as previously mentioned. The data extraction sheets will be kept for seven years after completion of the study and then shredded. As mentioned previously, all the electronic information remains password protected and kept on a password protected computer at the NWU. A copy is kept on an external hard drive which is in the possession of the researchers. The data is also password protected on an external hard drive and the device is locked away in the PI office. Only the research team has access to data sheets and electronic data.

3.4.4 Benefits

Once the SAMAC larger study is concluded written reports will be sent to the individual hospitals as well as to the relevant ministries of health, to provide a situational analysis about the management of SAM in their institutes. This research will also provide Ghana with knowledge of what the current practises are within their referral hospitals. This information could help to shift the focus on their shortcomings and to guide them in adjustments and improvements in the implementation of the guideline. This research could, therefore, assist in the achievements of the SDGs, and especially improve the mortality rate of Ghanaian children admitted for SAM treatment.

It is anticipated that the findings of the SAMAC larger study will contribute to the knowledge base informing the WHO on best practice for the management of SAM in patients aged 0 – 59 months. The larger study will thus have an indirect benefit on the treatment protocols of all infants and children diagnosed with SAM, especially in terms of admission criteria, medical nutrition therapy and fluid management.

3.4.5 Anticipated Risks and Precautions

The data captured from medical records onto data extraction forms remain anonymous, private and confidential. This means that no risks are anticipated, and we can assume that the benefits outweigh the potential risks in the study.

CHAPTER 4 RESULTS

Chapter Three explains the methods used to obtain the results presented in Chapter Four. Thus, this chapter presents the results according to the aims and objectives of this sub-study. The aim of this sub-study is to determine the association of admission- and transfer criteria with the clinical outcomes in patients (24 to 59 months) treated for SAM in three referral hospitals in Ghana. To achieve this aim, the following objective was set: 1) to determine hospital clinical practices regarding admission- and transfer criteria (in terms of MUAC and WLZ/WHZ) for patients aged 24 – 59 months diagnosed with SAM, (2) to determine the clinical outcomes including but not limited to LOS, mortality, weight gain during treatment, and secondary infections, and (3) to determine the associations between admission- and transfer criteria with clinical outcomes in patients (24 – 59 months) treated for SAM. The objectives will be discussed as per hospital.

4.1 Description of Study Sample

The complete database for Ghanaian children diagnosed with SAM between 0 – 59 months consisted of 606 patients. To address the aim of this sub-study, the data of 135 patients between the ages of 24 – 59 months were extracted.

As seen in **Table 4-1**, 65% (n=88) of the patients were admitted at TTH, followed by KATH (20%; n=27) and PML (15%; n=20). The majority of the patients (70.4%; n=95) were between 24 – 35 months, followed by 19.2% (n=26) and 10.4% (n=14) in the age group of 36 – 47 months and 48 – 59 months, respectively. Males accounted for 52% (n=70) and females for 48% (n=65) of the study sample. At PML, males (n=16) were admitted four times more often than females (n=4). At KATH, females (n=18) were admitted twice more often than males (n=9).

Table 4-1: Sample size stratified according to gender and per hospital

	Total sample size (n=135)	KATH (n=27)	PML (n=20)	TTH (n=88)
Age (months)				
24 – 35	95	18	12	65
36 – 47	26	5	4	17
48-59	14	4	4	6
Gender				
Male	70	9	16	45
Female	65	18	4	43

n: number of participants
KATH: Komfo Anokye Teaching Hospital
PML: Princess Marie Louise
TTH: Tamale Teaching Hospital

4.2 Anthropometric Characteristics at Admission and Discharge from In-patient Treatment

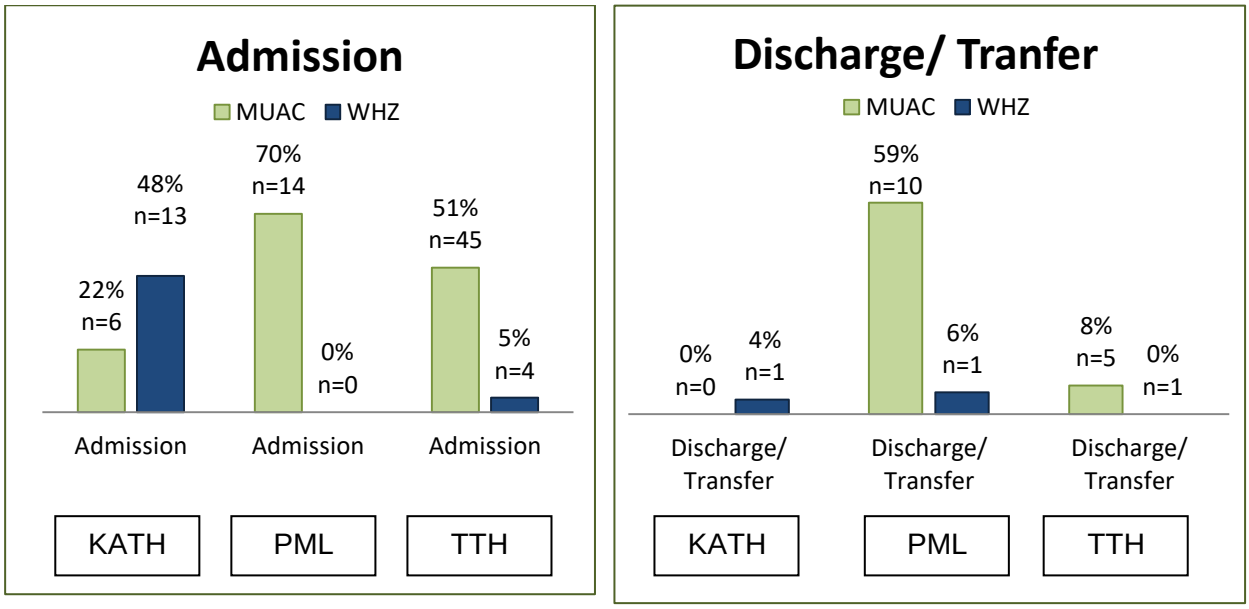
4.2.1 Indicators of Severe Acute Malnutrition

The percentage of reported anthropometric measurements differed per hospital. The percentage of MUAC and WHZ data reported per hospital are indicated in **Figure 4-1**. Considering the entire study sample (n = 135), 118 patients had an unreported WHZ, while 70 had an unreported MUAC measurement. The median MUAC on admission was 110mm (IQR: 103; 120), while the median WHZ was -4.14 (IQR: -5.73; -2.53). PML, in comparison with the other hospitals, most frequently reported on MUAC (70%; n=14) at admission, followed by TTH (51%; n=45) and KATH (22%; n=6). KATH reported on WHZ in 48% (n=13) of patients at admission. The WHZ was only reported in 4.5% (n=4) at TTH and none at PML.

At discharge from in-patient treatment, WHZ was reported in only one medical record (WHZ = -3.77), whereas MUAC was reported in 11% (n=15) of medical records (median = 113mm and IQR: 110; 123). Considering per hospital, no MUAC values were reported at KATH on discharge, while PML and TTH reported MUAC in 10 and five medical records, respectively. The median value for MUAC on discharge from in-patient treatment at PML and TTH was 112mm (IQR: 108; 115) and 125mm (IQR: 123; 129), respectively.

4.2.2 Weight

The anthropometrical data at admission per hospital is indicated in **Table 4-2** and discharge data in **Table 4-3**. Of the 135 patients, admission weight was reported for 133, while weight was reported for 99 patients at discharge from in-patient treatment. Weight was, therefore, the anthropometric measurement most commonly reported. The median weight at admission was 8.0kg (IQR: 6.9; 9.2) (**Table 4-2**) and at discharge from in-patient treatment 8.2kg (IQR: 7.3; 9.3) (**Table 4-3**). Patients admitted to PML presented with the highest median weight gain during admission (admission weight = 8.0kg and IQR: 7.0; 10.0; discharge weight = 8.4kg and IQR: 6.98; 10.3), whereas the median weight of patients admitted to KATH slightly decreased (admission weight = 8.6kg (IQR: 6.9; 10.0); discharge weight = 8.38kg (IQR: 7.5; 9.1)).



WHZ: weight for height Z-score
MUAC: Mid-upper arm circumference
KATH: Komfo Anokye Teaching Hospital
PML: Princess Marie Louise
TTH: Tamale Teaching Hospital

Figure 4-1: The percentage reported anthropometric data (MAUC and WHZ) on admission and discharge from in-patient treatment stratified per hospital

4.2.3 Height

The median height reported in 35 of the 135 patients at admission was 82cm (IQR: 79.0; 89.0), while only one height of 74.0cm was reported on discharge. On admission at KATH, height was reported in all (100%; n=27) the medical files, whereas TTH and PML reported height in 1% (n=8) and 0.5% (n=1) of the patients, respectively. This is indicative that the anthropometric practices differ from hospital to hospital.

4.2.4 Growth Standards

We identified the WAZ as the most commonly used growth standard in comparison to WHZ and WLZ. On admission, the WAZ was reported in 51 medical files (median = -4.54 and IQR: -5.13; -3.76). Considering each hospital, KATH reported WAZ in 14 records (median = -4.49 and IQR: -5.14; -3.76). PML reported WAZ in 15 medical records (median = -4.35 (IQR: -4.95; -3.77), while TTH reported on the WAZ in 22 of the patients on admission (median = -4.59 and IQR: -5.13; -3.36). HAZ is the second most commonly reported growth standard since 35 medical records reported HAZ on admission with a median of -2.33 (IQR: -3.69; -1.33).

Table 4-2: Anthropometric data on admission as per hospital

	Total (n=135)		**KATH (n=27)**		**PML (n=20)**		**TTH (n=88)**	
	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)
Weight (kg)	133	8.0 (6.9; 9.2)	27	8.6 (6.90; 10.0)	19	8.0 (7.0; 10.0)	87	8.0 (6.8; 9.0)
Height (cm)	35	82.0 (79.0; 89.0)	26	82.5 (79.0; 87.0)	1	87.0 -	8	82.0 (77.5; 92.25)
MUAC (mm)	65	110 (103; 120)	6	110 (90; 117)	14	110 (100; 119)	45	112 (105; 120)
WAZ	51	-4.54 (-5.13; -3.76)	14	-4.49 (-5.14; -3.76)	15	-4.35 (-4.95; -3.77)	22	-4.59 (-5.13; -3.36)
HAZ	35	-2.33 (-3.69; -1.33)	26	-2.30 (-3.33; -1.35)	1	-0.28 -	8	-3.43 (-4.25; -1.0)
WHZ	17	-4.14 (-5.73; -2.53)	13	-4.14 (-5.73; -3.45)	0	- -	4	-2.85 (-7.27; -1.17)

n: number of participants
KATH: Komfo Anokye Teaching Hospital
PML: Princess Marie Louise
TTH: Tamale Teaching Hospital
MUAC: Mid-upper arm circumference
WAZ: weight-for-age Z-score
HAZ: height-for-age Z-score
WHZ: weight for height Z-score
IQR: Interquartile range

On discharge from in-patient treatment, 41 medical files reported the WAZ (-4.07 and IQR: -4.92; -3.81) (**Table 4-3**). The median discharge WAZ at KATH, PML and TTH was -4.1 (IQR: -5.79; -3.77), -4.11 (IQR: -4.71; -3.57) and -4.04 (IQR: -4.64; -3.81), respectively. HAZ was only reported for one patient, admitted to PML, at discharge (HAZ = -5.16). It is important to note that although 17 patients were discharged from in-patient treatment (n=15) or transferred (n=2) from PML, the weight for 19 patients is available (**Table 4-3**). This is due to the fact that the weight of the patients who absconded (n=1) and patients that were discharged against medical advice (n=1) was reported in the medical records and subsequently was added to the statistical analysis.

Table 4-3: Anthropometric data on discharge as per hospital

	Total (n=110)		**KATH (n=24)**		**PML (n=19)**		**TTH (n=67)**	
	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)
Weight (kg)	99	8.2 (7.3; 9.3)	18	8.38 (7.5; 9.1)	19	8.4 (6.98; 10.30)	62	8.05 (7.3; 9.1)
Height (cm)	1	74.0 -	0	- -	1	74 -	-	- -
MUAC (mm)	15	113 (110; 123)	0	- -	10	112 (108; 115)	5	125 (123; 129)
WAZ	41	-4.07 (-4.92; -3.81)	8	-4.1 (-5.79; -3.77)	16	-4.11 (-4.71; -3.57)	17	-4.04 (-4.64; -3.81)
HAZ	1	-5.16 -	0	- -	1	-5.16 -	0	- -
WHZ	1	-3.77 -	0	- -	1	-3.77 -	0	- -

n: number of participants
KATH: Komfo Anokye Teaching Hospital
PML: Princess Marie Louise
TTH: Tamale Teaching Hospital
MUAC: Mid-upper arm circumference
WAZ: weight-for-age Z-score
HAZ: height-for-age Z-score
WHZ: weight for height Z-score
IQR: Interquartile range

4.3 Clinical Signs and Medical Complications of Study Sample at Admission

The clinical signs and medical complications of the study sample are indicated in **Figure 4-2** and **Figure 4-3** respectively. Of the 135 patients in this study group, 56% (n=75) were admitted with visible signs of emaciation, while 46% (n=62) presented with some degree of oedema. Thirty patients (22%) presented with severe oedema, 13 (10%) with moderate, 19 (14%) with mild and 53 (39%) with no oedema (**Figure 4-5**). Fifteen percent (n=20) of the medical records, however, did not report on whether oedema was present. As discussed in Chapter Three, mild oedema (grade +) is diagnosed when it presents itself in both feet or ankles; moderate oedema (grade ++) presents in both feet plus the lower legs, hands or lower arms, and severe oedema (grade +++) presents as generalised bilateral pitting in both feet, legs, arms and face (Ghana Health Services, 2010).

Respiratory infection occurred in about a fifth of the patients (21% n=29), followed by gastroenteritis (n=26) and urinary tract infection (n=9). Diarrhoea and vomiting were present on admission in 70 and 63 of the patients, respectively, while 41 patients were dehydrated. Of the 135 patients, nine had hypoglycaemia, six were in shock and another six presented with convulsions. Three patients were unconscious and one experienced hypothermia. Other clinical signs noted on admission included irritability (n=28), eye signs of vitamin A deficiency (n=5), dermatitis (n=42), severe pallor (n=25), and slow capillary refill (n=5) – the latter two being clinical signs of anaemia. On admission, 26 patients were diagnosed with anaemia (this includes a diagnosis of moderate anaemia, severe anaemia, anaemia due to malaria, and microcytic anaemia). It is important to note that these clinical signs and medical complications are recorded from the medical records, and are thus defined and diagnosed as per the medical practitioner's assessments.

Malaria was reported in a quarter (25%; n=34) of the patients, a positive HIV status in four percent (n=5) on admission, while none of the patients was reported to have TB (**Figure 4-2**). It is, however, important to note that the status of HIV and TB at admission was reported by the caregivers and not per positive medical tests. On discharge from in-patient treatment, a further 13% (n=18) of the patients were diagnosed to be HIV infected as per medical testing conducted during hospital stay. The HIV status of the majority of the patients (56%; n=76) remains unknown. Of the 62 patients that got tested for TB during their hospital stay, 11 tested positive

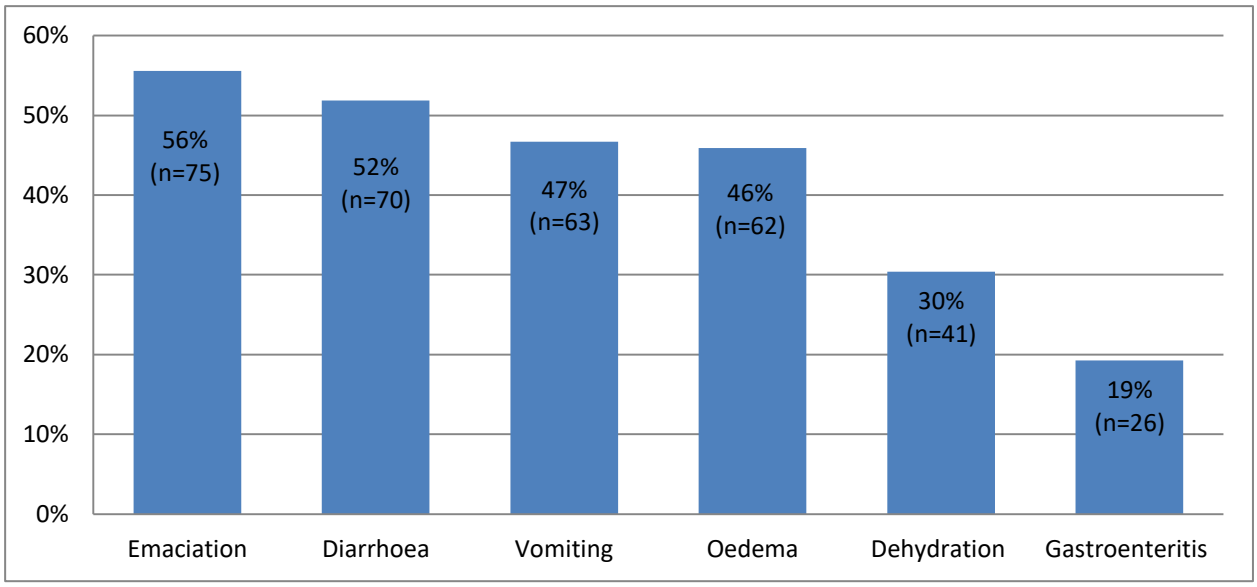


Figure 4-2: Clinical signs and symptoms as reported in patient files

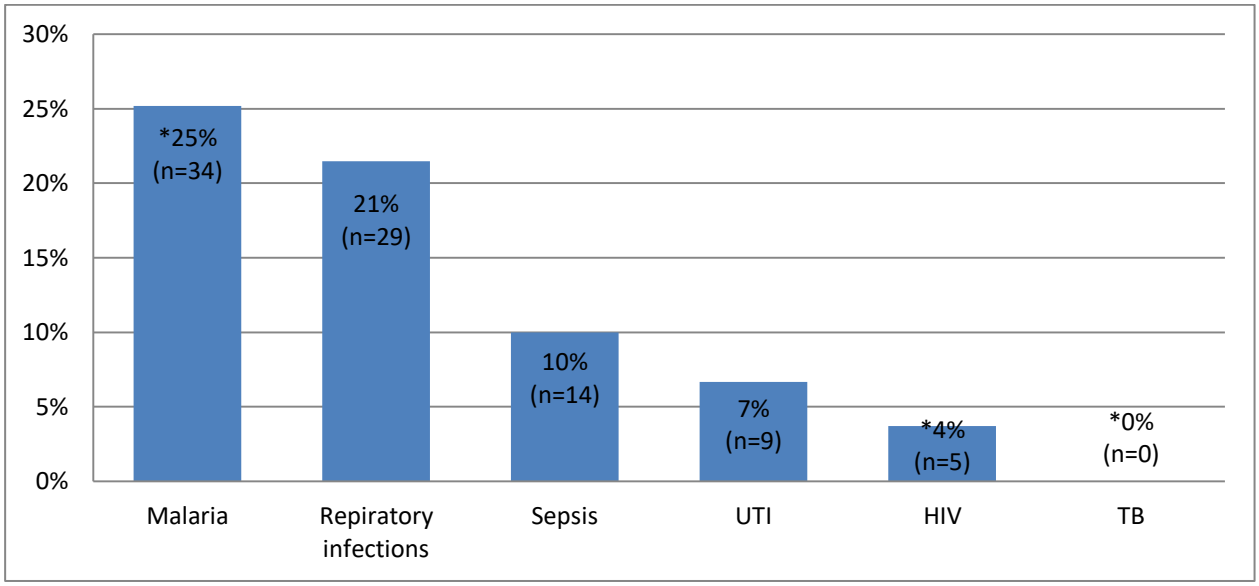


Figure 4-3: Medical complications in the study sample on admission as reported in patient files

HIV: human immunodeficiency virus
UTI: urinary tract infection
*As reported by caregivers on day of admission

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4.3.1.1 Clinical Signs and Medical Complications at Admission per Hospital

Of the 27 patients admitted at KATH, eight patients presented with diarrhoea and eight with vomiting. Severe pallor was observed in 12 patients, three presented with irritability, five were diagnosed with respiratory infections, and 10 patients were reported to have malaria. KATH presented with the highest percentage (67%; n=18) of patients admitted with emaciation, followed by PML (50%; n=9), and TTH (48%; n=48). Of the 88 patients admitted to TTH, 53 presented with diarrhoea and 18 with irritability, severe pallor was observed in 10 patients, 46 had a history of vomiting, 13 had respiratory infections, while malaria was reported in 22 of the patients. All the patients (n=5) experiencing eyes signs of vitamin A deficiency, and reported to have severe anaemia (n=9) were admitted at TTH. Patients admitted at PML (n=20), presented with diarrhoea (n=9), irritability (n=7), severe pallor (n=3), vomiting (n=9), respiratory infections (n=11), and malaria (n=2).

4.4 Outcomes of Severe Acute Malnutrition treatment in patients aged 24-59 months

4.4.1 Clinical Outcome

Whereas the majority (76%; n=103) of patients were discharged from in-patient treatment, a mortality rate of 19% (n=25) was observed in the study sample (**Table 4-4**). It was noted from the medical records that only 1% (n=2) of patients were referred for CMAM. Both these patients were admitted at PML. TTH had the highest mortality rate (24%; n=21), followed by KATH (11%; n=3) and PML (5%; n=1). TTH and PML both had one patient who absconded and one patient who was discharged against medical advice. At KATH there was only one patient who was discharged against medical advice while none absconded.

The results further reported as from section 4.3.2 will exclude that of deceased patients (n=25). Data is given for the 110 patients who left hospital (discharged from in-patient treatment, discharged against medical advice, and absconded).

Table 4-4: Outcomes stratified according to treatment and clinical outcomes as per hospital

Clinical Outcomes								
	Total (n=135)		KATH (n=27)		PML (n=20)		TTH (n=88)	
	n	%	n	%	n	%	n	%
Decease	25	19%	3	11%	1	5%	21	24%
D/C	103	76%	23	85%	15	75%	65	74%
DAMA	3	2%	1	4%	1	5%	1	1%
Absconded	2	1%	0	0%	1	5%	1	1%
Refer	2	1%	0	0%	2	10%	0	0%

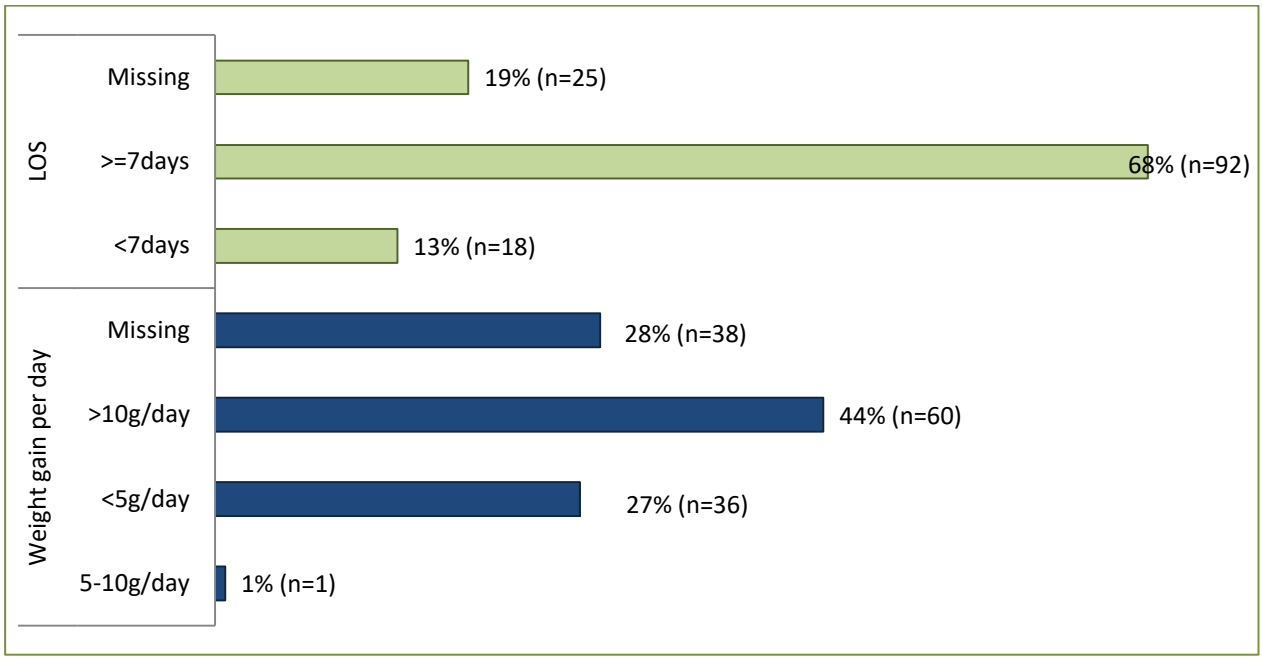
Clinical Outcomes								
	Total (n=110)		KATH (n=24)		PML (n=19)		TTH (n=67)	
	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)
LOS (days)	110	11 (8.0; 18.0)	24	12 (7.0; 18.5)	19	13 (8.0; 23.0)	67	10 (8.0; 17.0)
Weight gain per day (kg)	97	0.03 (-0.02; 0.08)	18	0.03 (-0.02; -0.06)	18	0.03 (-0.01; 0.09)	61	0.04 (-0.04; 0.08)

n: number of participants
KATH: Komfo Anokye Teaching Hospital
PML: Princess Marie Louise
TTH: Tamale Teaching Hospital
D/C: discharge from hospital
DAMA: discharge from hospital against medical advice
LOS: length of hospital stay
Kg: kilogram
IQR: Interquartile range

4.4.2 Length of Hospital Stay

LOS was determined by calculating the difference between admission and discharge day – this including patients who absconded. Data from the 25 deceased patients (indicated as “missing”

in **Figure 4-4**) was not taken into consideration when determining the LOS. The median LOS for the 110 patients who survived was 11 days (IQR: 8.0; 18.0) as seen in **Table 4-4**. Patients admitted to PML had a longer hospital stay: PML presented with a median LOS of 13 days (IQR: 8.0; 23.0), followed by KATH 12 days (IQR: 7.0; 18.5) and TTH 10 days (IQR: 8.0; 17.0). LOS was divided categorically into patients who had an equal to seven days or shorter hospital stay, and those who had a hospital stay of longer than seven days (**Figure 4-4**)**.** The majority of patients (n=92) had a LOS longer than seven days.



LOS: length of hospital stay

Figure 4-4: Frequency as per outcomes of LOS and weight gain per day

4.4.3 Weight Gain

The median daily weight gain was calculated for patients whose admission and discharge data were available (n=97). Other than the 25 patients who died and were therefore excluded for determining weight gain, a further 13 medical records did not report on either admission or discharge weight. During hospital stay, a median weight gain of 0.35kg (IQR: -0.4; 0.8) was observed in 97 patients, translating into a weight gain of 3g/day (IQR: -0.02; 0.08). At KATH, the median weight gain (n = 24) was 3g/day (IQR: -0.02; -0.06), 3g/day (IQR: -0.01; 0.09) at PML (n = 18) and 4g/day (IQR: -0.04; 0.08) at TTH (n = 61).

Weight gain per day was also divided categorically into a weight gain of less than 5g/day, between 5 and 10g/day and more than 10g/day. Less than half of the patients (44%; n=60) had a weight gain of more than 10g/day, one patient had a weight gain between 5 and 10g/day, and 36 had a weight gain of less than 5g/day.

4.4.4 Oedema as Outcome

As with admission, the grade of oedema reported at discharge is based on the health care practitioners' assessment. At discharge from in-patient treatment, the majority of patients (n=96) did not present with any oedema (**Figure 4-5**). Twenty-four percent (n=32) of the medical records did not report the grade of oedema at discharge, including that of the 25 deceased patients. KATH and TTH each discharged one patient with moderate oedema; TTH discharged a further four patients with mild oedema, and PML discharged one patient with severe oedema.

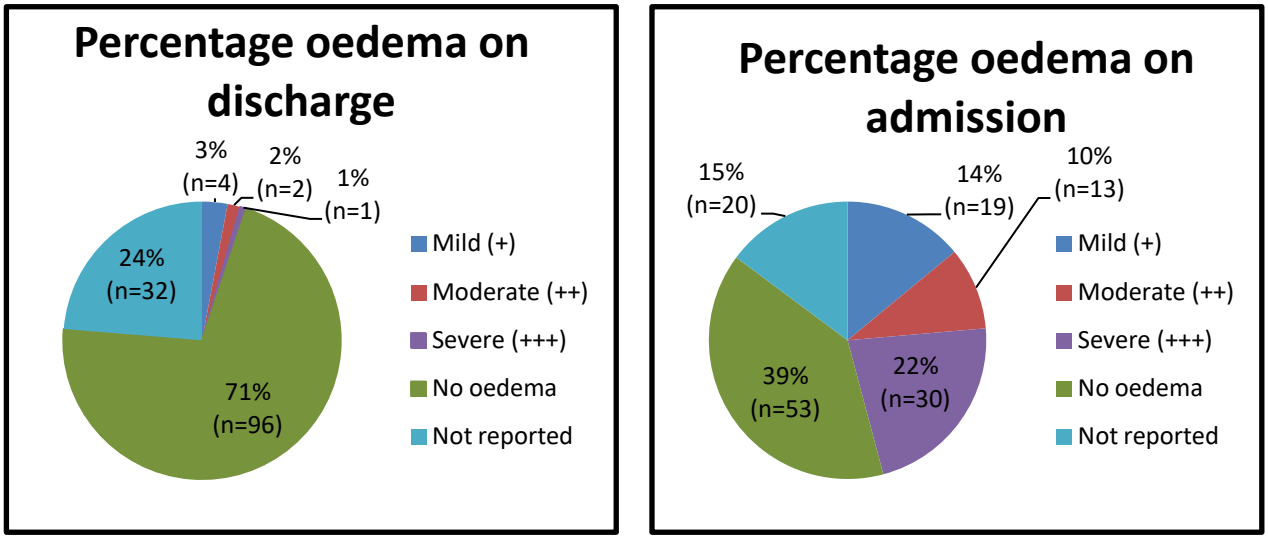


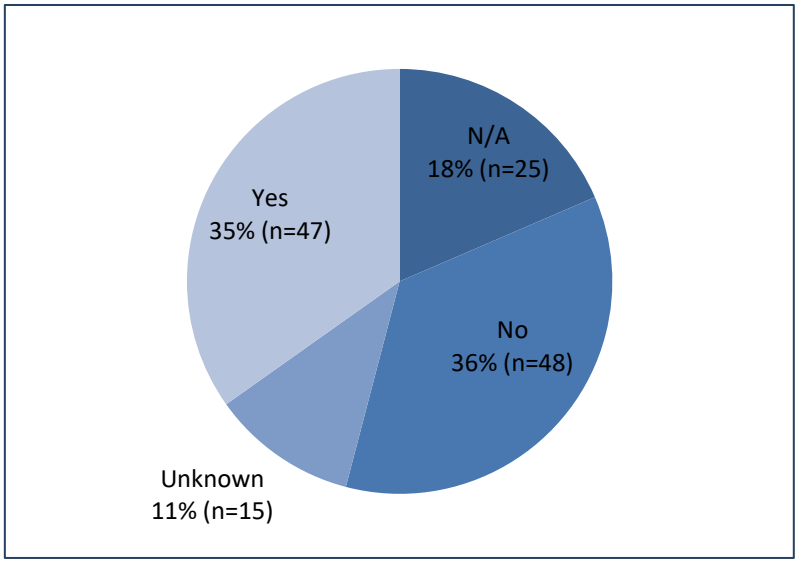
Figure 4-5: Number of patients presenting with clinical signs of oedema on admission and discharge

4.4.5 Appetite

Seven of the patients in our study sample presented with poor appetite on discharge from in-patient treatment, while 91 patients did have an appetite on the day of discharge. Of the seven patients presenting with poor appetite on discharge, three were discharged at PML and four at TTH. KATH did not discharge any patient from in-patient treatment without an appetite.

4.4.6 Infection Status

On discharge from in-patient treatment, secondary infections were resolved in 35% (n=47) of the patients. Thirty-six percent (n=48) of patients were however discharged with infections. Eleven percent (n=15) of the medical records did not report on this. It is important to note that chronic infections such as HIV (n=18) and TB (n=10), would not have been resolved during hospital stay which contributes to the number of patients discharged with infections. For the 25 deceased patients, this outcome was not applicable (**Figure 4-6).**



N/A- not applicable

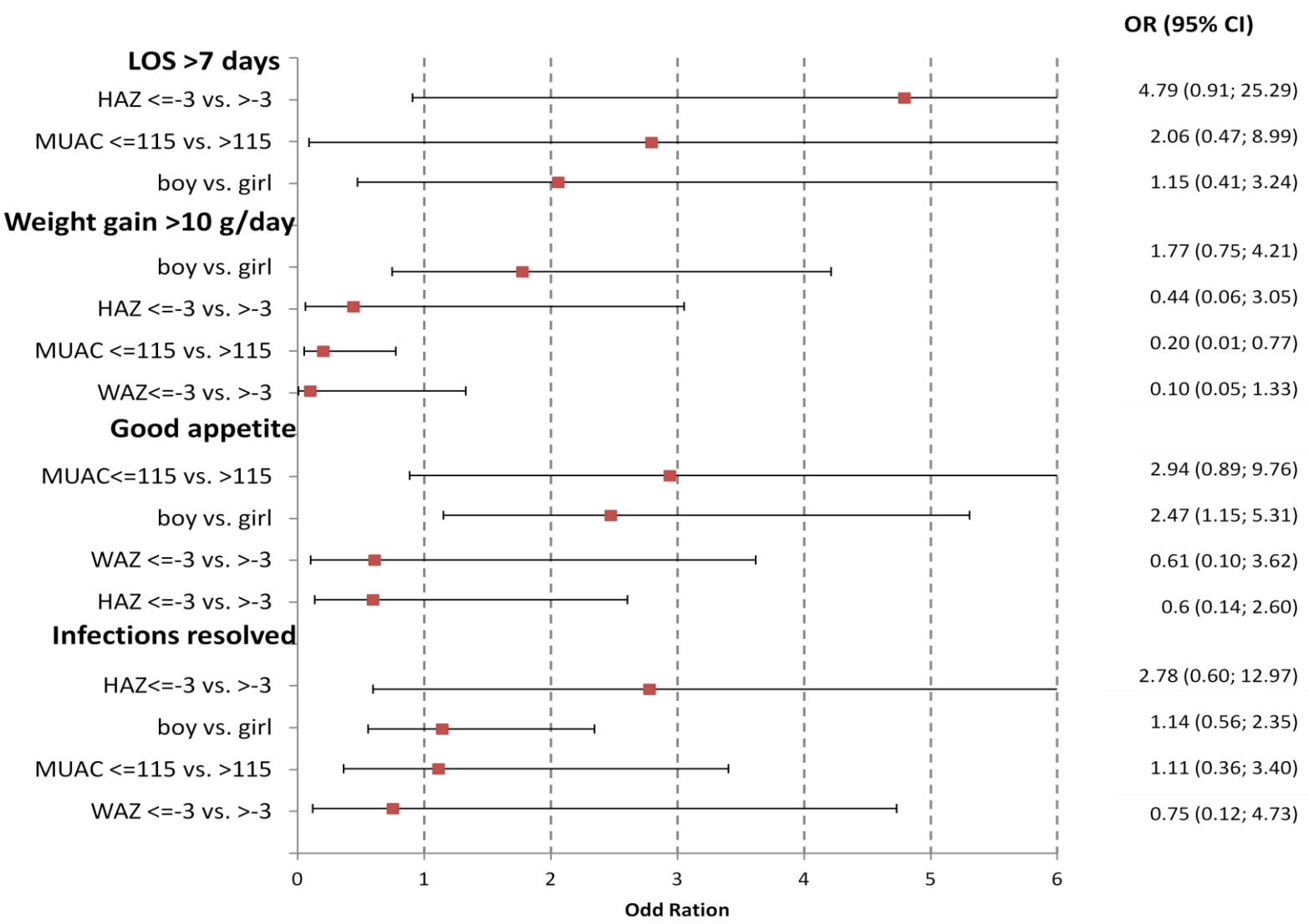
Figure 4-6: Secondary infections resolved as at discharge from in-patient treatment

4.5 The Association between Anthropometrical Measurements at Admission and Discharge Criteria and Clinical Outcomes

Comparisons among groups were determined using linear regression to estimate OR. Sequential modelling was applied and adjusted for age, gender and oedema. The OR with 95% confidence interval (CI) of the associations investigated is indicated in the forest plot in **Figure 4-7**. No association were found between anthropometric characteristics on admission and clinical outcomes (this including LOS, mortality, weight gain during admission, good appetite, and whether infections were resolved) as the CI crosses the value 1 in all, expect one, OR reported. Furthermore, the p-value for each OR was also > 0.05, which indicated non-significance. This is probably due to the great number of anthropometric data which was not reported on admission, as discussed previously. A borderline significance was, however, found

between patients with an admission MUAC of less than 115mm and weight gain of more than 10g/day (OR 0.20; 95%CI 0.01 – 0.77; p< 0.0526).

As discussed in the methodology, readmissions were included in the study population of the SAMAC larger study. If the patient was readmitted to another facility this would not be in our analysis as we only gathered data from three hospitals. No association could be made between discharge characteristics and clinical outcomes since there were no readmissions within our study group.



OR: Odd ration
CI: confidence interval
WAZ: weight-for-age Z-score
HAZ: height-for-age Z-score
MUAC: mid-upper arm circumference

Figure 4-7: Associations of admission anthropometric characteristics and gender with clinical outcomes

CHAPTER 5 DISCUSSION

We analysed the data of 135 Ghanaian patients between the ages of 24 and 59 months admitted for the treatment of SAM in three tertiary hospitals. Data of patients admitted from the year 2013 was collected to evaluate whether the updated WHO diagnostic and discharge criteria for the in-patient treatment of SAM (WHO, 2013) are being used. To the author's knowledge, this is one of the earliest studies of its kind which aims to determine the association of admission- and transfer criteria with the clinical outcomes in older patients (>23 months).

5.1 Gender and Age of Study Sample

Males accounted for 52% and females 48% of the study sample. Our results are concurrent with other studies which reported males to represent between 48 - 54% of their study sample (Aguayo *et al*., 2015, Saaka *et al*., 2015, Walana *et al*., 2016). Khara (2016) concluded that the probability of wasting decreases with an increase in a child's age. Growth faltering often occurs during the time of transitioning from exclusive breastfeeding to the introduction of solids, as breastmilk alone is insufficient to meet nutritional requirements after the age of six months (WHO, 2003). Patients between the ages of 6 - 23 months have been identified as more susceptible to malnutrition if sufficient energy, protein, essential fatty acids and micronutrients are not introduced timeously (Black *et al*., 2008, Arabi *et al*., 2012, Walana *et al*., 2016). Recent studies also report SAM to mainly occur in children younger than the age of 23 months (Dale *et al*., 2013, Aguayo *et al*., 2015, Tette *et al*., 2015, Walana *et al*., 2016, Akparibo *et al*., 2017).

The current WHO in-patient treatment guideline for SAM recommend using one MUAC cut-off point (<115mm) for identifying SAM in children between the age of 0 and 59 months (WHO, 2013). Since MUAC has a linear increase with age, it is, therefore, more likely to diagnose younger children (Hossain *et al*., 2017b). Consequently, it is possible that a proportion of children above 23 months might be undetected by using MUAC as a criterion for SAM (Aguayo *et al*., 2015, Hossain *et al*., 2017b).

5.2 Characteristics at Admission and Discharge

5.2.1 Anthropometrical Characteristics on Admission

Our first objective was to determine hospital clinical practices regarding admission- and transfer criteria (in terms of MUAC and WHZ score) for patients aged 24 – 59 months diagnosed with SAM. Although the WHO guideline provides diagnostic and discharge criteria, knowledge regarding the implementation of protocols and practices in hospitals remains limited. According to Tickell and Denno (2016), focussing on the implementation of the guideline could improve outcomes for patients treated from SAM. Further, by diagnosing SAM correctly, over 400 000 deaths can be prevented (Black *et al*., 2013). In this study sample, 17 (12.5%) medical records reported the WHZ, while 65 (48%) records reported MUAC on admission. This is concurrent with Akparibo *et al.* (2017) who identified a great number of unreported data for the identification of SAM, and that MUAC remains the measurement most commonly used for the diagnosis of SAM. MUAC, a simple technique for the measurement of muscle stores, is cost-effective and is, therefore, more frequently used than WHZ (WHO, 2007). Visible signs of emaciation were present in 56% of patients. Our data, thus, indicates a greater number of patients admitted on visible signs of emaciation, rather than on anthropometric indices of wasting (WHZ <-3 SD or MUAC <115mm). This study, therefore, identified the practice regarding the criterion used for admission is not occurring as per WHO protocol (WHO, 2013).

The median value of the MUAC on admission is 110mm (IQR: 103.0; 120.0), which is particularly low seeing as the MUAC of a healthy child at five years of age is 174mm and 175mm for girls and boys, respectively (Hossain *et al*., 2017b). Similarly, low WHZ (median = -4.14 and IQR: -5.37; -2.53) and WAZ (median = -4.54 and IQR: -5.13; -3.76) were recorded on admission. More patients also presented with severe oedema (n=30) than with moderate (n=19) or mild (n=13) oedema. Therefore, our study emphasises the severity of malnutrition in children admitted for SAM in the age group 24 – 59. This data suggests that there are still improvements to be made regarding the early identification of children at risk before they develop complications such as oedema.

WAZ is the most commonly used growth standard amongst the three growth standards; 38% (n=51), 26% (n=35) and 12.5% (n=17) of the WAZ, HAZ and WHZ was reported at admission, respectively. This could be due to the easy measurements which are required to plot the WAZ. On the other hand, the equipment, time and skills to measure height are limited and therefore HAZ and WHZ are not always plotted by health care professionals. Similar findings, with regards to missing anthropometric data, were reported in Uganda (Akugizibwe *et al*., 2013). This can be due to the increased workload at health care facilities and/or the shortage of staff.

The poor compliance could also be due to staff attitude; however, it is beyond the scope of this study. Explaining the poor compliance with the WHO guideline is a research question of the larger SAMAC study and will, therefore, be reported by another team member.

The median HAZ on admission is reported to be below the -2 SD, thus indicating stunting in our study sample. However, of the 135 medical records included for statistical analysis, only 35 of the reported on HAZ at admission. Nevertheless, patients who are wasted have a higher risk of becoming stunted, since the body can only have linear growth while energy reserves are available (Saaka and Galaa, 2016, Khara, 2016). Stunting, yet again, increases the risk of wasting (Dasgupta *et al*., 2015, Development Initiatives, 2018, UNIGME, 2018). Wasting and stunting are both associated with an increase in mortality, especially when both occur in a child (UNIGME, 2018). There are, as of yet, no clear mechanisms which explain wasting as the cause of stunting (Saaka and Galaa, 2016). The reoccurrence of acute malnutrition has been reported to be as high as 27.5% at 9 months after discharge from patient treatment care, consequently precipitating the risk of stunting (O'Sullivan *et al*., 2018). However, in our study sample, no readmissions occurred. This does not exclude the possibility of the participant being treated at another hospital or facility.

5.2.2 Anthropometrical Characteristics on Discharge from In-Patient Treatment

As mentioned, a great number of anthropometric data was not reported on admission. This was also the case at discharge from in-patient treatment. With this said, the transfer from in-patient to CMAM is not recommended to be based on anthropometric assessments, but rather clinical improvement (WHO, 2013). The WHO, therefore, does not require the anthropometric measurements to be taken on discharge from in-patient treatment (or otherwise known as transfer). However, noting the anthropometry measurement on discharge from in-patient treatment could aid in the monitoring of the patient when he/she is followed-up as an out-patient. In Ghana, if a patient is transferred from in-patient to community-based management, they receive a treatment card to take with them to their follow-up. Since they will be followed up within the community, and not at the same facility, the treatment card has all relevant information (such as their anthropometry) to monitor their progress (Ghana Health Services, 2010). It is possible that health care providers report the transfer information (including the anthropometry on discharge from in-patient treatment) on the treatment card and not in the medical record. This can explain the limited data which is available in medical records on discharge.

During follow-up a health care practitioner can discharge a patient from the entire treatment programme (in-patient and community-based management) when he/she has been without

oedema for at least two weeks, or the WLZ/WHZ is above -2 SD, or when the MUAC is above 125mm (WHO, 2013). However, it is critical that the same anthropometric indicator used to confirm SAM, is used to discharge a patient from the treatment programme. As only in-patient treatment practices are studied by the SAMAC larger study, data on whether the patient was discharged from the entire programme was not obtained by the data extraction form.

5.2.2.1 Clinical Signs and Medical Complications

Forty-six percent of patients presented with oedema on admission - more patients presented with severe oedema (n=30) than with moderate (n=19) or mild oedema (n=13). This further emphasises the severity of SAM in our study sample. Other studies found that patients admitted for SAM presented with a much lower rate of oedema (1 - 32%) than our study sample (Mogeni *et al*., 2011, Saaka *et al*., 2015, Tette *et al*., 2015, Frison *et al*., 2015). Saaka *et al*. (2015) found that oedema was more commonly associated with children older than 24 months ($p<0.001$). Thus, the high number of patients presenting with oedema can be a result of our study sample's age. With this said, more studies will be required to establish an association. Genetics could also have an influence on why some patients present with oedema while others present with wasting (Sheppard *et al*., 2017). However, research regarding genetic differences in SAM patients is very scant.

The supplementation of vitamin A in children can decrease mortality rates up to 23% (USAID, 2009). Vitamin A supplementation is the highest in the central region of Ghana, where PML is situated in comparison to other regions of Ghana (Ghana Statistical Service, 2015). Therefore, it is possible that the higher supplementation of vitamin A within the central region could contribute to a lower mortality rate as observed in our study sample at PML. Tette *et al.* (2015) concluded that vitamin A supplementation has no relation to anthropometric measurements. Nevertheless, all 5 of the patients presenting with eye signs of vitamin A deficiency were admitted at TTH. TTH is situated in the northern region where vitamin A supplementation is the lowest (Ghana Health Services, 2010).

Anaemia, which is seen as a clinical outcome, is another commonly encountered complication among children with SAM (WHO, 2013). Anaemia often occurs due to bacteraemia, micronutrient deficiency as a result of sub-optimal intake, hookworm infection, HIV infection and frequent periods of malaria (Bailey *et al.*, 2015). On admission, 26 patients were diagnosed with anaemia which included moderate anaemia, severe anaemia, anaemia secondary to malaria, and microcytic anaemia. Furthermore, clinical signs indicative of anaemia were also noted: 25 patients presented with severe pallor and five patients had a slow capillary refill.

However, the data are as recorded from the medical records, and are thus defined and diagnosed as per the medical practitioner's assessment. Iron deficiency is the most prevalent anaemia amongst Ghanaian children (Ghana Statistical Service, 2015). Reports have shown that between 80 - 95% of malnourished patients present with severe anaemia of which iron deficiency anaemia are the most prevalent (Masoga, 2018). Iron deficiency anaemia is most accurately diagnosed by a low serum of ferritin (WHO, 2011), and it is, therefore, probable that should the results for serum ferritin levels be available, the number of patients with anaemia in our study sample would be greater.

Acute infections are likely to induce or worsen malnutrition as it increases catabolism and malabsorption (Rodríguez *et al*., 2011, WHO, 2014). Also, chronic infections such as HIV and TB have a detrimental long-term affected on the nutrition status of children (Black *et al*., 2013). Infectious diseases further decrease appetite and subsequently, food intake will also decrease (Rodríguez *et al*., 2011). This is a vicious cycle as undernutrition, yet again, increase the risk for infectious disease due to a decreased immunity and resistance to other infections (Black *et al.*, 2013). It is estimated that about half the deaths of children under the age of five are caused by infectious diseases, especially in Sub-Saharan Africa, including respiratory infections (16%), diarrhoea (8%), sepsis (7%) and malaria (5%) (UNIGME, 2018). In this study, infectious diseases are also a factor which contributes to the exacerbation of malnutrition as diarrhoea, malaria, respiratory infections and sepsis were present in 52%, 25%, 21% and 10%, respectively. Another study done in Uganda found the prevalence of diarrhoea at admission to be higher (52%) in comparison to our results (Grenov et al., 2019). HIV, which is a chronic infection, is between three and 10 times less present in our study population in comparison to other studies including SAM patients (Fergusson and Tomkins, 2009, Amadi *et al.*, 2016).

5.3 Outcomes of Patients Treated as In-Patients for Severe Acute Malnutrition

5.3.1 Clinical Outcomes

The second objective of this sub-study was to determine the clinical outcomes of children managed as in-patients for SAM. Almost 19% of patients died (n=25), while more than 75% of patients were discharged from in-patient treatment (n=103). This is in contrast to other studies conducted in Ghana, as they found the discharge rate from in-patient treatment to be higher (Saaka *et al*., 2015, Walana *et al*., 2016). Saaka *et al*. (2015) conducted a retrospective chart review of 603 paediatric patients between 0 and 11 years of age admitted for SAM; 84.8% were discharged from in-patient treatment. Walana *et al*. (2016) also conducted a retrospective study

of 969 patients admitted for SAM between the ages of 0 - 59 months and their results indicated an 82.3% discharge rate from in-patient treatment. Although the two latter studies were also conducted in Ghana, the difference in age group and smaller study sample could contribute to the difference in discharge rate. Also, the severity of SAM in our age group, which was referred to earlier, could contribute to the lower discharge rate which was observed.

The WHO uses the term 'transfer' to describe when a child is discharged from in-patient treatment (CMAM), while 'discharge' refers to a child who exits the entire (both the in-patient and community-based) treatment programmes. The minority (n=2) of patients were referred for further treatment in CMAM. This is in unlike other studies conducted in Ghana which found the transfer rate to be between 58.6% and 65.2% (Saaka *et al*., 2015, Walana *et al*., 2016). Therefore, the accuracy of the number of patients who were transferred in this study is disreputable. Further, this question was not clearly phrased on the data extraction form (Addendum 7). The question is stated in the extraction form as follows: was the patient referred to an out-patient clinic. The extraction form did not query whether a child was transferred to CMAM or discharged from the programmes. Also, due to the referral system of Ghana, as previously mentioned, the health care provider might have written this information on the treatment card rather than in the medical record. We thus suggest, being that the SAMAC larger study is a multi-country, multi-hospital study which still ongoing and that the data extraction form is rephrased to determine a more accurate number of patients who are referred to CMAM.

According to UNICEF (2013a) patients who reside in The Greater Arcca region (where PML is situated) is less at risk for mortality. This is mainly due to The Greater Arcca region having a greater income, more females completing secondary education and improved sanitation practises (Ghana Statistical Service, 2015). The northern region (where TTH is situated) is more rural - sanitation practices are poor and income is less (Ghana Statistical Service, 2015). Since patients living in more rural regions with lower income have a greater risk for malnutrition (Akombi *et al*., 2017, Ricci *et al*., 2018), it can explain why there are more admissions of SAM at TTH in comparison to PML and KATH. TTH also presented with an IQR indicative of more severe wasting (median WHZ = -2.85 and IQR: -7.27; -1.17) on admission. Furthermore, all patients diagnosed with anaemia of a severe form (n=9) were admitted to TTH, while none was identified at KATH or PML. Hence, it is suggested that Ghana focus on improving the malnutrition factors in the Northern region.

5.3.2 Secondary infections

On discharge from in-patient treatment, secondary infections were resolved in 35% of patients (**Figure 4-6),** while 36% were discharged with an infection. In the rest of the patients, this was not reported or they died or absconded. It is important to note that this question was extracted from the medical record as follows: if a child had to continue with antibiotics after discharge (received antibiotics to take home) it indicated that the infection had not yet been resolved, and *vice versa*. It is furthermore important to note that chronic infections, such as HIV (n=18) and TB (n=10), would not have resolved during hospital stay and this contributes to the number of patients discharged with an infection. On discharge of in-patient treatment, chronic infections were thus present in 28 patients and a total of 48 children remained infected with an infection on discharge from in-patient treatment.

5.3.3 Weight Gain and Length of Hospital Stay

As previously stated, 46% of patients were admitted with oedema. Patients who are oedematous will experience water retention, consequently, the water-weight will increase their absolute weight (Frison *et al*., 2015). It is therefore expected that during in-patient treatment patients with nutritional oedema will firstly lose weight (that is the water-weight) and that weight gain will only occur once oedema subsided.

During the rehabilitation phase, which occurs around day seven of admission (**Figure 2-4**), a rapid weight gain of 10g/kg/day is expected (Cloete, 2015). In Ghana, though, patients do not remain treated as in-patients until full recovery as they are transferred into CMAM during the rehabilitation phase (Ghana Health Services, 2010). This is concurrent with our data as the median LOS in our study population is 11 days (IQR: 8.0; 18.0). Hence, discharge soon after entering the rehabilitation phase, as well as the majority of our study sample presenting with oedema on admission contributes to the poor weight gain (3g/day (IQR: -0.02; 0.08)) that occurred.

PML had a longer LOS and presented with an almost 4-fold decrease in mortality compared to the mortality rate of the total study sample. PML was also most compliant with recording the MUAC measurement on admission **(Figure 4-2)**.

5.4 Associations of admission and transfer criteria with clinical outcomes

No association was found between the anthropometric measurements on admission and the clinical outcomes. This is mainly due to the large proportion of unreported anthropometric measurement with admission. However, a borderline significance ($p < 0.0526$) was found between the patients with an admission MUAC of less than 115mm and weight gain of more than 10g/day during admission. This is concurrent with other studies which also found that more severely malnourished patients with a lower MUAC had a higher percentage weight gain (Goossens *et al*., 2012, Dale *et al*., 2013). Goossens *et al.* (2012) conducted a study in Burkina Faso, analysing 24 792 anthropometric measurements of malnourished patients and their outcomes. They concluded that patients with a MUAC between 111 - 115mm had a higher percentage weight gain, while patients with a MUAC lower than 100mm had the poorest outcomes. Dale *at al*. (2013) concluded that patients in CMAM with a MUAC lower than 115mm had an increase weight gain in comparison to those with a MUAC >116mm. Therefore, the more malnourished patients would have a longer rehabilitation phase subsequently gaining more weight as expected in this phase.

As discussed in the methodology, readmissions were included in the study population as part of the SAMAC larger study. No readmissions though occurred within our study sample. Therefore, no association could be evaluated between the discharge criteria and the outcomes as both were measured at the same time.

5.5 Strengths and Limitations

This study is based on previously recorded information from medical records. The accuracy of the evaluation of treatment practices is dependent on the accuracy of documentation in the patient file. As, the treatment practises may differ from the patient file, this is seen as a limitation. .

This study included medical records from the year 2013, after the updated WHO guideline ('*Updates on the Management of Severe Acute Malnutrition in Infants and Children*') was published. Hence, we analysed the implementation of the currently recommended guideline. Also, an important strength of this study is that data was mostly captured and cross-checked by registered dietitians which limits but not exclude the possibility for mistakes.

Using a data extraction form is both a strength and a limitation for this study. An extraction form can be interpreted differently by data extractors. Therefore, our SAMAC team developed a standard operations procedure (SOP) for the extraction of data. All data extractors received training on the SOP. Nevertheless, there is no guarantee that the SOP will guide all the scenarios that might occur.

This study, however, has limitations including the data extraction form being unclear on whether a patient was transferred for CMAM or discharged from the treatment programmes. The transfer/discharge criteria could not be associated with the outcomes seeing as no re-admissions occurred. Further, the great number of unreported anthropometric data could be a potential source of bias. The clinical signs and medical complications that were recorded are defined and diagnosed as per the medical practitioner's assessments. Thus, there was no control over the quality and consistency of clinical and medical diagnosis made at admission and discharge.

The limited number of medical records (n=135) reporting SAM in children >23 months is another limitation is our study. Although this is a small study group only representing Ghana, the larger SAMAC study is a multi-country study which will include a great number of patients treated for SAM. Together with the limited access to the discharge documentation limits this study as it cannot describe the last objective.

CHAPTER 6 CONCLUSION

The aim of this sub-study is to determine the association of admission- and transfer criteria with the clinical outcomes as per hospital in children (24 to 59 months) treated for SAM in three referral hospitals in Ghana. The main findings of this study, according to the objectives are as follows:

- To determine hospital clinical practices regarding admission- and transfer criteria (in terms of MUAC and WLZ/WHZ score) for children aged 24 – 59 months diagnosed with SAM:

Although there are a great number of anthropometric measurements unreported, MUAC is more frequently used than WHZ to diagnose SAM. Visible signs of emaciation are still being used as diagnostic criteria for SAM. This study, therefore, identified that the practice for admitting a SAM patient is not occurring as per WHO protocol. According to Tickell and Denno (2016), focussing on implementing the WHO SAM treatment guideline could improve outcomes for patients suffering from SAM. Therefore we recommended that Ghana shift the focus towards improving the implementation for a better outcome of in-patient treatment. This can be done by training of healthcare practitioners and raising awareness of the guidelines available.

Using one MUAC cut-off value for the entire age group of 0 - 59 months may further contribute to the severity of SAM in older children (>23 months). The WHO also urges for further research to refine the MUAC cut-off values to identify SAM in children aged 24 - 59 (WHO, 2013). Thus, we recommend further investigating suitable cut-off values for different age groups to improve the diagnostic criteria in children older than 24 months. It is envisaged, that the larger SAMAC study will report more reliable cut-off values in different age groups to admit and transfer SAM.

The high percentage of patients presenting with oedema, as well as the low values of MUAC, WHZ and WAZ recorded on admission, is indicative of the severity of Ghanaian patients admitted for SAM. The minority of patients were referred to CMAM which increase the risk for the reoccurrence of SAM, subsequently leading to stunting. Therefore, Ghana must place emphasis on CMAM for (1) early identification before complications develop and (2) follow-up after discharge from in-patient care.

- To determine clinical outcomes including but not limited to the length of hospital stay (LOS), mortality, weight gain during treatment, and secondary infections;

The median length of hospital stay was 11 days which is expected as the patients are discharged or transferred after entering the rehabilitation phase (usually occur after seven

days). Our study population experienced a high mortality rate above that of which is expected when applying the WHO guidelines. Patients experienced a poor median weight gain during admission which could be ascribed to the high oedematous admissions. If children were discharged on antibiotics, it was seen that their infections were not resolved. It is also not expected that chronic infections such as HIV would resolve. Therefore, a large portion of children were discharged with an infection.

- To determine the associations of admission- and transfer criteria with clinical outcomes in children (24 – 59 months) treated for SAM

No readmissions occurred in this study sample. Therefore, no association could be evaluated between the discharge criteria and the outcomes as both were measured at the same time. Nevertheless, to avoid confusion, we suggest the WHO refers to 'achieve recovery' rather than discharge from treatment. Discharge from treatment can be misinterpreted as the discharge from in-patient care.

Overall, the Ghanaian health system requires more research for explaining inadequate practises and upholds healthcare practitioners accountable for incompliance. Furthermore, our results lay emphasis on the need for Ghana to focus on their CMAM programme; to ensure patients are early admitted as well as transferred for follow-up treatment.

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ANNEXURES

ANNEXURE 1: HREC APPROVAL FOR THE LARGER SAMAC STUDY

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

Private Bag X6001, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Web: http://www.nwu.ac.za

Faculty of Health Sciences Ethics Office for Research, Training and Support

Health Research Ethics Committee (HREC)

Tel: 018-285 2291
Email: Wayne.Towers@nwu.ac.za

19 January 2018

Dr MJ Lombard
Nutrition
CEN

Dear Dr Lombard

APPROVAL OF YOUR APPLICATION BY THE HEALTH RESEARCH ETHICS COMMITTEE (HREC) OF THE FACULTY OF HEALTH SCIENCES

Ethics number: NWU-00063-17-S1

Kindly use the ethics reference number provided above in all future correspondence or documents submitted to the administrative assistant of the Health Research Ethics Committee (HREC) secretariat.

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: -

Application type: Larger study

Children: Category 1 - No more than minimal risk (monitoring report required annually)

You are kindly informed that your ethics approval application has been successful and fulfils all requirements for approval. Your study is approved for a year and may commence from 19/01/2018. It, however, requires specific conditions to be fulfilled during the progress of your study:

a. 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.

As the study progresses the stipulated documents should be submitted to Ethics-HRECProcess@nwu.ac.za with a cover letter with a specific subject title indicating "Outstanding documents for approval: NWU-XXX-XXX." The letter should include the title of the approved study, the names of the researchers involved, that the documents are being submitted as part of the conditions of the approval set by the HREC, the nature of the document i.e. which condition is being fulfilled and any further explanation to clarify the submission.

The *e-mail*, to which you attach the documents that you send, should have a specific subject line indicating the nature of the submission, as well as the nature of the document being sent e.g. "Outstanding documents for approval: NWU-XXX-XXX." This submission will be handled via the expedited process.

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. A monitoring report should be submitted two months prior to the reporting dates as indicated i.e. annually for minimal risk studies, six-monthly for medium risk studies and three-monthly for high risk studies, to ensure timely renewal of the study. A final report must be provided at completion of the study or the HREC, Faculty of Health Sciences must be notified if the study is temporarily suspended or terminated. The monitoring report template is obtainable from the Faculty of Health Sciences Ethics Office for Research, Training and Support at Ethics-HRECMonitoring@nwu.ac.za. Annually, a number of studies may be randomly selected for an internal audit.

The HREC, Faculty of Health Sciences requires immediate reporting of any aspects that warrants a change of ethical approval. Any amendments, extensions or other modifications to the proposal or other associated documentation must be submitted to the HREC, Faculty of Health Sciences prior to implementing these changes. These requests should be submitted to Ethics-HRECApply@nwu.ac.za with a cover letter with a specific subject title indicating, "Amendment request: NWU-XXX-XXX". The letter should include the title of the approved study, the names of the researchers involved, the nature of the amendment/s being made (indicating what changes have been made as well as where they have been made), which documents have been attached and any further explanation to clarify the amendment request being submitted. The amendments made should be indicated in yellow highlight in the amended documents. The *e-mail*, to which you attach the documents that you send, should have a specific subject line indicating that it is an amendment request as well as the nature of the amendment e.g. "Amendment request: NWU-XXX-XXX". This submission will be handled via the expedited process.

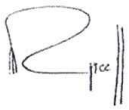
Any adverse/unexpected/unforeseen events or incidents must be reported on either an adverse event report form or incident report form to Ethics-HRECIncident-SAE@nwu.ac.za. The *e-mail*, to which you attach the documents that you send, should have a specific subject line indicating that it is a notification of a serious adverse event or incident in a specific project e.g. "SAE/Incident notification: NWU-XXX-XXX". Please note that the HREC, Faculty of Health Sciences has the prerogative and authority to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process.

The HREC, Faculty of Health Sciences complies with the South African National Health Act 61 (2003), the Regulations on Research with Human Participants (2014), the Ethics in Health Research: Principles, Structures and Processes (2015), the Belmont Report and the Declaration of Helsinki (2013).

We wish you the best as you conduct your research. If you have any questions or need further assistance, please contact the Faculty of Health Sciences Ethics Office for Research, Training and Support at Ethics-HRECApply@nwu.ac.za.

Yours sincerely

Prof Wayne Towers
HREC Chairperson



Prof Minrie Greeff
Ethics Office Head

ANNEXURE 2: HREC APPROVAL FOR THIS SUB-STUDY

Private Bag X1290, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Fax: 018 299-4910
Web: http://www.nwu.ac.za

Research Ethics Regulatory Committee
Tel: 018 299-4849
Email: nkosinathi.machine@nwu.ac.za

ETHICS APPROVAL LETTER OF STUDY

Based on approval by the North West University Health Research Ethics Committee (NWU-HREC) on 27/11/2018, the NWU Health Research Ethics Committee hereby approves your study as indicated below. This implies that the North-West University Research Ethics Regulatory Committee (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: Association between admission and transfer criteria and clinical outcomes of children (24-59 months) treated for severe acute malnutrition in three Ghanaian referral hospitals – the SAMAC study.
Study Leader/Supervisor (Principal Investigator)/Researcher: Ms C Conradie
Student: C Nel

Ethics number:

N	W	U	-	0	0	0	6	3	-	1	7	-	A	1	-	0	2
Institution				Study Number						Year			Status				

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Application Type: Sub study
Commencement date: 2018/11/27 **Risk:** **Minimal**
Expiry date: 2019/11/30
Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of an annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.

Special in process conditions of the research for approval (if applicable): None

General conditions:
While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, the following general terms and conditions will apply:

- *The study leader/supervisor (principle investigator)/researcher must report in the prescribed format to the NWU-HREC:*
  - *annually (or as otherwise requested) on the monitoring of the study, whereby a letter of continuation will be provided, and upon completion of the study; and*
  - *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.*
- *The approval applies strictly to the proposal as stipulated in the application form. Should any amendments to the proposal be deemed necessary during the course of the study, the study*

leader/researcher must apply for approval of these amendments at the NWU-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.

- *Annually a number of studies may be randomly selected for an external audit.*
- *The date of approval indicates the first date that the study may be started.*
- *In the interest of ethical responsibility the NWU-RERC and NWU-HREC reserves 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 NWU-HREC or that information has been false or misrepresented;*
    - *submission of the annual (or otherwise stipulated) monitoring report, the required amendments, or reporting of adverse events or incidents was not done in a timely manner and accurately; and / or*
    - *new institutional rules, national legislation or international conventions deem it necessary.*
- *NWU-HREC can be contacted for further information or any report templates via Ethics-HRECApply@nwu.ac.za or 018 299 1206.*

The NWU-HREC 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 NWU-HREC or the NWU-RERC for any further enquiries or requests for assistance.

Yours sincerely

Digitally signed by Wayne Towers
Date: 2018.12.04 21:35:19 +02'00'

Prof Wayne Towers
Chair NWU Health Research Ethics Committee

Current details: (22351930) M:\DSS1\8533\Monitoring and Reporting Cluster\Ethics\Certificates\Templates\Research Ethics Approval Letters\9.1.5.4.2 HREC Ethical Approval Letter.docm
3 December 2018

File reference: 9.1.5.4.2

ANNEXURE 3: GHANA HEALTH ETHICS REVIEW COMMITTEE

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: ghsrec@gmail.com

MyRef. GHS/RDD/ERC/Admin/App 1637
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.

GHS-ERC Number	GHS-ERC: 09/06/17
Project Title	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)
Approval Date	16th July, 2017
Expiry Date	15th July, 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 4: PREMISSION LETTRES TO HOSPITALS

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOM CAMPUS

te Bag X6001, Potchefstroom
11 Hoffman Street, Potchefstroom
Building G16, Room 140
South Africa 2520

Tel: +2718 299-1111/2222
Web: http://www.nwu.ac.za

Centre of Excellence for Nutrition
Tel: +2718 299-2085
Email: tani.lombard@nwu.ac.za

28 April 2017

To whom it may concern

Re: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

I am Dr Martani Lombard, senior lecturer and researcher at the Centre of Excellence for Nutrition, North-West University, Potchefstroom, South Africa. We would like to request permission to conduct research from medical records in your facility. The title of the study is: "Evaluation of admission criteria and treatment guidelines of *Sub-Saharan* Africa infants and children (0-59 months) diagnosed with severe acute malnutrition – the SAMAC-Study". Ethical approval for the study has been obtained from the North-West University Health Sciences Research Ethics Committee as well as from the Departments of Health from South Africa, Ghana, Malawi and Botswana.

In the guideline 'Updates on the Management of Severe Acute Malnutrition in Infants and Children', published by the WHO in 2013, an update on the evidence used to produce the recommended treatment guidelines, is given. This update urges for further research on the treatment of SAM as the majority of treatment guidelines, although regarded as a strong recommendation, is based on low or very low quality evidence. The aim of the SAMAC study is to evaluate and compare different practices, hospital protocols and WHO recommendations regarding admission criteria and treatment guidelines (nutrition, fluid and electrolyte management) of SAM infants and children in *Sub-saharn* Africa. Hospitals from three *Sub-saharan* African countries (South Africa, Ghana, and Botswana) will be included in the study. Data from 13 000 medical records of infants and children between the ages of 0 - 59 months that was admitted for the treatment of SAM (regardless of the diagnostic criteria used) to any of the included hospitals between January 2013 and December

2021 will be extracted. The extracted data, collected in a reverse chronological order, will be stratified according to predetermined age groups and country.

Should you agree to participate in the study a research team (including two data collectors with nursing or dietetics backgrounds and one researcher) will visit your facility for two to three weeks per year. During this time the team will collect data from the medical records of infants and children (0-59 months) diagnosed with SAM. Data will be collected anonymously and no medical records will leave the allocated offices at you facilities.

Upon completion of the data, you will receive a report indicating the current statistics of your facility regarding SAM. Data will also be presented at relevant international conferences and published in peer reviewed journals.

We will appreciate it if you will allow us access to your facilities' medical records. It is anticipated that this study will inform the WHO regarding the effectiveness of the current SAM treatment guidelines and that of other relevant protocols.

Kind regards

Martani Lombard
Senior Lecturer
PhD, RD(SA)
Centre of Excellence for Nutrition
School of Physiology, Nutrition and Consumer Sciences
North-West University, Potchefstroom Campus

ANNEXURE 5: KATH APPROVAL LETTER

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"

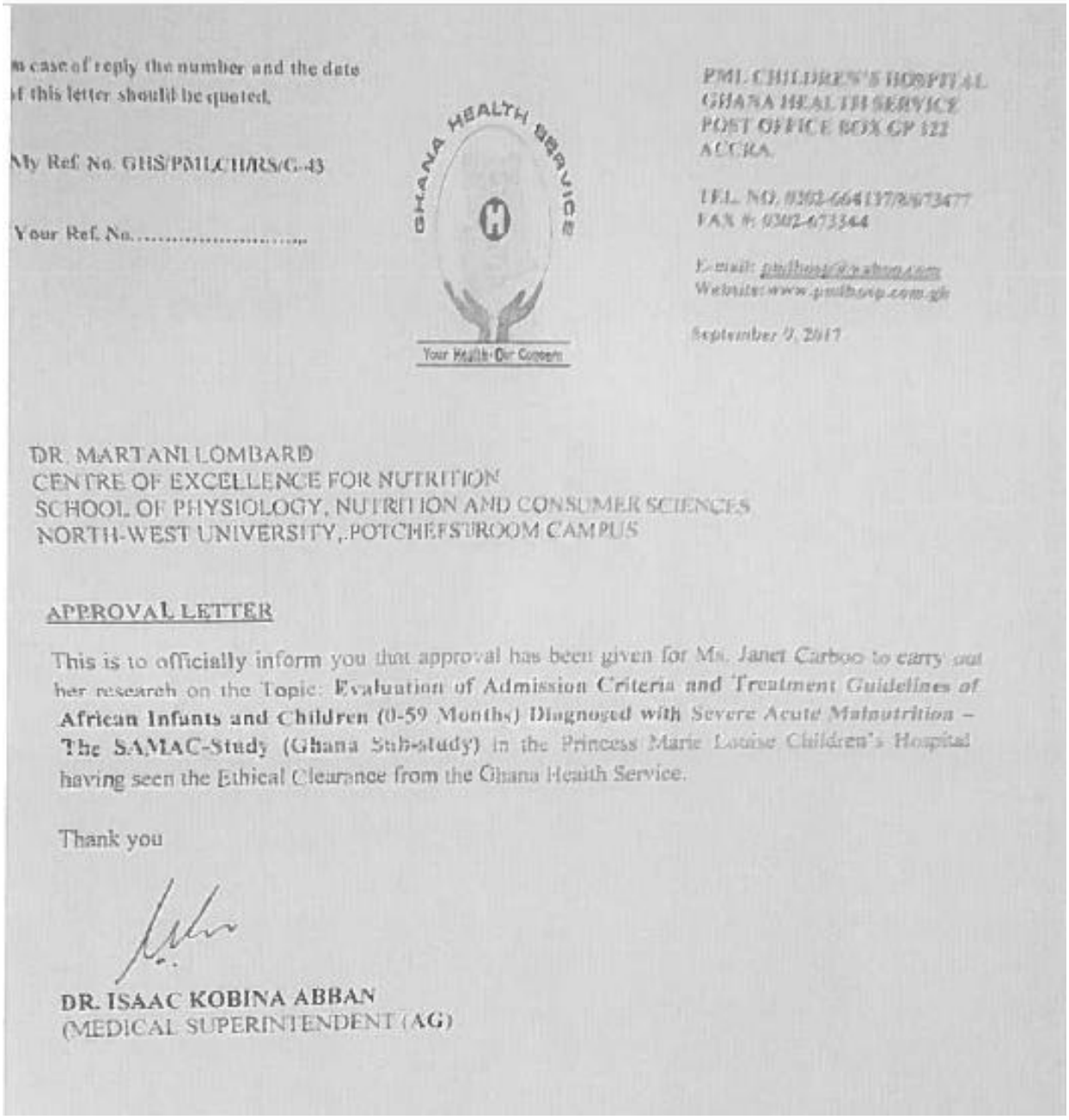
Approval is hereby given for you to conduct the study entitled **"Evaluation of admission criteria and treatment guidelines of sub-Sahara African infants and children (0-59 months) diagnosed with severe acute malnutrition – the SAMAC- study at Komfo Anokye Teaching Hospital"** subject to ethical approval.

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

ANNEXURE 6: PML APPROVAL LETTER



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

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

Your Ref. No. .....

GHANA HEALTH SERVICE

Your Health Our Concern

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

TEL. NO. 0302-664137/8/673477
FAX #: 0302-673344

E-mail: pmlhosp@yahoo.com
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)

ANNEXURE 7: TTH APPROVAL LETTER

Department of Research &Development
Tamale Teaching Hospital

TTH/R&D/SR/46
28/03/2018

TO WHOM IT MAY CONCERN

CERTIFICATE OF AUTHORIZATION TO CONDUCT RESEARCH IN TAMALE TEACHING HOSPITAL

I hereby introduce to you **Dr. Martani Lombard (Primary Investigator), Dr. Robin Dolman, Mrs. Cornelia Conradie, Dr. Cristian Ricci and Prof. Etienne Nel (Co-Primary Investigators),** A team of researchers from the centre of Excellence for Nutrition (CEN) at North-West University, Potchefstroom, South Africa. They have been duly authorized to conduct a study on **"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)".**

Please accord them the necessary assistance to enable them complete their study. If in doubt, kindly contact the Research Unit on the second floor of the administration block or on Telephone 0209281020. In addition, kindly report any misconduct of the Researcher to the Research Unit for necessary action.

Please note that this approval is given for a period of four months, beginning from 28th of March, 2018 to 15th of July, 2018.

Thank You.

ALHASSAN MOHAMMED SHAMUDEEN
(HEAD, RESEARCH & DEVELOPMENT)

ANNEXURE 8: SCREENING TOOL

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 quesitons 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: unspesified metabolic, neurodevelopmental or any other growth disorder)

Date	Hospital	File number	Criteria for inclusion:											
			Age between 0 - 59mo?		Diagnosis of SAM?		Diagnosis of condition or disease related to SAM?		Medical problems not related to SAM is NOT present?		Date of file ≥ 2013?			
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED
			Y	N	Y	N	Y	N	Y	N	Y	N	INCLUDED	EXCLUDED

ANNEXURE 9: DATA EXTRACTION REGISTER

SAMAC

Participant register: Botswana

Nr	Date	Hospital	File number
B-001			
B-002			
B-003			
B-004			
B-005			
B-006			
B-007			
B-008			
B-009			
B-010			
B-011			
B-012			
B-013			
B-014			
B-015			
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B-025			
B-026			
B-027			
B-028			
B-029			
B-030			
B-031			
B-032			
B-033			

B-034			
B-035			
B-036			
B-037			
B-038			
B-039			
B-040			

ANNEXURE 10: DATA EXTRACTION FORM

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 on admission to current ward*)

2.1. Date of admission	**20**	Y	M	D	**2.2. Date of birth**	**20**	Y	M	D	**2.3. Current Age**	
2.4. Gender	**Boy**		**Girl**		**2.5. New admission**	Yes	No	**2.6. Readmission**		Yes	No
2.7. Weight on admission (kg)	***Kg***				**2.8. Height/length measurement (cm)**	***cm***					
	Not recorded					**Not recorded**					
2.9. Which of the following was measured:	**Height**		**Length**		**Not indicated**						
2.10. MUAC (mm)			**2.11. Weight for height Z score**	-3	-2	-1	0				
	Not recorded										
2.12. Oedema grade	0	+ (mild)	++ (moderate)	+++ (severe)							

2.13. Clinical Signs	Irritability		Wasting		Eye signs		Diarrhoea	
	Dermatitis		Severe pallor		Shock		Vomiting	
	Convulsions		Irregular heart beat		Weak pulse		Fast pulse	
	Slow capillary fill (> 3 seconds)				Cold hands / feet			

2.14. Other clinical signs noted			
2.15. HIV status	Positive	Negative	Unknown
2.16. ARV treatment	No	Started while in hospital	Yes, Prior to admission
2.17. List ARV medications			
2.18. TB Status	Positive	Negative	Unknown
2.19. List TB medications			

2.20. Medical complication/diagnosis on admission								
Conscious on admission	Not reported	Yes	No	Hypoglycaemia at admission (< 3 mmol/L)	Not reported	Yes	No	
Dehydration at admission	Not reported	Yes	No	Hypothermia at admission (< 35 ^{0}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	
Other								
2.21. Did the patient receive any IV	Yes	No	**2.22. If yes, Type of IV fluid received**					
Rate		**Total volume per day**		**Duration** *(no of days)*:				
2.21. Did patient receive 10% glucose or sucrose solution within 30 minutes of admission	Yes	No						
Route		**Rate**		**Total volume**		**Duration**		

2.22. Did the patient receive ReSoMal?						Yes	No
Route		**Rate**		**Total volume**		**Duration**	
2.22. Did the patient receive other oral rehydration solutions at admission?						Yes	No
Route		**Rate**		**Total volume**		**Duration**	

3. BED CHART INFORMATION									
DATE	**UNIT**								
3.1 Pulse									
3.2. Temperature									
3.3. Blood glucose									

3. BED CHART INFORMATION									
3.4. Heart rate									
3.5. Blood tests									
S-Na									
S-K									
S-Cl									
S-Urea									
S-Creatinine									

3. BED CHART INFORMATION									
S-Albumin									
S-CRP									
Red blood count									
Hb									
Haematocrit									
MCV									
MCH									

3. BED CHART INFORMATION									
MCHC									
Platelet count									
White blood count									
S-Fe									

3. BED CHART INFORMATION									

4. FEEDING

4. FEEDING																
4.1. When were feeds initiated		**Date**			**Time**				**Not recorded**							
4.2.	**F75**	Yes	No	**Name of product:**				**Rate**		Pre-mixed		Self-mixed				
Starter feeds	Nr of feeds/day	Date														
		Number														
	Total volume/ day	Date														
		ml														
	Infant formula	Yes	No	**Name of product:**				**Rate**		Pre-mixed		Self-mixed				
	Nr of feeds/day	Date														
	Total volume/ day	ml														
	Breastfeeding	Yes	No													

4. FEEDING

	Nr of feeds/day	Date											
		Number											
	Other	Yes	No	**Name of product:**			**Rate**		Pre-mixed		Self-mixed		
	Nr of feeds/day	Date											
		Number											
	Total volume/ day	Date											
		ml											

3.3. Was the patient feeding ward diet or solids while on starter formula	Yes	No	**3.4. If Yes, what other feed was given**	

3.5. For Self-mixed feeds record recipe:

4. FEEDING

3.6. Route of feeding		NGT		Oral		**3.7.Date NGT removed**													
3.8. When were feeds transitioned		Date		20	Y	M	D												
3.9. Transition feed	**F100**	Yes	No	**Name of product:**				**Rate**		Pre-mixed		Self-mixed							
	Nr of feeds/day	Date																	
		Number																	
	Total volume/ day	Date																	
		ml																	
	Infant formula	Yes	No	**Name of product:**				**Rate**		Pre-mixed		Self-mixed							
	Nr of feeds/day	Date																	

4. FEEDING

	Total volume/ day	ml											
	Breastfeeding	Yes / No											
	Nr of feeds/day	Date											
		Number											
	RUTF	Yes / No	**Name of product:**				**Rate**		Pre-mixed		Self-mixed		
	Nr of feeds/day	Date											
		Number											
	Total volume/ day	Date											
		ml											
	Other	Yes / No	**Name of product:**				**Rate**		Pre-mixed		Self-mixed		
	Nr of	Date											

4. FEEDING

	feeds/day	Number										
	Total volume/ day	Date										
		ml										

3.10. Was the patient feeding ward diet or solids while on transition formula	Yes	No	**3.11. If Yes, what other feed was given**	

3.12. For Self-mixed feeds record recipe:

4. DEHYDRATION										
4.1 Vomiting	**Date**									
	(nr of incidences per day)									
4.2. Diarrhoea	**Date**									
	(nr of incidences per day)									
	Consistency of stool (watery, loose, normal or hard)									

5. ELECTROLYTE AND TRACE ELEMENT PRESCRIPTIONS	Did the patient receive any of the following:									
5.1. Potassium Chloride solution	Yes	No	Date							
			Dosage							
5.2. Trace element mix ($MgSO_4$ 280mg; $ZnSO_4$ 36mg; $CuSO_4$ 0.1mg/ 1ml oral solution)	Yes	No	Date							
			Dosage							

5. ELECTROLYTE AND TRACE ELEMENT PRESCRIPTIONS			Did the patient receive any of the following:							
5**.3. Oral Magnesium**	Yes	No	Date							
			Dosage							
5.4. $MgSO_4$ IM	Yes	No	Date							
			Dosage							
5.5. Zinc (zinc sulphate, gluconate, acetate or picolinate)	Yes	No	Date							
			Dosage							
5.6.	Yes	No	Date							
			Dosage							
5.7.	Yes	No	Date							
			Dosage							

6. MICRONUTRIENTS			Did the patient receive any of the following:	
Micronutrient				

6. MICRONUTRIENTS	Did the patient receive any of the following:									
6.1. Vitamin A (If multiple administrations, indicate dosage and date)	Yes	No	Date							
			Dosage							
6.2. Folic Acid	Yes	No	Date							
			Dosage							
6.3. Multivitamin	Yes	No	Date							
			Dosage							
6.4.Iron	Yes	No	Date							
			Dosage							
6.5.	Yes	No	Date							
			Dosage							
6.6.	Yes	No	Date							
			Dosage							

7. MEDICAL TREATMENT	Did the patient receive any of the following:								
			Route			**Date started**	**Date stopped**	**Dosage**	**Frequency**
7.1. Ceftriaxone	Yes	No	IM	IV	Oral				

7. MEDICAL TREATMENT	Did the patient receive any of the following:								
7.2. Ampicillin	Yes	No	IM	IV	Oral				
7.3. Amoxicillin	Yes	No	IM	IV	Oral				
7.4. Gentamicin	Yes	No	IM	IV	Oral				
7.5. Cephalosporin	Yes	No	IM	IV	Oral				
7.6. Chloramphenicol	Yes	No	IM	IV	Oral				
7.7. ciprofloxacin co-trimoxazole	Yes	No	IM	IV	Oral				
7.8 Metronidazole	Yes	No	IM	IV	Oral				
	Yes	No	IM	IV	Oral				

7. MEDICAL TREATMENT	Did the patient receive any of the following:								
	Yes	No	IM	IV	Oral				
	Yes	No	IM	IV	Oral				
Treatment for parasitic worms:	Yes	No	IM	IV	Oral				
Mabendazole	Yes	No	IM	IV	Oral				
	Yes	No	IM	IV	Oral				
	Yes	No	IM	IV	Oral				
Blood transfusion	Yes	No							
Plasma transfusion	Yes	No							
Other medication:									
Name	Yes	No	IM	IV	Oral				
Indication									
Name:	Yes	No	IM	IV	Oral				

7. MEDICAL TREATMENT	Did the patient receive any of the following:								
Indication									
Name	Yes	No	IM	IV	Oral				
Indication									
Name	Yes	No	IM	IV	Oral				
Indication									
Name	Yes	No	IM	IV	Oral				
Indication									
Was HIV treatment withheld	Yes	No	Date stopped		Date initiated		Duration without HIV medication		
Was HIV treatment dosages adjusted since admission?	Yes	No	Medication	Dosage adjustment	Medication	Dosage adjustment	Medication	Dosage adjustment	
Was HIV treatment medication changed	Yes	No	Admission medication (dosage)			Changed medication (dosage)			

7. MEDICAL TREATMENT			Did the patient receive any of the following:	
since admission?				

ADDITIONAL PROGRESS NOTES

ANTHROPOMETRY					
DATE					
Weight (kg)					
MUAC					
CLINICAL					
Appetite					
Oedema					
Other signs					
FEEDS					

Product					
Rate					
NGT/Oral					
Other (Ward diet)					
ORAL REHYDRATION					
ReSoMal rate					
Other					

IV Fluids					
Type					
Rate					

4. DISCHARGE DATA (*Status of child on date of discharge to home*)													
4.1. Date of discharge	**20**	Y	M	D	**4.2. Date of Death**	**20**	Y	M	D	**4.3. Cause of death**			
4.4. Weight (kg)	*Kg*				**4.5. Height/length measurement (cm)**	*cm*				**Not indicated**			
4.6. Which of the following was measured:					**Height**			**Length**		**Not indicated**			
4.7. MUAC (mm)					**4.8. Weight for height Z score**	-3		-2		-1		0	
4.9. Oedema grade	0				+ (mild)			++ (moderate)		+++ (Severe)			
Tested for TB	Yes		No		Tested for HIV	Yes		No		Referred to outpatient clinic / facility	Yes		No
Good appetite	Yes		No		Infections resolved	Yes		No		5 day consecutive weight gain	Yes		No
4.10. Other clinical signs noted on Discharge													

Caregiver given nutrition and health education	Yes	No