Association between admission and transfer criteria and clinical outcomes of infants and children (0-59 months) treated for severe acute malnutrition in Botswana

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Dissertation accepted in fulfilment of the requirements for the degree Masters of Science in Dietetics at the

North-West University

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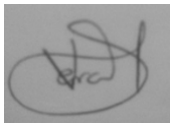
Graduation: May 2020

Student number: 28134486

PREFACE

This is a mini-dissertation compiled by Vera Moonga for the degree Magister Scientiae (M.Sc) in Dietetics. It comprises four chapters of which the third are written in article format. Chapter 1 is the general introduction to the study and Chapter 2 entails a detailed literature review of the topic. Chapter 3 is an article titled “Association between admission and transfer criteria and clinical outcomes of infants and children (0 – 59 months) treated for severe acute malnutrition in Botswana” to be submitted for publication to the South African Medical Journal. The article was written by Vera Moonga according to the author’s instructions derived from the *South African Medical Journal*. Chapter 4 is the discussion of the study findings, recommendations and conclusion. The article is co-authored by Dr Martani Lombard, Ms Cornelia Conradie and Ms Maemo Lesiapeto, who all gave permission for the article to be submitted for examination purposes as part of this mini-dissertation.

“By submitting this research assignment, I Vera Moonga declare that all the content of the work with the exception of acknowledged references is my own original work, under the supervision of Dr Martani Lombard and co-supervision of Ms Cornelia Conradie. I have not previously in its entirety or in part submitted it for obtaining any qualification. I hereby provide consent for the article to be published as part of the M.Sc in Dietetics mini-dissertation at the North-West University”.



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ACKNOWLEDGEMENT

The successful completion of this mini-dissertation would not have been possible without the outstanding mentorship given by my supervisor Dr Martani Lombard and co-supervisor Mrs Cornelia Conradie. I truly appreciate your mentorship and investment into the completion of this research project.

I would also like to express my sincere gratitude to the following for their valuable input:

- North-West University for the learning opportunity and support;
- Dr Cristian Ricci for the statistical analysis;
- Maemo Lesiapeto for being a mentor and co-author in Botswana;
- Ministry of Health and Wellness Botswana for allowing us to conduct our research in the hospital.

In a very special way, I would also love to thank my husband and children for inspiring and supporting me to achieve my dreams. You held my hand throughout the entire journey and ensured my success. To my parents and siblings, thanks for your prayers, love and support. I am indeed grateful to you all.

Lastly, I am grateful to my God almighty for his love and mercy that He continues to shower upon me and my family. I would not be what I am without His faithfulness.

ABSTRACT

Background

Complicated severe acute malnutrition (SAM) in children under 59 months demonstrates an increase on a country's economic burden and higher child mortality rates. Despite focussed efforts, 17 million children remain affected by SAM, with a quarter of them residing in Africa. High in-patient mortalities up to 46% have been reported within sub-Sahara Africa. Very few studies have verified the efficacy of the current World Health Organization (WHO) in-patient hospital admission and transfer criteria against clinical outcomes such as recovery, hospital stay (LOS) and mortality. In Botswana, the updated WHO SAM management guidelines have been taken into consideration when drafting the more recent 'integrated management of acute malnutrition and underweight in children and adolescents (IMAMU)' guidelines. However, since these guidelines are still in draft format, the current WHO admission and transfer criteria serve only as a reference. Furthermore, the association between the admission and transfer criteria with clinical outcomes are yet to be established. The aim of this study was to determine the association between SAM in-patient admission and transfer criteria and clinical outcomes of children aged 0 - 59 months in Botswana.

Objectives

To achieve the study aim, the following objectives were set: to describe basic demographic profiles of those represented on the data extraction forms, to describe admission and transfer criteria, to describe basic clinical outcomes (recovery, LOS and mortality) and to identify associations between admission and transfer criteria and clinical outcomes.

Methods

Data was extracted from medical records of children aged 0 – 59 months admitted for the in-patient treatment of SAM in a referral hospital from January 2013 - May 2018. Data extracted included demographic and anthropometric profiles and clinical presentations on both admission and transfer. Data were analysed using SAS version 9.4. and logistic regressions were conducted to test for associations between admission and transfer criteria and clinical outcomes (LOS, weight gain and mortality).

Results

All available, relevant files in the hospital were idendified. A total of 101 medical records were included in the study. Admission and transfer practices observed were not in line with the current

WHO recommendations. Weight-for-height z-scores (WHZ) were measured in 54% of children at admission and in none on transfer. The mid-upper-arm-circumference (MUAC) was poorly measured. Only 17% and 1% of children had a MUAC measurement at admission and transfer respectively. Results revealed a LOS of 17 days, average daily weight gain of 5.4 g/kg/day, and a mortality rate of 28%. Oedema at admission was associated with an increased risk of mortality (P = 0.045). Neither a WHZ < -3 SD or a MUAC ≤ 115 mm at admission or transfer had any associations on the LOS (P = 0.998 and P = 0.906), weight gain (P = 0.914 and P = 0.218) and mortality (P = 0.377 and P = 0.265) respectively.

Conclusion

Adherence to the recommended WHO admission and transfer criteria was poorly conducted. Daily weight gain and mortality were below and above the acceptable global SPHERE levels respectively. Oedema on admission was associated with an increased risk of mortality. The lack of association between other admission and transfer criteria and clinical outcomes of interest could have been due to the poor compliance of anthropometric measures.

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LIST OF ABBREVIATIONS

CMAM	Community-based management of acute malnutrition
HAZ	Height-for-age z-score
HIV	Human immunodeficiency virus
HREC	Health Research Ethics Committee
IFPRI	International Food Policy Research Institute
IMAMU	Integrated management of acute malnutrition and underweight
IMCI	Integrated management of childhood illness
IQR	Interquartile range
LAZ	Length-for-age z-score
LMIC	Lower middle-income country
LOS	Length of stay
MAM	Moderate acute malnutrition
MOHW	Ministry of Health and Wellness
MUAC	Mid-upper-arm-circumference
NWU	North-West University
PEM	Protein energy malnutrition
PMH	Princess Marina Hospital
SAM	Severe acute malnutrition
SDG	Sustainable development goals
UN	United Nations
UNICEF	United Nations International Children’s Emergency Fund
WAZ	Weight-for-age z-score
WHA	World Health Assembly
WHO	World Health Organization
WHZ	Weight-for-height z-score
WLZ	Weight-for-length z-score

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CHAPTER 1 INTRODUCTION

1.1 Background

Undernutrition in children under the age of 59 months is a major public health concern threatening child survival and wellbeing (Muller & Krawinkel, 2005:279). Globally, it contributes to nearly half of all child mortalities, equating to 3.1 million deaths annually (Black *et al*., 2013:16). Specific consequences of undernutrition include micronutrient deficiencies and impaired weight gain and/ or linear growth retardation, also referred to as underweight, wasting and stunting respectively (Muller & Krawinkel, 2005:279). According to the 2018 Global Nutrition Report, undernutrition in children remains a global burden (Hawkes *et al*., 2018:9). Recent estimates in the 2019 Levels and Trends of Child Malnutrition Report, published by United Nations Children's Fund (UNICEF), World Health Organization (WHO), and World Bank Group, indicate that globally 149 million children are stunted, and 49 million wasted (UNICEF *et al*., 2019:4-6). Majority of the global burden rests within Africa and Asia, with Africa being home to 39% and 28% of all stunted and wasted children respectively (UNICEF *et al*., 2019:3). This is of concern as the Global Nutrition Report indicates very slow progress, (particularly in Africa) towards the attainment of the Sustainable Development Goal (SDG) set to end all forms of malnutrition by the year 2030 (Hawkes *et al*., 2018:9).

Severe acute malnutrition (SAM), also known as known severe wasting is a volatile form of wasting (WHO *et al*., 2014:1). It is a healthcare problem requiring urgent intervention owing to its heightened risk of disease and mortality (WHO *et al*., 2014:1). In Africa, 14 million children under 59 months are wasted, and 4 million severely wasted, with over 80% residing within the sub-Sahara region (UNICEF *et al*., 2019:9). The World Health Assembly (WHA) childhood wasting target stands at reducing and maintaining levels of childhood wasting in inclusion of severe wasting to under 5% (WHO *et al*., 2014:2). However, globally, of the 118 countries that reported the prevalence of wasting in 2013, more than half had a national average prevalence greater than 5% (WHO *et al*., 2014:2). Currently, no African region or country has attained the WHA wasting target (UNICEF *et al*., 2017:12). In addition, the majority of wasted and severely wasted children live outside of the humanitarian context where treatment programmes are not available (WHO *et al*., 2014:2). The WHO wasting policy brief report estimates that less than 15% of wasted and severely wasted children globally are currently reached by treatment services (WHO *et al*., 2014:2). The poor coverage of children with wasting and severe wasting should be of major global apprehension, given the well-established link between wasting, disease and mortality (WHO *et al*., 2014:2). These statistics are worrying, considering the well-established link between undernutrition and mortality (WHO *et al*., 2014:2).

1.2 Undernutrition in Botswana

Botswana is an economically stable country with a population of just over 2 million. In addition to economic stability, the country boasts good healthcare infrastructure, access to healthcare services, and nutrition programmes for its citizens (Creek *et al*., 2010:14). However, despite economic and healthcare stability, Botswana is not exempted from the endemic of undernutrition in children. A study conducted in Botswana in 2007, estimated that 13% of children under 59 months were undernourished, with 26% stunted, 13.5% underweight and 7% wasted (United Nations (UN), 2010: UNICEF, 2007). However, a recent study by Ricci *et al.* (2019a:1597-1605) estimated the prevalence of stunting and underweight at 31.5% and 11.2%, respectively. Comparisons between these two studies reveal poor progress by Botswana in tackling undernutrition in children. The lack of progress is further substantiated by the 2018 Global Nutrition Report, which also highlights Botswana as one of the countries with slow progress towards the reduction of wasting in children (Hawkes *et al*., 2018:12).

1.3 Severe acute malnutrition

Severe acute malnutrition (SAM) occurring in children under 59 months is of substantial global concern. It is a threat to child survival, as it carries a very high mortality rate (Ricci *et al*., 2019b:e12723). Globally, approximately 19 million children are affected by SAM and near a million child mortalities per year can be attributed to SAM (Black *et al*., 2013:12). Black *et al.* (2008:247) further states that mortality is likely to occur 9 times more in children with SAM in comparison to their healthy peers. These figures do not include children who die of oedematous malnutrition, therefore suggesting an even higher number of child deaths being attributed to SAM (Collins *et al*., 2007:453). In addition to high mortality rates, SAM is also associated with other poor clinical outcomes. Complications arising from SAM are linked to increased morbidity such as a higher incidence of pneumonia, sepsis, diarrhoea, poor wound healing, and a lack of weight gain in children (Norman *et al*., 2008:6). This is also associated with increased hospital stay and health care costs (Norman *et al*., 2008:6).

Severe acute malnutrition commonly manifests in early childhood, between the ages of 6 and 24 months. Several factors can be attributed to the occurrence of SAM in infants and young children. This critical age phase is dominated by rapid physical and neurological development largely dependent on adequate nutritional intake (Murray & Manary, 2014:266). Apart from the high nutritional demands, SAM in infants and young children is also largely reflective of poor nutrition associated with suboptimal breastfeeding practices, poor quality complementary foods, and a low-protein diet (Black *et al*., 2008:250). Another factor predisposing young children to SAM is that immunological systems develop and mature with time, therefore infants

and younger children are more susceptible to frequent and more severe infections in comparison to older children (Martorell, 1999:290).

1.3.1 Diagnosis of severe acute malnutrition

The diagnosis of SAM in children under the age of 59 months is partly dependent on the correct assessment and precise interpretation of anthropometric and clinical indicators. Anthropometric indices used in the diagnosis of SAM include weight-for-length / height z score (WLZ / WHZ), and the mid-upper-arm-circumference (MUAC). In 2006, the WHO released new growth standards for children aged 0 - 59 months on which all WHO definitions and estimates of undernutrition are based (WHO, 2009:3). In accordance with these standards, the WHO defines SAM as a WLZ / WHZ < -3 SD of the median of the WHO growth standards or a MUAC ≤ 115 mm and / or the presence of bilateral lower limb oedema in infants and children aged 6 - 59 months (WHO, 2013:19). In 2007, multilateral United Nations (UN) agencies (UNICEF, WHO and the World Food Program) endorsed the community-based management of acute malnutrition (CMAM). The CMAM model includes, depending on the presence or absence of complications, both in-patient care in stabilization centres/hospitals and out-patient care in out-patient therapeutic programmes (WHO *et al*., 2007:3).

The current WHO guidelines endorse this CMAM approach in the management of SAM. The guidelines recommend that infants and children aged 6 - 59 months of age, with either a WLZ / WHZ < -3 SD and / or a MUAC ≤ 115 mm, or bilateral oedema, should immediately be admitted to a health facility (WHO, 2013:20). Out-patient treatment of SAM is endorsed in children who pass the appetite test and are clinically well and alert (WHO, 2013:20). In-patient treatment is recommended for all children presenting with complicated SAM. Children with SAM are referred to as 'complicated' if they have clinical features of infection or metabolic disturbance, severe oedema, poor appetite and / or present with one or more of the integrated management of childhood illness (IMCI) danger signs (Jones & Berkley 2014:S1). The IMCI danger signs include fever, acute respiratory tract infections, diarrhoea, malaria, measles, ear infections, and poor immunization status (Perkins *et al*., 1997:33). The WHO recommends that children be transferred to out-patient care for further management once medical complications are resolved, and children have a good appetite, and are clinically well and alert (WHO, 2013:20).

Severe acute malnutrition in infants less than 6 months of age was previously considered unconventional. However, it is progressively being recognized and the prevalence is indicated to be increasing (Kerac *et al*., 2011:1009). Despite the growing burden of SAM, guidelines defining SAM in this age group were only included in the most recent updated WHO guidelines

(WHO, 2013:60). According to these guidelines, SAM in infants less than 6 months of age is defined as a WLZ < -3 SD, unexplained weight loss and / or the presence of bilateral lower limb oedema (WHO, 2013:63). Until recently, there were no guidelines available on the in-patient admission, and transfer criteria of infants less than 6 months of age. In the latest WHO SAM guidelines, a section has been included in the identification and management of SAM in infants less than 6 months (WHO, 2013:60). Similar to the 6 - 59 month age group, in-patient admission is recommended for infants identified with complicated SAM (WHO, 2013:63). Complicating factors include: any serious clinical condition or medical complication, recent weight loss or failure to gain weight, ineffective feeding, pitting oedema, and any other medical or social issues requiring further investigations (WHO, 2013:63). Transfer to out-patient care is recommended when all clinical conditions or medical complications are resolved (WHO, 2013:64).

1.4 Quality of current World Health Organization admission and transfer criteria

In the recently updated WHO guidelines on the ‘’Management of Severe Acute Malnutrition in Infants and Children’’, an entire section is dedicated to the in-patient admission and transfer criteria of infants aged 0 - 5 months, and infants and children aged 6 - 59 months (WHO, 2013). However, despite the criteria carrying a strong recommendation, the evidence base used for the development of the recommendations is of very low and low quality, respectively (WHO, 2013:20). In a systematic review conducted to review the admission, transfer and discharge criteria for infants less than 6 months of age with SAM, no studies were found that directly examined the admission and transfer criteria using the WHO growth standards (WHO, 2013:15). In another systematic review conducted to examine the admission, transfer criteria of children aged 6 - 59 months with SAM, only 11 pertinent epidemiological studies were found (Roberfroid *et al*., 2013:6). However, all the studies were deemed to be of low quality, due to the lack of randomized control trials and other relevant studies (WHO, 2013:15). Owing to the scarcity of good quality evidence, the WHO has highlighted the need for more research regarding the in-patient admission and transfer criteria of infants and children aged 0 - 59 months diagnosed with SAM (WHO, 2013:20).

1.5 Problem statement

Severe acute malnutrition in children under the age of 59 months is an increasing global health concern. Africa is identified as one of the worst affected regions with 4 million children severely wasted, a quarter of these children reside in sub-Sahara Africa (UNICEF *et al*., 2019:3). Despite the lack of current prevalence estimate rates for wasting and severe wasting,

Botswana is not exempted from these statistics. In the 2018 Global Nutrition Report, Botswana is highlighted as one of the countries in Africa with unacceptably high rates of child undernutrition, in inclusion of wasting and severe wasting (Hawkes *et al*., 2018:12). Botswana currently has no endorsed guidelines for the management of SAM, and the current WHO recommendations serve as reference.

In the recently updated guidelines on the 'Management of Severe Acute Malnutrition in Infants and Children' (WHO, 2013), a section is dedicated to the admission and transfer criteria of infants and children aged 0 - 59 months. However, despite the criteria carrying strong recommendations, the evidence they are based on is of low to very low quality. This is largely due to the lack of good quality studies examining the admission and transfer criteria of children aged 0 - 59 months diagnosed with SAM and admitted for in-patient care (WHO, 2013:20). Furthermore, there is scarcity of information pertaining to the influence of admission and transfer criteria on clinical outcomes.

This study is a sub-study to the larger Severe Acute Malnutrition in African Children (SAMAC) study. The large study is in response to the WHO research plea which indicates the need for further research on SAM. The SAMAC study is a multi-country, multi-hospital, longitudinal study with data being collected in five sub-Sahara African countries including Botswana, Ghana, Kenya, Malawi and South Africa. It is anticipated that data from the large study will form part of a greater body of research, informing the WHO on the extent of implementation of the current WHO recommendations.

This study is a sub-study of a larger study titled: Evaluation of admission criteria and treatment guidelines of sub-Sahara Africa infants and children (0 - 59 months) diagnosed with severe acute malnutrition - the SAMAC-study.

1.6 Research aim of larger SAMAC study

The aim of the larger SAMAC study is to evaluate current admission criteria and treatment protocols and practices for the various conditions related to SAM (in infants and children 0 - 59 months) in hospitals of five sub-Sahara African countries in relation to mortality, length of hospital stay, relapse and disease severity.

1.7 Objectives of larger SAMAC study

To reach the aim of the larger SAMAC study the following objectives have been set:

1. To compare current international (including WHO guidelines), national, provincial and hospital practices for the in-hospital management of SAM;

   The primary outcomes for this part of the study are to compare different treatment protocols in terms of their specific recommended admission and discharge criteria, micronutrient and electrolyte supplementation (for each age group (0 - 5 months, 6 - 11 months, 12 – 23 months, 24 – 59 months)), therapeutic feeding approaches (for each age group), hydration treatment protocol (for each age group) and prescription of medication for the treatment of infections and infectious diseases (for each age group).

2. To assess the association between treatment practices and outcomes (mortality, length of stay, relapse and severity) regarding:
   a. Admission and discharge criteria according to age groups (0 - 5 months, 6 – 11 months, 12 – 23 months, 24 – 59 months);
   b. Micronutrient supplementation according to age groups (0 - 5 months, 6 - 11 months, 12 – 23 months, 24 – 59 months);
   c. Therapeutic feeding regimens according to age groups (0 - 5 months, 6 - 11 months, 12 – 23 months, 24 – 59 months);
   d. Treatment according to hydration status for age groups (0 - 5 months, 6 - 11 months, 12 – 23 months, 24 – 59 months);
   e. Medication prescribed according to age groups (0 - 5 months, 6 - 11 months, 12 – 23 months, and 24 – 59 months).

3. To develop and validate a SAM severity score based on the association between admission and discharge criteria, treatment practices and outcomes (length of stay and mortality).

This mini-dissertation is a sub-study of the larger SAMAC study and focuses on parts of objectives 1 and 2a of the large study. The following information depicts that of the sub-study.

1.8 Research aim of sub-study

The aim of this sub-study was to determine the associations between admission and transfer criteria and clinical outcomes of infants and children admitted with SAM in one randomly selected referral hospital in Botswana.

1.9 Research objectives of sub-study

To achieve the study aim, the following objectives were set:

1. to describe basic demographic profiles of those represented on the data extraction forms,

2. to describe admission and transfer criteria,

3. to describe basic clinical outcomes (length of stay [LOS], recovery and mortality),

4. to identify associations between admission and transfer criteria and clinical outcomes.

For each of the above objectives the following clinical outcome measurements will be taken:

- Length of stay (LOS)
- Mortality
- Growth through changes in z-scores [height-forage (HAZ), weight-for-age (WAZ) and WLZ / WHZ] and MUAC

1.10 Structure of mini-dissertation

This mini-dissertation is written in article format as per the specifications of the North-West University (NWU) postgraduate guidelines. It comprises four chapters.

Chapter 1 is the introductory chapter, presenting the background of malnutrition and SAM, study rationale, research aims and objectives and outcome measurements of the study. It also outlines the structure of the mini-dissertation and contributions of the authors to the research.

Chapter 2 presents a review of the current literature on acute malnutrition with emphasis on SAM. It will also provide the current WHO and Botswana criteria on the in-patient admission and out-patient transfer of children with SAM. The information in the literature review is the base serving as the guide to the interpretation of the results.

Chapter 3 is the article “Association between admission and transfer criteria and clinical outcomes of infants and children (0 – 59 months) treated for severe acute malnutrition in Botswana”. It will be submitted to the South African Medical Journal (SAMJ) to be considered for publication.

Chapter 4 serves as the concluding chapter of this mini-dissertation, giving a holistic summary of the study and recommendations for future research.

References are given at the end of each chapter. All references, with the exception of the references for Chapter 3, are written according to the North-West University Harvard reference style. The references for Chapter 3 are written in the Vancouver style, as per the author instructions of the SAMJ.

1.11 Contribution of the authors

The different roles SAMAC sub-study team members involved in this sub-study are shown in **Table 1.1**.

Table 1.1: Roles of Botswana SAMAC sub-study team

Team Member	Institution of affiliation	Role in the study
Ms Vera Moonga (M.Sc student)	North-West University Centre of Excellence for Nutrition	Concept development, data collection, analysis, interpretation and write up of the mini-dissertation.
Dr Martani Lombard (Principal Investigator and supervisor)	North-West University School of Physiology, Nutrition and Consumer Science, Centre of Excellence for Nutrition	Supervisory and mentorship role during concept development, data collection, analysis, interpretation and write up of the mini-dissertation.
Ms Cornelia Conradie (Principal Investigator and co-supervisor)	North-West University School of Physiology, Nutrition and Consumer Science, Centre of Excellence for Nutrition	Co-supervisory and mentorship role during concept development, data collection, analysis, interpretation and write up of the mini-dissertation
Ms Maemo Lesiapeto	Ministry of Health and Wellness Botswana, Princess Marina Hospital	Data collection and mentorship

The following addenda are appended:

Addendum B: Ethics approval: North-West University

Addendum C: Ethics approval: Botswana Ministry of Health and Wellness

Addendum D: Ethics approval: Princess Marina Hospital

Addendum E: SAMAC screening form

Addendum F: SAMAC study register

Addendum G: SAMAC data extraction form

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CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In this chapter, the current literature on severe acute malnutrition (SAM) in infants and children below the age of 59 months is reviewed. It gives an overview of malnutrition in this age group, consequences, and its causes. Thereafter it will define SAM, highlight the different types, its diagnosis and management. The review will look at the current World Health Organization (WHO) in-patient admission and transfer criteria and associated clinical outcomes. Lastly, it is important to mention that malnutrition is classified as either undernutrition or overnutrition. The context of this study focuses on undernutrition in children, therefore the term malnutrition will from here on will refer to undernutrition in infants and children (0 - 59 months).

2.2 Overview of infant and young child malnutrition

Undernutrition is a burden of significant public health concern. The WHO defines undernutrition as the deficits between the supply of nutrients and energy and the body's requirements to safeguard growth, and maintenance of specific body functions (de Onis *et al*., 1993:703). Globally, undernutrition is rife and presents an important risk factor affecting child health (Muller & Krawinkel, 2005:279). Children under 59 months of age are susceptible to undernutrition and its effects. According to Prentice (1993:33), infants and young children have physiologically higher nutrient requirements, needed to support rapid growth and development. Inadequate nutrition, therefore, stems into growth retardation and may ultimately result in poor health status and death (Ricci *et al*., 2019a:1597).

The term 'undernutrition' primarily refers to the deficiency of macronutrients (carbohydrate, protein and fat) which manifests as protein-energy malnutrition (PEM) resulting in wasting and stunting (MaCallan, 2005:14). Macronutrient deficiency is one of the major causes of child morbidity and mortality among children in developing countries (Bloss *et al*., 2004:260). Furthermore, low to middle-income countries (LMIC) carry the largest burden of macronutrient deficiencies. According to the 2019 United Nations Children's Fund (UNICEF), WHO, and World Bank Group joint child undernutrition estimates report, Asia and Africa share the majority of the global child undernutrition burden (UNICEF *et al*., 2019:3). In Africa, 30% of children are stunted, 7% wasted and 2.1% severely wasted (UNICEF *et al*., 2019:12). Undernutrition can also refer to specific deficiencies of vitamins or trace elements, also known as micronutrients (Macallan, 2005:14). The two constituents often occur in unison. Macronutrients and micronutrients accompany each other in food, therefore a macronutrient deficiency is also highly indicative of a micronutrient deficiency (Macallan, 2005:14).

Botswana is an upper-middle-income country within the Southern African region with a gross national income per capita of US $13,102 (Ulriksen, 2017:73). It has a population of approximately 2 million people, of which 12% are children under the age of 59 months (Central Statistics Office (CSO), 2011). Despite being an economically stable country, Botswana has a high mortality rate of children under 59 months of 30 per 1 000 live births (Mogobe *et al*., 2015:13). Undernutrition contributes to the high mortality rate among children under 59 months. Approximately 4% of deaths among children in this age group in Botswana are directly attributed to undernutrition (Mogobe *et al*., 2015:13). A recent study conducted by Ricci *et al* (2019a:1601-1602) estimated the prevalence of stunting and underweight in Botswana at 31.5% and 11.2% respectively.

2.3 Consequences of undernutrition in children

Undernutrition in early childhood is a threat to child wellbeing, development and survival. Short term consequences include growth retardation, cognitive-developmental delay and increased susceptibility to disease and death (Victora *et al*., 2016:479). Children with undernutrition often present with negative outcomes such as a compromised immunity which increase the risk of infections and susceptibility of other co-morbidities such as obesity, diabetes and hypertension (Black *et al*., 2008:244). Inadequate nutrition during infancy and early childhood years may also lead to poor cognitive development resulting in a low intelligence quotient and poor learning skills (UNICEF *et al*., 2017:2). Other consequences further include a shorter than average adult height and reduced economic productivity in the long term (Black *et al*., 2008:244).

2.4 Causes of undernutrition in children

The causes of undernutrition in children are complex. They are best explained by the UNICEF conceptual framework for undernutrition, which categorizes the determinants of undernutrition according to a quantitative hierarchical arrangement (UNICEF, 1998:26; Ricci *et al*., 2019b:e12723). The conceptual framework, as illustrated in **Figure 2.1**, identifies causes of undernutrition in children to be due to basic (societal level), underlying (household or family level), and immediate (individual level) factors, whereby factors at one level influence other levels (UNICEF, 1998:26; Ricci *et al*., 2019b:e12723).

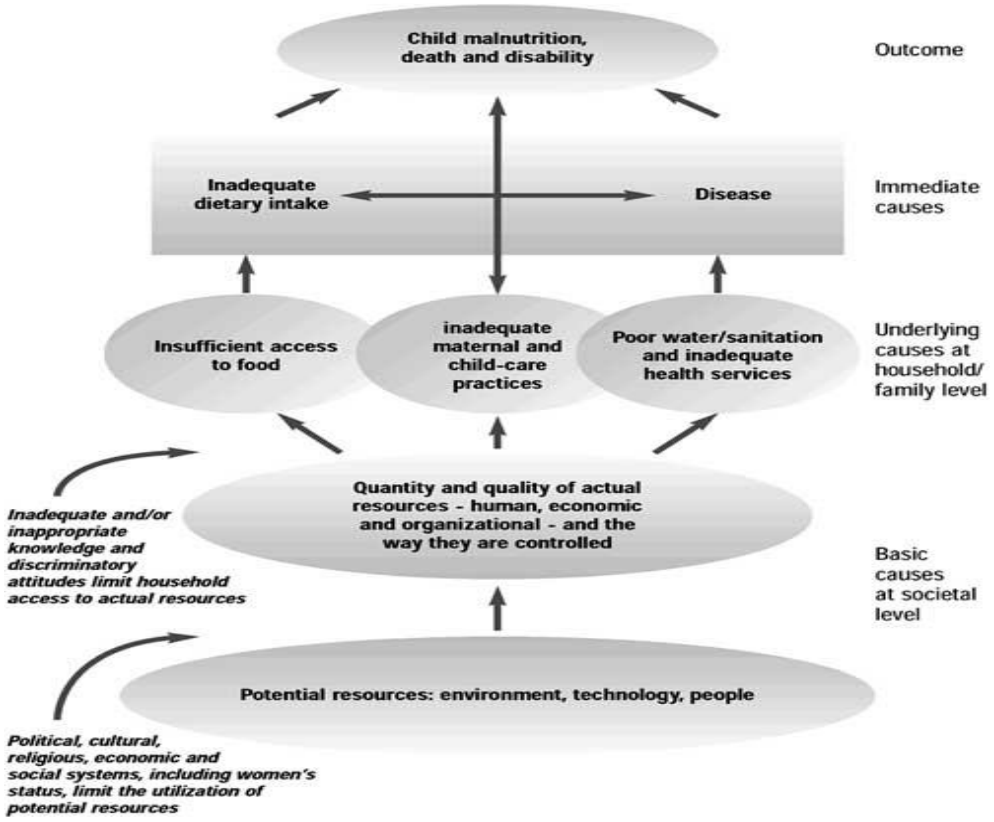

Figure 2.1: UNICEF conceptual framework of undernutrition in children. Source: adapted from *State of the world's children*, 1998.

2.4.1 Basic causes of undernutrition

According to the UNICEF conceptual framework for undernutrition (**Figure 2.1**), basic causes of child undernutrition can be attributed to either economic, environmental or socio-political factors (UNICEF, 1998:26). These emerge at national and international levels and affect the control and availability of food (Katona & Katona-Apte, 2008:1583). The role of governments in the prevention of child undernutrition cannot be disputed. The political ideology and priorities of governments affect the nutritional and health status of children in any given population (Katona & Katona-Apte, 2008:1583). Unfortunately, most African governments pay little or no attention to determining strategies that ensure the alleviation of undernutrition, particularly in children (Bain *et al*., 2013:125). Furthermore, misappropriation of funds and resources within the sub-Sahara African region has led to economic inequalities, further aggravating the burden and consequences of undernutrition (Bain *et al*., 2013:125).

2.4.2 Underlying causes of undernutrition

Underlying causes of undernutrition influence the ability of the household and individual to access appropriate nutrition at community level (Reinhardt & Fanzo, 2014:4). They include insufficient household food security, inadequate childcare and a lack of access to health care services, as shown in **Figure 2.1** (UNICEF, 1998:26; Ricci *et al*., 2019b:e12725). These causes have a more direct link with child undernutrition than the basic causes.

The US Department of Agriculture defines household food security as the access by all household members, at all times, to sufficient, safe and nutritious food that meets dietary needs and food preferences to support an active and healthy lifestyle (Coleman-Jensen *et al.,* 2016:2). Household food insecurity negatively affects food available for consumption, and hence reduced dietary diversity and nutrient intake (Osei *et al*., 2010:484). Children under 59 months are vulnerable to food insecurity. Household food insecurity in children is associated with a higher prevalence of hospitalization, nutritional deficiencies, morbidity and mortality in comparison with children living in food-secure households (Cook *et al*., 2004:1433; Ricci *et al*., 2019b:e12725). Poverty is a major cause of household food insecurity. Global poverty estimates indicate that approximately 770 million people in the world live in extreme poverty (Castañeda *et al*., 2018:250). This is concerning given the relationship between poverty and the prevalence of child undernutrition. Poverty limits the availability of resources to access or procure food, therefore underprivileged households are unlikely to sustain decent household nutrition.

The nutritional status of children is linked to the ease and access to quality and affordable health care services (Ricci *et al*., 2019b:e12725). Katona and Katona-Apte (2008:1583) identified the availability of immunizations, essential drugs, and accessibility to healthcare facilities as crucial factors in the reduction of child undernutrition. A lack of immunizations and essential drugs contribute to childhood illness, catalysing the development of undernutrition (Katona & Katona-Apte, 2008:1583). The quality of the health environment, this including acceptable water safety levels, good sanitation, lack of overcrowding and access to good shelter, are also determinants of a child's nutritional status (Bain *et al*., 2013:122; Ricci *et al*., 2019b:e12725). Unsafe environments stimulate the incidence of disease, increasing the vulnerability of children to undernutrition (Katona & Katona-Apte, 2008:1583).

A lack of adequate childcare is also an associated contributing factor of undernutrition in children. According to Bain *et al.* (2013:126), sub-optimal breastfeeding and weaning practices contribute significantly towards undernutrition in infants. Exclusive breastfeeding is the recommended form of nutrition during the first 6 months of life. It provides all the essential

elements required for normal growth and development and contains several factors that protect children from infections and other disorders (Cernadas *et al*., 2003:136). Despite the protective effect of exclusive breastfeeding against undernutrition in the first 6 months of life, global exclusive breastfeeding rates stood at 40% in 2016 (Global Nutrition Report, 2017:31). This is less than the set global nutrition target of 50% by the year 2025 (Global Nutrition Report, 2017:31). It is even lower in sub-Saharan Africa, where only 37% of infants are exclusively breastfed in the first 6 months of life (Victora *et al*., 2016:447). Factors identified to contribute to early cessation of breastfeeding include maternal health risks, cultural, demographic and socio-economic factors (Santo *et al*., 2007:213). Sub-optimal feeding practices during the complementary phase also increase the risk of undernutrition in infants. Typical complementary foods used in the sub-Sahara African setting are cereal porridges, which generally has a low protein and poor micronutrient quality (Black *et al*., 2008:251). This contributes largely to insufficient nutritional intake, responsible for undernutrition in children.

2.4.3 Immediate causes of undernutrition

According to the UNICEF conceptual framework **(Figure 2.1)**, immediate causes of undernutrition in children are inadequate dietary intake and disease (UNICEF, 1998:26). These causes are the compounding effect of the basic and underlying causes emerging at the individual level (Reinhardt & Fanzo, 2014:2). The relationship between inadequate dietary intake and the manifestation of undernutrition are strongly linked. Inadequate food intake encompasses both the quantity and quality of the diet (Reinhardt & Fanzo, 2014:5). Inadequate nutritional quantity and quality reflected by macronutrient and micronutrient undernutrition affect biological processes that govern growth, immunity and development (Reinhardt & Fanzo, 2014:5).

The presence of disease in children can either be a source or consequence of undernutrition. A compromised immunity secondary to illness increases susceptibility to infections (Katona & Katona-Apte, 2008:1583). Diarrhoea and other common childhood infections can lead to a lack of absorption or loss of nutrients (Reinhardt & Fanzo, 2014:5). This can further be aggravated by loss of appetite and diversion of nutrients due to the immune system's response to disease, and urinary nitrogen losses, damaging the body's defence mechanisms (Katona & Katona-Apte, 2008:1583). In addition to weakening of the immune system, the presence of disease increases nutritional requirements and creates an environment of periodic inadequate dietary intake, consequently impairing growth and development in children (Katona & Katona - Apte, 2008:1583). A weakened immune system is a consequence of undernutrition. Undernutrition further leads to increased muscle loss, mucosal damage, and invasion by

pathogens, feeding into the undernutrition infection vicious cycle as shown in **Figure 2.2** (Katona & Katona - Apte, 2008:1583).

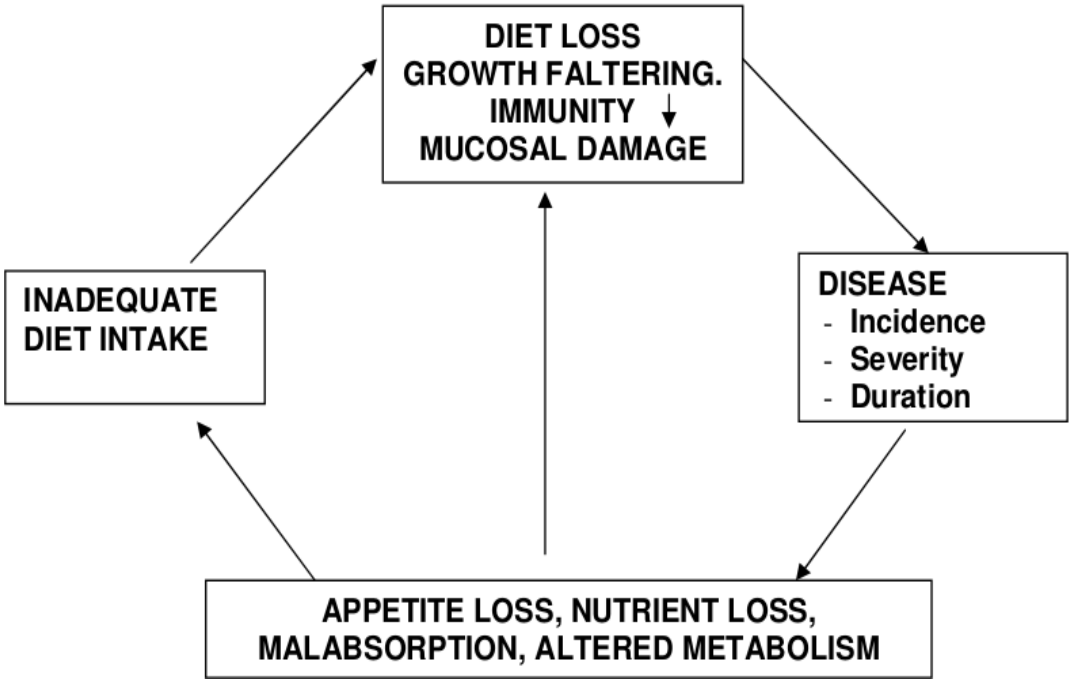

Figure 2.2: Undernutrition and infection cycle. Source: adapted from Katona and Katona-Apte, 2008.

2.5 Severe acute malnutrition

Protein-energy malnutrition is a recognized macronutrient disorder whereby the body fails to access adequate energy and protein needed for optimal growth and function (Antwi, 2011:12). Anthropometric indices are the main criteria used in the assessment of PEM / growth inadequacy in children under 59 months (WHO, 1995:161). The assessment and determination of PEM in children are mainly based on the interpretation of three anthropometric indicators: length / height-for-age (LAZ / HAZ), weight-for-age (WAZ), and weight-for-length / height z-scores (WLZ / WHZ). These indices are age and sex-specific and are derived by comparing length / height and weight measurements with reference curves of LAZ / HAZ, WAZ, and WLZ / WHZ (WHO, 1995:162). Another anthropometric indicator used in the assessment of PEM is the mid-upper-arm-circumference (MUAC). The MUAC has historically been used as an alternative indicator in the assessment of PEM, particularly in the absence of height and weight measurements (De Onis *et al*., 1997:11). Deficits in one or more of these indices are commonly regarded as evidence of PEM (WHO,1995:162). According to Bose and Mandal (2010:132), z-scores of ≤ -2 SD of WAZ and / or WHZ represent wasting (acute malnutrition), whilst z-scores of ≤ -2 SD of LAZ / HAZ define stunting (chronic

malnutrition). A MUAC ≤ 125 mm in children under 59 months is also used as a proxy for wasting (De Onis *et al*., 1997:11). Protein-energy malnutrition is classified as being either acute or chronic depending on period of clinical presentations.

Acute malnutrition is a highly volatile condition occurring as a response to inadequate intakes of one or more macronutrients, thus failing to sustain optimal body function (Manary & Sandige, 2008:1227). Macronutrient deficiency may arise secondary to inadequate diet, poor absorption of ingested nutrients, or the presence of disease, subsequently increasing requirements for nutrients while promoting a nutrient wasting and catabolic state (Manary & Sandige, 2008:1227). Acute malnutrition is defined as a WLZ / WHZ below -2 SD from the median WHZ of the WHO reference population (WHO, 1995:163). This measure signifies low body tissue and fat mass in children relative to their height, also known as wasting / thinness (Rahman *et al*., 2009:295). Acute malnutrition is categorized as either moderate acute malnutrition (MAM) or SAM, dependent on the severity. The risk of mortality in acute malnutrition is directly related to the severity. Moderate wasting is associated with a mortality rate of 30 - 148 per 1 000 children and severe wasting is associated with a mortality rate of 73 - 187 per 1 000 children per year (Collins, 2006:2). However, with appropriate and timely treatment, acute malnutrition is treatable and reversible (Jesson & Leroy, 2015:150).

Severe acute malnutrition is a severe form of PEM and presents in three clinical forms: severe wasting, oedematous malnutrition or a combination of severe wasting and oedema. They are differentiated based on clinical findings, with the primary distinction being the presence or absence of oedema (Grover & Ee, 2009:1058). Severe wasting, also known as non-oedematous SAM, is the more common presentation of SAM. It occurs secondary to the body's adaptation to starvation due to severe caloric deprivation (Grover & Ee, 2009:1058). Severe wasting / non-oedematous SAM as defined by the WHO (2009:2), is a WHZ < -3 SD from the median of the WHO 2006 growth standards or MUAC ≤ 115 mm. Severe wasting / non-oedematous SAM can also be assessed clinically. According to Grover & Ee (2009:1058), severe wasting / non-oedematous SAM is characterized clinically by depletion of subcutaneous fat stores, muscle wasting, and the absence of oedema. Visible signs of muscle wasting include thin face (old man appearance), prominence of ribs, back and scapula bones, arms and thighs presenting with loose skin and flabby muscle, loss of subcutaneous fat and muscle wasting in the gluteal region (Trehan & Manary, 2015:283). Severe wasting / non oedematous SAM follows a recent and significant loss of weight within a short period (Trehan & Manary, 2015:283).

Severe acute malnutrition presented as oedematous malnutrition is characterized by the presence of bilateral pitting oedema of nutritional origin. Nutritional oedema is a physical

finding of SAM which presents bilaterally on the dorsum of the hands and feet (Manary & Sandige, 2008:1227). Oedematous malnutrition typically occurs from a diet lacking adequate amounts of protein but with the normal caloric intake (Grover & Ee, 2009:1059). The oedema results from a combination of low serum albumin, increased cortisol, and inability to activate the antidiuretic hormone (Grover & Ee, 2009:1059). This is often aggravated by the presence of pre-existing infections (Grover & Ee, 2009:1059). Oedematous malnutrition is graded as mild (affecting only the feet), moderate (involving feet and legs and or the upper limbs), and severe/generalised (moderate and facial) (Antwi, 2011:12). Children with nutritional oedema do not have primary renal, hepatic, or cardiac disease, and they do not have ascites (Manary & Sandige, 2008:1227). The clinical picture is characterized by an almost normal WAZ due to fluid retention, marked dermatoses, hypo-pigmented hair, distended abdomen and hepatomegaly (Grover & Ee, 2009:1059). Oedematous SAM is associated with a higher mortality rate than severe wasting (Manary & Sandige, 2008:1228). The presence of bilateral pitting oedema of nutritional origin is used as an independent criterion for identifying SAM (WHO, 2013:19).

The last form of SAM is the combination of severe wasting and oedema, characterized by a combination of wasting and the presence of nutritional oedema (Trehan & Manary, 2015:283). Stunting is also a common clinical feature of this form of SAM (Grover & Ee, 2009:1060). Children presenting with this clinical manifestation of SAM are generally the most seriously ill and carry the highest risk of mortality (Trehan *et al*., 2016:128).

2.5.1 Severe acute malnutrition in infants below six months

Severe acute malnutrition occurring in infants aged 0 - 5 months is a growing global health concern. It is estimated that 3.8 million infants below the age of 6 months suffer from SAM, and the prevalence is reported to be increasing (Kerac *et al*., 2011:1008). Traditionally the management of SAM has typically focused on the 6 - 59 month age group, often neglecting younger infants (Kerac *et al*., 2015:S30). Health policies for this special age group fall in a grey area between guidelines for neonatal care and those for the management of SAM in older infants and children aged 6 - 59 months (Kerac *et al*., 2015:S30). This conventionally made the management of SAM challenging in this age group. Physiologically, this vulnerable age comprises of the transition from sole breastmilk dependence to the end of dependence on breast milk as the sole source of nutrition (Kerac *et al*., 2015:S30). In addition, physiological differences between this age group and older infants and children also warrant a different approach in the management of SAM (WHO, 2013:60). Physiological processes such as thermoregulation, renal and gastrointestinal functions are immature in infants less than 6 months and may require modified approaches to the management of SAM (WHO, 2013:60).

In addition to other problems such as low birth weight, persistent diarrhoea, recurrent sepsis, underlying chronic diseases and disability, SAM is largely reflective of suboptimal feeding practices, specifically exclusive breastfeeding (WHO, 2013:60). Exclusive breastfeeding in infants less than 6 months is considered the ideal for ensuring optimal nutritional intake, adequate growth and supporting a strong immune system (WHO, 2013:60). Unfortunately, exclusive breastfeeding rates are low. In low-income countries, it is estimated that only 37% of infants below 6 months are exclusively breastfed (Victora *et al*., 2016:478).

2.5.2 Diagnosis of severe acute malnutrition

The diagnosis of SAM in children is partly dependent on correct anthropometric assessment and interpretation. The WHO defines SAM as a WLZ / WHZ < -3 SD, MUAC ≤ 115 mm and/or the presence of bilateral lower limb oedema (WHO, 2013:19). Anthropometric assessment involves the physical taking of weight, length / height and MUAC measurements and comparing them to relevant WHO reference charts (WHO, 1995:162). This is in exclusion of the oedematous form of SAM. The use of anthropometric indices and corresponding WHO growth standards does not accurately diagnose oedematous malnutrition due to the added weight of the oedema fluid (WHO, 1999:4). Weight-for-length / height is the most objective way of assessing for recent nutritional inadequacies resulting in weight loss / weight gain failure (Antwi, 2011:13). This measure implies a low body tissue and fat mass in children relative to their length / height and is used to diagnose wasting (Rahman *et al*., 2009:295). The MUAC can also be used to diagnose wasting. Under conditions of reduced energy and protein intake, lower levels of subcutaneous fat and muscle mass tend to correspond to a decrease in the MUAC (Fernandez *et al*., 2010:e196).

The WLZ / WHZ has always been the preferred method of identifying and diagnosing severe wasting / non-oedematous SAM. Historically, MUAC has often been used as a substitute indicator, particularly in the absence of weight and length / height measurements (Fiorentino *et al*., 2016:2). However, the use of MUAC in the diagnosis of SAM has recently gained popularity. The WHO and UNICEF propose the use of WLZ / WHZ and MUAC as two independent criteria for the diagnosis of severe wasting / non-oedematous SAM in children aged 6 - 59 months (Briend *et al*., 2012:130). However, discrepancies exist between WLZ / WHZ and MUAC as indicators in the diagnosis of severe wasting / non-oedematous SAM.

The use of WLZ / WHZ as the preferred method of diagnosing severe wasting / non-oedematous SAM in children carries the advantage of being gender-specific and requires no prior knowledge of age (WHO, 1995:165). This is especially useful in emergency situations where children's ages are unknown (WHO, 2008:7). However, despite proven benefits, the

use of WLZ / WHZ is not widespread and lacks the consistency of use, particularly in the African setting (Berkley *et al*., 2005:591). Associated problems include challenges in the attainment of an accurate weight and height from distressed children, busy settings, and a lack of calibrated equipment (Berkley *et al*., 2005:592). Furthermore, determination of WLZ / WHZ also depends on correctly plotting separate values and establishing an intersection point. This is dependent on knowledgeable health workers and availability of WLZ / WHZ charts, which may not always be readily available (Berkley *et al*., 2005:592).

Measuring MUAC is another method used to assess nutritional status of children. During periods of inadequate energy and protein intake, lower levels of subcutaneous fat and muscle mass correspond to a decrease in MUAC (Fernandez *et al*., 2010:e196). This corresponding reduction allows for the determination of wasting in children. Measuring of MUAC involves the use of a colour-coded, non-stretch plastic measuring tape used for obtaining arm circumference. The colour codes estimate the degree of wasting, with red representing severe wasting, orange moderate wasting and green no wasting. Historically, MUAC has often been used as a substitute indicator in the diagnosis of severe wasting / non-oedematous (Fiorentino *et al*., 2016:2). However, its usage gained popularity with the development of community-based management of SAM (WHO *et al*., 2007:2). The use of the MUAC comes with benefits that favour its usage over WLZ / WHZ. The MUAC has been labelled as a portable, simple, low cost, age and sex independent objective method of assessing wasting in children in comparison to WLZ / WHZ (Berkley *et al*., 2005:592). Owing to the simplicity and low cost of measuring, MUAC is preferred for rapid screening of malnutrition among children at community level (Fernandez *et al*., 2010:e196). In addition to its resourcefulness at community level, MUAC has also been proved useful in emergency situations such as those of famine, where the measuring of weight and height tend to be difficult (WHO, 1995:171).

In 2009, the WHO estimated only a 40% overlap in children identified to have malnutrition between the two indicators (WHO, 2009:5). Results from a study conducted by Laillou *et al.* (2014:2-3) among Cambodian children diagnosed with SAM, showed that more than 90% of children with a WHZ < -3 SD would have remained unidentified with the use of a MUAC of ≤ 115 mm as the only screening tool. Reversely, 80% of children with a MUAC ≤ 115 mm would also have been missed with the use of WHZ < -3 SD as the sole indicator (Laillou *et al*., 2014:2-3). Fernandez *et al.* (2010:e196-e198) reported similar findings in 39 nutritional surveys conducted by doctors without borders across 10 countries. From the surveys, it was found that 75% of the children with a WHZ < -3 SD were not identified by a MUAC ≤ 115 mm (Fernandez *et al*., 2010:e196-e198). The outcomes of these studies suggest that WLZ / WHZ and MUAC may not identify the same set of severely malnourished children. Therefore, use of either WLZ

/ WHZ or MUAC as the only diagnostic criteria for SAM may result in the potential exclusion of some high-risk and critically ill children from treatment (Berkley *et al*. 2005:594).

The lack of correlation is also depicted in the ability of the two indicators to predict the same risk of mortality in children with severe wasting / non-oedematous SAM. A MUAC ≤ 115 mm has been indicated to predict mortality better than WHZ < -3 SD. The superiority of MUAC to predict mortality has been demonstrated by several studies. In a study conducted by Grellety *et al.* (2015:3-5) they compared WHZ and MUAC and their independent abilities to predict mortality in Sudanese children with severe wasting. It was found that children admitted using a WHZ < -3 SD and MUAC ≥ 115 mm had a four times higher risk of mortality in comparison to children admitted using only a MUAC < 115 mm. In another recent study conducted among Indian children with SAM, the risk of death in children having a MUAC ≤ 115 mm was twice as high as children having WHZ < -3 SD and a MUAC > 115 mm (Sachdeva *et al*., 2016:2515-2517). Equally the results of these two recent studies confirm the findings of similar older studies conducted by Briend *et al.* (2012), Fernandez *et al.* (2010), and Berkley *et al.* (2005) which found the MUAC to be superior to WHZ in predicting mortality. The lack of correlation between WLZ / WHZ and MUAC suggests potential benefit in using a combination of both criteria in the diagnosis of SAM.

2.6 Management of severe acute malnutrition

Common approaches in the management of SAM include both out-patient care in out-patient therapeutic programmes and in-patient care in hospitals, dependent on the presence or absence of complications. Children diagnosed with SAM are referred to as 'complicated' if they have clinical features of infection or metabolic disturbance, severe oedema, poor appetite and or present with one or more of the integrated management of childhood illness (IMCI) danger signs (Jones & Berkley 2014:S1). The IMCI danger signs include fever, acute respiratory tract infections, diarrhoea, malaria, measles, ear infections and a poor immunization status (Perkins *et al*., 1997:33).

Before 2007, the endorsed treatment for both complicated and uncomplicated SAM was admittance into hospitals for medical treatment and nutritional rehabilitation using fortified liquid milks (F75 and F100) (Murray & Manary 2014:266). In well-resourced countries, the treatment of SAM using the hospital facility proved successful regardless of the presence or absence of complications (Murray & Manary 2014:266). However, in settings of chronic poverty such as Africa and Asia, treatment of SAM using this approach proved ineffective, with only 25% of children admitted with SAM attaining a WHZ > -2 SD (Murray & Manary 2014:266). Limitations of the hospital facility approach in the African setting included a lack of adequate

hospital capacities to treat large numbers of children, and restrictions with coverage and intended impact (Teketse *et al*., 2012:2). Furthermore, overcrowding single units were found to further predispose the compromised sick child to a higher risk of infection from nosocomial communicable pathogens (Murray & Manary 2014:267). Therefore, this treatment approach was associated with lengthier hospital admissions and increased risk of morbidity and mortality.

In 2007, multilateral UN agencies (UNICEF, WHO and the World Food Program) endorsed the community-based management of acute malnutrition (CMAM). The CMAM model recommends in-patient care in hospital facilities for children with complicated SAM and out-patient care in out-patient therapeutic programs in the absence of complications (WHO *et al*., 2007:3). This approach permitted the treatment of large numbers of children with uncomplicated SAM within their communities at out-patient therapeutic programmes without requiring admission into a hospital facility (Teketse *et al*., 2012:3).

2.7 World Health Organization admission criteria

The critical decision of admitting children diagnosed with SAM largely lies in the correct identification and interpretation of anthropometric indicators and clinical presentations. According to the WHO (2013:20), infants and children aged 6 - 59 months of age, identified to have a WLZ / WHZ < -3 SD or MUAC < 115 mm of the WHO growth standards or the presence of bilateral lower limb oedema, should be immediately admitted to a programme for the management of SAM (**Table 2.1**). It is recommended that children identified with SAM initially undergo a full clinical examination to confirm the presence or absence of medical complications (WHO, 2013:20). Out-patient treatment of SAM is endorsed in children who pass the appetite test and are clinically well and alert and in-patient admission into hospital facilities is recommended for children presenting with complicated SAM (WHO, 2013:20), with no or poor appetite.

Present data trends indicate a progressive increase in the incidence of SAM in infants less than 6 months of age. Despite the recognized increasing burden of SAM in this age group, specific guidelines addressing the identification and management of SAM in this special age group were only included in the recently updated WHO guidelines for the “Management of severe acute malnutrition in infants and children” (WHO, 2013:60). The identification of infants less than 6 months of age with SAM and warranting of in-patient care also largely relies on correct identification and interpretation of anthropometric indicators and clinical signs. According to the WHO (2013:63), infants less than 6 months of age diagnosed with SAM and any other complicating issues as detailed in **Table 2.1**, should be admitted for in-patient care.

Table 2.1: World health organization in-patient admission criteria

WHO recommendation	Quality of evidence
Criteria for identifying children with SAM for treatment (6-59 months)	
Children with a WLZ / WHZ < -3, MUAC <115 mm, or a degree of bilateral oedema should be immediately referred for a full assessment at a treatment centre.	Strong recommendation, low quality evidence
Should SAM be identified, the child should first be assessed with a full clinical examination to confirm medical complication and the presence/ absence of appetite. Should the child have an appetite and are clinically well, the child should be treated as an outpatient.	Strong recommendation, low quality evidence
Criteria for admission into in-patient care (6-59 months)	
MUAC < 115 mm and / or WLZ / WHZ < -3, or bilateral oedema Severe bilateral oedema, no medical complication, and good appetite SAM presenting with one or more IMCI danger signs SAM with any medical complications, oedema or failed appetite test	Strong recommendation, very low quality evidence
Criteria for identifying infants with SAM for treatment (0-5 months)	
Infants with WLZ < - 3, or presence of bilateral pitting oedema, or infants who have been identified to have poor weight gain and not responding to nutrition counselling and support, and or any infant presenting with any IMCI danger signs should be admitted for further assessment.	Strong recommendation, very low quality evidence
Criteria for in-patient care (0-5 months)	
Any serious clinical condition or medical complication Recent weight loss or lack of weight gain Ineffective feeding (attachment, positioning and suckling) directly observed for 15-20 minutes Pitting oedema of any grade Medical or social issues needing more detailed assessment or intensive support	Strong recommendation, very low quality evidence

WHO: World Health Organization; SAM: severe acute malnutrition; WLZ: weight-for-length-z-score; WHZ: weight-for-height-z-score; MUAC: mid-upper arm circumference; IMCI: Integrated management of childhood illness. Source: (WHO, 2013).

The summary of the quality of evidence used for the in-patient admission criteria of children with SAM aged 0 - 59 months is shown in **Table 2.1**. However, despite the criteria carrying very strong recommendations, it is based on low and very low evidence. This is mainly due to the lack of randomized control trials and other studies which scrutinized the in-patient admission and transfer criteria of children with SAM aged 0 – 59 months (WHO, 2013:15).

Secondary to the lack of good quality evidence, the WHO has highlighted the need for more research regarding the in-patient admission criteria of these infants and children (WHO, 2013).

2.8 World Health Organization transfer criteria

Succeeding in-patient treatment of SAM, infants and children are in need of continued nutritional rehabilitation and monitoring. A summary of the transfer criteria of infants and children aged 0 - 59 months with SAM as per the WHO recommendations are shown in **Table 2.2**. The WHO recommends that children aged 6 - 59 months be transferred to out-patient nutrition therapeutic programs when medical complications are resolved, children have a good appetite, and are clinically well and alert (WHO, 2013:20). According to the WHO (2013:20), the decision to transfer children with SAM from in-patient care to out-patient nutrition therapeutic programmes should be determined by the stability of their clinical condition and not on improvements of anthropometric indicators such as WLZ / WHZ and MUAC. However, slight discrepancies exist in the transfer recommendations with regards to infants below the age of 6 months. According to the WHO (2013:64), infants less than 6 months of age can be transferred to an out-patient nutrition therapeutic program when medical complications are resolved, good appetite established and infants present as clinically well and alert**.** Satisfactory weight gain on either exclusive breastfeeding or replacement feeding should also be established. Weight above the median of the WHO growth velocity standards or a weight gain of more than 5 g/kg/day for at least 3 successive days is recommended prior to transfer to out-patient care (WHO, 2013:65)**.** In addition to the resolution of medical complications and adequate weight gain, the immunization status of the infant should be proved up to date, and social and follow up support organised for the mother or caregiver (WHO, 2013:65)**.**

However, it is of importance to note that despite the WHO transfer criteria being strongly recommended, the quality of the evidence they are based on is of low and very low quality. This is indicative of the need for further research pertaining to the transfer criteria of infants and children with SAM from in-patient care to out-patient nutrition therapeutic programs (WHO, 2013).

Table 2.2: World Health Organisation transfer criteria of children with severe acute malnutrition

WHO recommendation	Quality of evidence
Transfer criteria children with SAM aged 6 - 59 months	
Medical complications including oedema resolved Good appetite Clinically well and alert Not based on anthropometric indicators such as WLZ / WHZ and or MUAC	Strong recommendation, low quality evidence
Transfer criteria of infants with SAM aged 0 - 5 months	
Medical complications including oedema resolved Good appetite Clinically well and alert > 5 g/kg/day for at least 3 successive days or Weight above the median of the WHO growth velocity standards Immunizations status up to date Social and follow up support organised for mother / caregiver	Strong recommendation, very low quality evidence

WHO: World Health Organization; SAM: severe acute malnutrition; WLZ: weight-for-length-z-score; WHZ: weight-for-height-z-score; MUAC: mid-upper arm circumference. Source: (WHO, 2013).

2.9 Botswana in-patient admission and transfer criteria

Severe acute malnutrition in Botswana was historically thought of as rare. However, this norm changed with the advent of the HIV pandemic in the nineties (MOHW, 2008). Prior to 2009, the management of SAM in Botswana was mainly guided by the “National guidelines for the management of severely malnourished children” (MOHW, 2008). These guidelines emphasized the management of SAM mainly through inpatient care (MOHW, 2008). In 2009, the Department of Public Health, under the Ministry of Health, adopted the CMAM approach in the management of SAM (Botswana IMAMU, 2015). Then, in 2014, the Ministry of Health Botswana commissioned the development of guidelines for the integrated management of acute malnutrition and underweight in children and adolescents (IMAMU) (Botswana IMAMU, 2015). The content of the guidelines was mainly influenced by the current WHO recommendations on the management of SAM in infants and children and the CMAM model (Botswana IMAMU, 2015). However, these guidelines are still at draft level and awaiting finalization. There are no specific national guidelines guiding the in-patient admission and transfer of children with SAM. The current WHO guidelines serve as a reference for the management of SAM in infants and children among health workers in Botswana.

2.10 In-patient admission and transfer criteria and clinical outcomes

Severe acute malnutrition requiring in-patient hospital admission is associated with detrimental outcomes such as increased mortality rate, length of hospital stay and poor recovery (Trehan *et al*., 2013:430). The minimum acceptable international standards set for the management of SAM is a cure rate of ≥ 75%, death rate ≤ 10%, and an average daily weight gain of > 8g/kg/day (SPHERE project team, 2011). Unfortunately, most hospitals in sub-Sahara Africa report poor recovery and high mortality rates of 10 - 40% among children hospitalized for the management of SAM (Fergusson & Tomkins, 2009:545). Few studies have been conducted, establishing the association between SAM in-patient admission and transfer criteria and clinical outcomes such as mortality, length of hospital stay (LOS) and actual recovery. In a systematic review conducted by Roberfroid *et al.* (2013), only one study was found which compared the clinical outcomes of children admitted and discharged using MUAC in comparison to WHZ. This study compared the mortality risk of hospitalized children admitted with a MUAC ≤ 115 mm in comparison to a WHZ ≤ -3 SD (Berkley *et al*., 2005:591-597). The highest risk of mortality (25%) was observed in children admitted with both a MUAC ≤ 115 mm and a WHZ ≤ -3 SD and not the independent use of either MUAC or WHZ (Berkley *et al*., 2005:593). In addition to mortality, the results of the study also showed that admission using a MUAC ≤ 115 mm alone was associated with a longer hospital stay and a higher likelihood of illness such as diarrhoea, coughing, anaemia, and bacteraemia (Berkley *et al*., 2005:594). No studies were found which compared the transfer criteria and clinical outcomes of children with SAM.

2.11 Summary

This review sought to highlight the currently available literature on SAM and the in-patient admission and transfer criteria of children under 59 months. The literature reveals the lack of good quality evidence with regard to SAM in-patient admission and transfer criteria and their associated clinical outcomes. Moreover, the lack of SAM guidelines both at national and hospital level, in inclusion of PMH further substantiates the need for more research pertaining to SAM in Botswana.

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CHAPTER 3 ARTICLE

Chapter three is the article titled “Association between admission and transfer criteria and clinical outcomes of infants and children (0 – 59 months) treated for severe acute malnutrition in Botswana”. The anticipation is that it will be considered for publication in the *South African Medical Journal* (SAMJ).

3.1 Title page

Association between admission and transfer criteria and clinical outcomes of infants and children (0 – 59 months) treated for severe acute malnutrition in Botswana

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Word count

Abstract (525)

Main Body word count (3887)

Number of references (40)

Number of tables and figures (9)

Author contributions: Dr Martani Lombard and Ms Cornelia Conradie developed the concept model of the study and offered mentorship. Maemo Lesiapeto assisted with data collection and interpretation of statistical findings. Vera Moonga was responsible for concept development, data collection, analysis, interpretation and write up of the entire research project. All authors edited the draft article and approved the final version of the article before publication.

Acknowledgements: We would like to thank the Dietetics, Records, and Paediatric departments of Princess Marina Hospital for the assistance rendered during the data collection process.

Source of funding: The study was self-funded.

Conflict of interest: None

3.2 Article to be submitted to the South Africa Medical Journal

ABSTRACT

Background

Complicated severe acute malnutrition (SAM) in children under 59 months demonstrates an increase on a country's economic burden and higher child mortality rates. Despite focussed efforts, 17 million children remain affected by SAM, with a quarter of them residing in Africa. High in-patient mortalities up to 46% have been reported within sub-Sahara Africa. Very few studies have verified the efficacy of the current World Health Organization (WHO) in-patient hospital admission and transfer criteria against treatment outcomes such as recovery, hospital stay (LOS) and mortality. In Botswana, the updated WHO SAM management guidelines have been taken into consideration when drafting the more recent 'integrated management of acute malnutrition and underweight in children and adolescents (IMAMU)' guidelines. However, since these guidelines are still in draft format, the current WHO admission and transfer criteria serve only as a reference. Furthermore, the association between the admission and transfer criteria with clinical outcomes are yet to be established. The aim of this study was to determine the association between SAM in-patient admission and transfer criteria and clinical outcomes of children aged 0-59 months in Botswana.

Objectives

To achieve the study aim, the following objectives were set: to describe basic demographic profiles of those represented on the data extraction forms, to describe admission and transfer criteria, to describe basic clinical outcomes (recovery, LOS and mortality) and to identify associations between admission and transfer criteria and clinical outcomes.

Methods

Data was extracted from medical records of children aged 0–59 months admitted for the in-patient treatment of SAM in a referral hospital from January 2013 - May 2018. Data extracted included demographic and anthropometric profiles and clinical presentations on both admission and transfer. Data were analysed using SAS version 9.4. and logistic regressions were conducted to test for associations between admission and transfer criteria and clinical outcomes (LOS, weight gain and mortality).

Results

All available, relevant files in the hospital were idendified. A total of 101 medical records were included in the study. Admission and transfer practices observed were not in line with the current WHO recommendations. Weight-for-height z-scores (WHZ) were measured in 54% of children at admission and in none on transfer. The mid-upper-arm-circumference (MUAC) was poorly measured. Only 17% and 1% of children had a MUAC measurement at admission and transfer respectively. Results revealed a LOS of 17 days, average daily weight gain of 5.4 g/kg/day, and a mortality rate of 28%. Oedema at admission was associated with an increased risk of mortality ($P = 0.045$). Neither a WHZ < -3 SD or a MUAC ≤ 115 mm at admission or transfer had any associations on the LOS ($P = 0.998$ and $P = 0.906$), weight gain ($P = 0.914$ and $P = 0.218$) and mortality ($P = 0.377$ and $P = 0.265$) respectively.

Conclusion

Adherence to the recommended WHO admission and transfer criteria was poorly conducted. Daily weight gain and mortality were below and above the acceptable global SPHERE levels respectively. Oedema on admission was associated with an increased risk of mortality. The lack of association between other admission and transfer criteria and clinical outcomes of interest could have been due to the poor compliance of anthropometric measures.

INTRODUCTION

Malnutrition is defined as the state in which deficits between energy, protein and other nutrients supply and the body's demand cause measurable adverse effects on growth and body function.[1] In children under 59 months of age, malnutrition encompasses a syndrome of nutritional disorders manifesting from inadequate intakes of macronutrients and/or micronutrients, resulting in wasting, stunting, and specific micronutrient deficiencies.[1] Significant milestones in curbing child malnutrition have been achieved within the last two decades.[2] However, despite the progress, estimates indicate that 49 million children remain wasted, with 17 million having severe acute malnutrition (SAM).[3] The majority of these children reside in Africa and Asia.[3] Severe acute malnutrition is associated with devastating consequences.[3,4] Children with SAM have a tenfold increased risk of mortality in comparison to well-nourished children.[5] In addition, SAM is associated with an increased susceptibility to infections, presenting an important risk factor of co-morbidities.[3] Due to the profound vulnerability to medical complications, disease and mortality, SAM is a common indication for paediatric hospital admissions.[6] Long term consequences include a less than average adult height, interfered cognitive developmental potential and reduced economic productivity.[5]

In the recently updated WHO SAM guidelines, SAM is defined as a weight-for-height (WHZ) < -3 SD of the median of the WHO growth standards or a mid-upper-arm-circumference (MUAC) ≤ 115 mm and/or the presence of bilateral oedema.[7] The management of SAM includes out-patient community-based management (CMAM) and in-patient hospital management.[8] In-patient admission is recommended for children presenting with infections or metabolic disturbance, severe oedema, and poor appetite.[9] Though these criteria are strongly recommended by WHO, the quality of research it is based on is of low and very low quality.[7] In 2009, Botswana adopted the CMAM approach.[10] Despite this, Botswana SAM guidelines are still at draft level and awaiting finalization[10] and the current WHO guidelines thus only serve as a reference for the management of SAM.

Acceptable international standards set for the management of SAM includes a recovery rate of ≥ 75% and a mortality rate of ≤ 10%.[11] Despite the containment of SAM being critical to child survival, many countries continue to report unacceptable levels in the management of SAM.[12] This is particularly typical of sub-Sahara Africa, where in-patient fatalities attributed to SAM remain as high as 40%.[12] For the most, persistently high case-fatality rates were deemed due to incongruous case management.[14] However, emerging studies suggest potential influences of admission and transfer criteria on outcomes of children with SAM.[15] Furthermore, very few studies have verified the efficacy of the current WHO in-patient admission and transfer criteria with regard to outcomes such as recovery, length of hospital stay (LOS) and mortality[7] To date, no studies have been conducted pertaining to SAM admission and transfer criteria in Botswana. Therefore, this study was conducted to determine the association between in-patient SAM admission and transfer criteria and clinical outcomes of infants and children aged 0-59 months.

METHODS

Study design

A retrospective longitudinal study was undertaken in a referral hospital, the largest referral and teaching hospital in Botswana. It is a hospital with a bed capacity of 530. The hospital boasts a range of medical specialities, including paediatric services. Most SAM cases received in the hospital are referrals from clinics and district hospitals.

Ethics

Ethical approval was obtained from the North-West University Health Research Ethics Committee (HREC) (NWU-00063-17-A1), Ministry of Health and Wellness (MOHW) (HPDME 13/18/1) Botswana, and Princess Marina Hospital (PMH) ethics committee (PMH 5/79 (442-1-2018). Medical record privacy and patient anonymity was upheld.

Data collection

Medical records were retrieved from the national paediatrics admission and discharge annual registers in reverse chronological order. A list with all identified records was submitted to the records department for retrieval assistance. Retrieved records were screened using an eligibility questionnaire. Eligibility included medical records of children irrespective of gender, age (0-59 months), admitted for in-patient treatment of SAM (regardless of severity, the presence or absence of appetite, oedema and/or any other infectious diseases secondary to SAM). Children diagnosed with SAM during admission also qualified for inclusion. Only medical records between January 2013 and May 2018 qualified for inclusion. Medical records prior to 2013 were not included since WHO amended treatment guidelines in 2012. Records of children diagnosed with metabolic, neurologic, growth disorders, prematurity and/or low birth weight (< 2.5 kg) were excluded. In addition, incomplete records, and those with undetermined treatment outcomes were also excluded.

Data was extracted privately from an assigned room within the records department by registered dieticians previously trained on the data collection process. The identification numbers of eligible medical records included were then entered into a registry to avoid duplicate capturing. Data extraction was conducted using a pre-designed data extraction form adapted from three WHO documents published on the WHO admission criteria and treatment guidelines to ensure content validity (WHO, 2010). Data collected included demographic information, admission data such as the date and time of admission, gender, age, anthropometric profile (weight, height/length, MUAC and WHZ), date of SAM diagnosis, oedema status, clinical signs and symptoms, HIV and tuberculosis (TB) status and medical complications present at admission. Clinical signs and comorbidities identified were as defined by managing clinicians. Transfer/in-patient discharge data was also extracted, including transfer anthropometric profile, weight gain, and resolution of medical complications, HIV and TB status, and appetite status. Treatment outcomes such as transferral or mortality were also extracted. The supervising researcher validated all extracted data against the medical records for accuracy daily.

A total of 247 identified medical record numbers were submitted to the medical records department for retrieval. Of those 177 were retrieved for screening, with 70 files deemed as missing. Of the 177 medical records screened, 101 qualified for inclusion in the study.

Statistical analysis

Data was captured from individual data extraction forms into Microsoft Access 2010, verified and cleaned before analysis. The admission and transfer anthropometric profiles of WHZ and MUAC of each child at admission were calculated using the WHO Anthro Plus (version 3.2.2, January 2011), using the % igrowup_standard macro for SAS (WHO,2017). Medical records of oedematous participants were exempted from calculations of WHZ. Length of hospital stay (LOS) was the difference between the date of admission and date of discharge or death. Average daily weight gain was calculated from the difference between mean weight at

admission and discharge and the average LOS. Clinical outcomes of interest included LOS, growth and mortality.

Data analysis was conducted using SAS version 9.4. Descriptive statistics including frequency analysis, calculation of the mean, standard deviation, median and the quartiles was done. Logistic regressions were conducted to test for associations between variables. The tests for associations included type 3 analysis of effects, Chi-Square tests, analysis of maximum likelihood estimates and odds ratio estimates. The tests were conducted at 5% level of significance and a p-value less than 0.05 was considered significant.

RESULTS

A total of 101 medical records of children aged 0-59 months admitted for the in-patient management of SAM were included in the final analysis of the study. Ninety-seven of the children were diagnosed within 24 hours of admission whilst the rest had SAM as a secondary diagnosis during the course of admission. Majority of children admitted were in the 6-59 months' age group (89%), 11% represented infants < 6 months. Fifty-three percent of the children were male and 47% female. Considering the mean age, the girls were slightly older than the boys. The mean age of the children was 14 months. Hospital practices with regard to anthropometric measurements on admission are shown in Table 1. All children had their weight and 90% had their height measured on admission. The mean weight and height was 6.48 kg and 69.78 cm respectively. The mean MUAC was 113.18 mm, measured in 17% of the children on admission. The mean WHZ on admission was -3.48 SD. Calculation of WHZ was not routinely done on admission.

Table 1: Demographic and anthropometric characteristics on admission

Profile	n	n (%)	Mean	(IQR)
Age (months)				
Total sample	101	100	14.23	(8.48; 17.22)
Male	54	53	13.55	(8.02; 16.39)
Female	47	47	15.01	(9.95; 18.17)
Hospital Practice				
Weight (kg)	101	100	6.48	(5.33; 7.50)
Height (cm)	90	89	69.78	(65.00; 74.00)
MUAC (mm)	17	17	113.18	(102.00; 115.00)
Z scores				
WHZ	55	54	-3.48	(-4.23; -3.00)

n: number; IQR: interquartile range; kg: kilograms; cm: centimetre; MUAC: mid-upper arm circumference; WHZ: weight-for-height z-score

On admission, 62% of children had severe wasting / non-oedmatous SAM and 34% oedematous SAM **(**Figure 1**)**. Approximately 40% of the children admitted had a WHZ < -3 SD and 12% a MUAC ≤ 115 mm **(**Table 2**)**. Table 2 also shows that of all the children

diagnosed with oedematous SAM, 51% presented with moderate oedema, 29% severe oedema and 20% mild oedema.

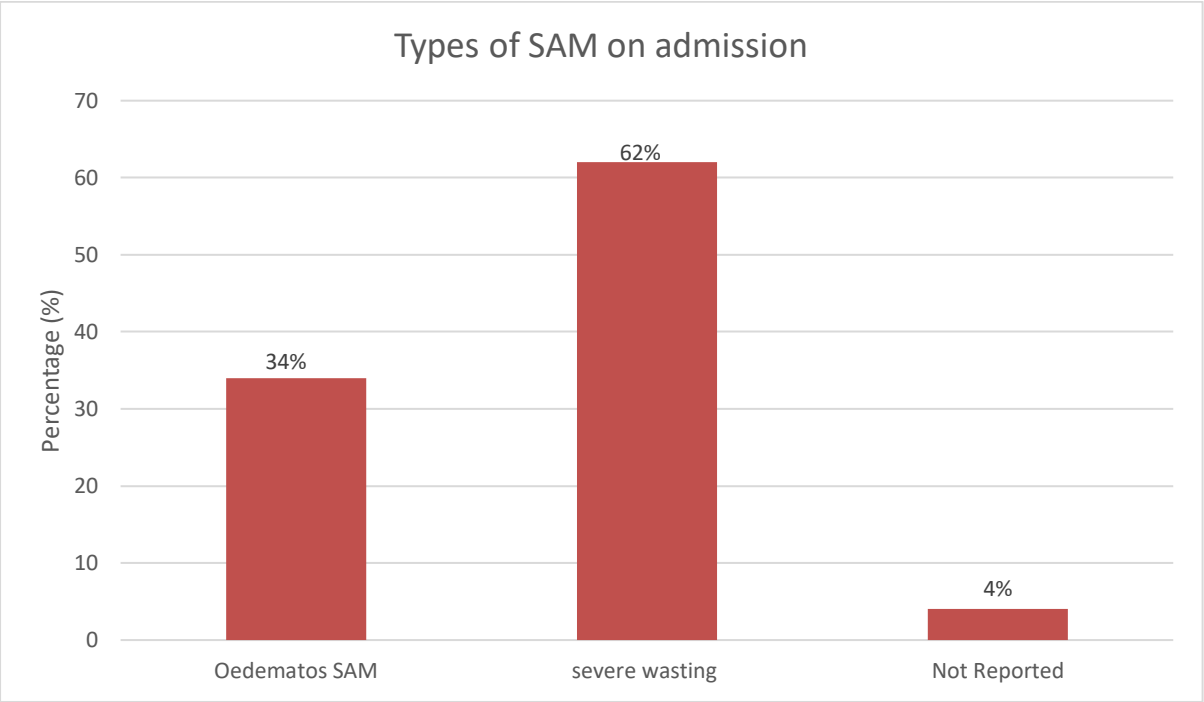

Figure 1: Types of severe acute malnutrition on admission

Table 2: Severe acute malnutrition admission criteria used by hospital

Criteria	n	n (%)
WHZ		
< -3	40	40
> -3	28	28
Unreported	33	32
MUAC		
≤ 115 mm	12	12
> 115 mm	5	5
Unreported	84	83
Oedematous malnutrition	**34**	**34**
Mild	7	20
Moderate	17	51
Severe	10	29
SAM diagnosed during admission	**4**	**4**

n: number; WHZ: weight-for-height z score; MUAC: mid-upper-arm-circumference; mm: millimetre

Clinical presentations on admission

The results show that irritability (93%), visible wasting (70%), diarrhoea (50%) and vomiting (43%) were the most prevailing clinical signs presented on admission. Other clinical signs and symptoms present at admission included: severe pallor (33%), dermatitis (27%), fast pulse (23%), irregular heartbeat (19%) and a slow capillary refill (18%). Medical complications accompanying the diagnosis of SAM are shown in Figure 2. Pneumonia was the most common medical complication (62%) followed by gastroenteritis (50%) and dehydration (45%).

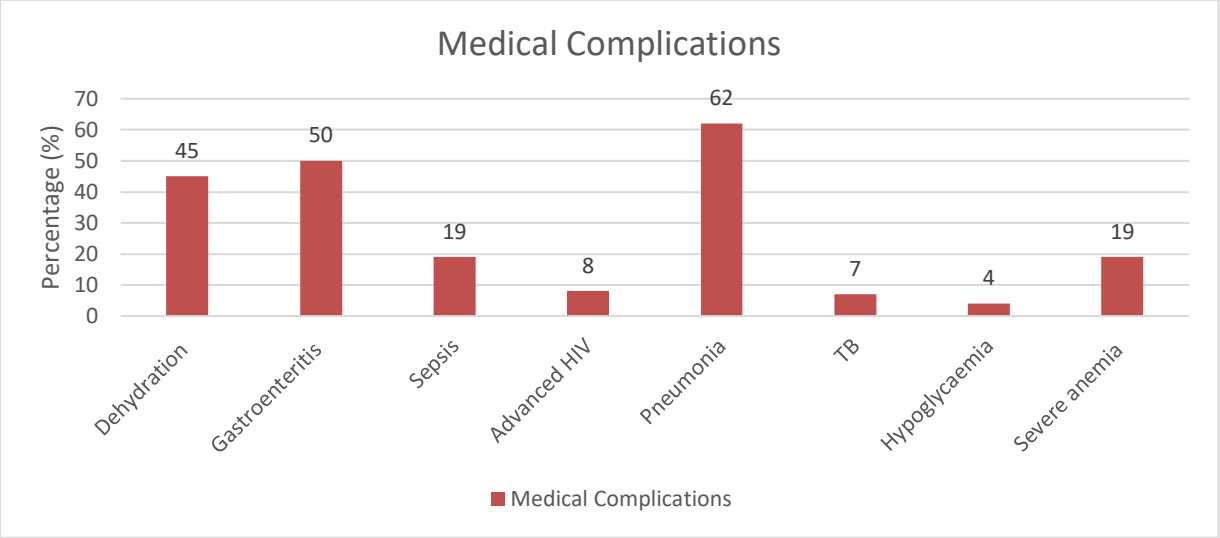

Figure 2: Medical complications present at admission

Recovery

The results show that oedema and infections resolved in 99% and 44% of the children respectively on transferral from in-patient management. Figure 3 also shows that 67% of the children admitted with SAM had a good appetite by the time of transfer.

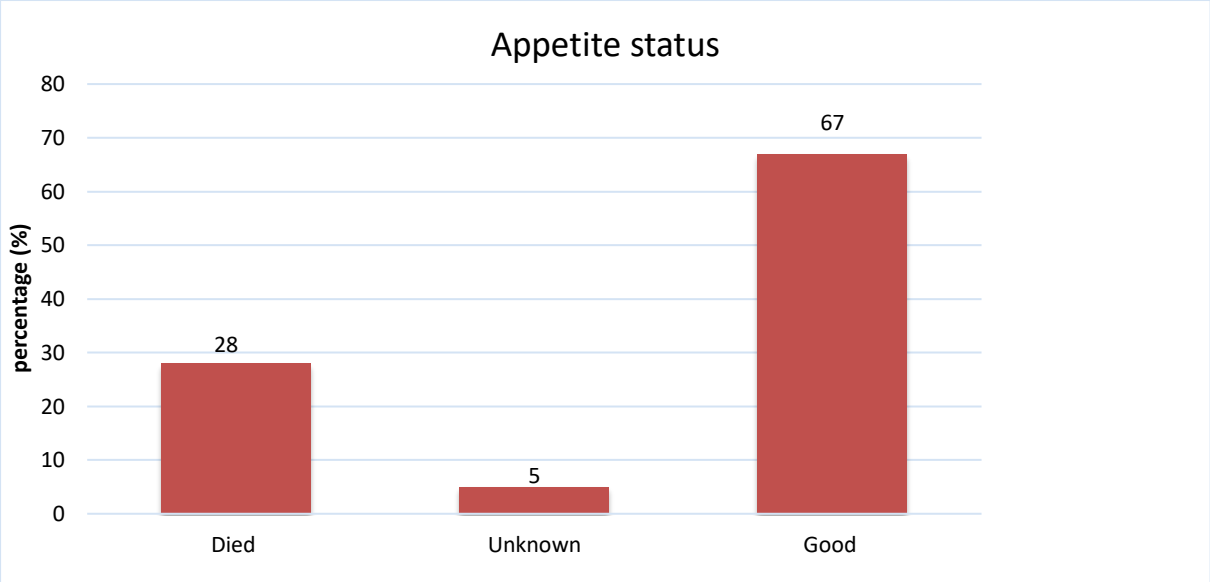

Figure 3: Appetite status on transfer

Anthropometric profiles on transfer

A total of 74 children survived to the point of transfer from in-patient hospital care, with 84% of them being transferred to an out-patient SAM rehabilitation centre. Approximately 16% of children were not referred to an out-patient therapeutic programme for follow up. Hospital practices show that all children had their weight measured at admission whilst 91% were measured on transfer (Table 3). The frequency of measuring height decreased from 90% at admission to only 3% on transfer. MUAC measurements were the least taken with only one child having had a measurement on transfer. The mean weight of the children increased from 6.48 kg to 7.34 kg between admission and transfer.

Table 3: Anthropometrics practices on transfer

Variable	n (Adm)	n (TF)	Adm Mean (IQR)	T/F Mean (IQR)
Hospital practice				
Weight (kg)	101	67	6.48	7.34
Height/ length (cm)	90	2	69.70	69.50
MUAC (mm)	17	1	113.18	110.00

n: number; Adm: admission; T/F: transfer; IQR: interquartile range; kg: kilograms; cm: centimetre; mm: millimetre; MUAC: mid-upper-arm-circumference

CLINICAL OUTCOMES

Clinical outcomes of interest included LOS, growth and mortality. Length of stay was calculated as the time period (in days) between admission and transfer. Growth was determined by weight gain and changes in z-scores. Mortality measured the number of children subjected to death after admission and before transfer.

Length of hospital stay

Table 4 shows the descriptive statistics for LOS, weight gain and weight gain per day. The average LOS was 17 days. Majority of the children (82%) had a LOS $\geq$ 7 days and only a few (8%) qualified for transfer within 7 days. The LOS had a range of 15 days with a lower quartile of 12 days and an upper quartile of 27 days.

Table 4: Descriptive statistics for length of stay and growth

Variable	N	Mean	SD	LQ	UQ
Length of stay (days)	73	17.01	25.57	12	27
Weight gain (kg)	67	0.72	0.66	0.35	1.04
Weight gain per day	67	0.04	0.05	0.02	0.07

n: number; SD: standard deviation; LQ: lower quartile; UQ: upper quartile: kg: kilogram

Growth

Growth was represented by weight gain and changes in z-scores. Table 4 also shows the descriptive statistics for weight gain during admission. The average total weight gain of the children during hospital stay was 0.72 kg. The average weight gain/kg/day was 5.4 g/kg/day. Growth was also determined by changes in z-scores. No changes in WHZ and MUAC were found between admission and transfer.

Mortality

A total of 27 children died during admission translating to a mortality rate of 28%. Table 5 reflects that 82% of all deaths were of children aged 6-59 months. Few deaths (18%) occurred among infants aged 0-5 months. Oedematous SAM was the primary diagnosis for 56% of all the deaths, and non-oedematous SAM 44%. Majority of mortalities (63%) occurred within the first 7 days of admission whilst 37% occurred after 7 days of admission. The longest duration to death was 30 days and the shortest < 24 hours.

Table 5: Mortality according to age group and type of malnutrition

Mortality	N	Percentage (%)
Age group (months)		
< 6	5	18
> 6 ≤ 59	22	82
SAM category		
Oedematous SAM	15	56
Non-oedematous SAM	12	44
Duration to death (days)		
< 7	17	63
> 7	10	37

n: number; SAM: severe acute malnutrition; WLZ: weight-for-length z score; WHZ: weight-for-height z score; SD: standard deviation; MUAC: mid-upper-arm-circumference; mm: millimetre

Relationships between admission criteria and clinical outcomes

The results as illustrated in Table 6, show that WHZ < -3 SD at admission did not influence LOS (P=0.998). There was also no significant statistical relationship between a WHZ < -3 SD at admission and the rate of weight gain during hospital stay (P=0.914) and also the risk of mortality (P=0.377). Table 6 further indicates the lack of a significant statistical relationship between a MUAC ≤ 115 mm at admission and LOS (P=0.906), weight gain during hospital stay (P=0.218) and mortality (P=0.265). The presence of oedema at admission regardless of the grade, was associated with an increased risk of mortality (P=0.045). However, no statistical relationships were found between the presence of oedema at admission and LOS (P=0.818) and weight gain during hospital stay (P=0.132). Furthermore, no associations were found with any of the transfer criteria used and the clinical outcomes of interest.

Table 6: Association between admission and clinical outcomes

Variables	Clinical outcomes (Chi square test p-value)		
Admission criteria	**LOS**	**Weight gain**	**Mortality**
WHZ< -3 SD	0.998	0.914	0.377
MUAC ≤ 115 mm	0.906	0.218	0.265
Oedema (any grade)	0.818	0.132	0.045

LOS: length of stay; WHZ: weight-for-height z score; MUAC: mid-upper-arm-circumference; mm: millimetres.

DISCUSSION

The aim of this study was to determine the association between SAM in-patient admission and transfer criteria and clinical outcomes of children aged 0-59 months in Botswana. The distribution of SAM by age group indicated that the majority of SAM admissions were within the 6-59 months age group, with the highest peak being in the 6-24 months (89%). This is expected, due to vulnerabilities accompanying the transition from sole reliance on exclusive breastfeeding to introduction of complementary feeds.[7] In addition to the norm, these findings corroborate studies conducted in Ghana and Nigeria respectively, which also found that the majority of children with SAM were aged between 6-59 months.[16,17] Despite the burden of SAM largely resting with children aged 6-59 months, this study also highlights the occurrence of SAM in infants less than 6 months. According to the WHO, SAM in this age group is surging, with sub-optimal exclusive breastfeeding practices being identified as one of the leading causes.[7]

The findings of this study suggest that WHZ was the more frequently utilized indicator used to diagnose SAM than MUAC. In at least 54% of the children, WHZ was reported on admission. The MUAC was poorly captured, with only 17% of the children having a documented MUAC measurement on admission. The poor measurement of the MUAC was not exclusive to this study. In a large study conducted among 5 health centres in Uganda, only 14% of children had a MUAC measurement on admission into an in-patient/ out-patient health facility.[18] The WHO recommends the use of both WHZ and MUAC as two independent criteria for the diagnosis of SAM.[7] However, in the study hospital, SAM admission practices demonstrate the inconsistent usage of the two indicators in the assessment and diagnosis of SAM. Several studies have illustrated that the two indicators do not identify the same set of children as having SAM.[19-21] The usage of only one indicator may potentially result in the exclusion of children with SAM from treatment.[19] Akugizibwe and colleagues, acknowledged poor documentation, high patient workload, poor health worker knowledge, and unavailability of resources such as weight scales, stadiometers, and MUAC tapes as some of the contributing factors to poor SAM admission practices.[18] In Botswana, the lack of national and hospital guidelines could have also contributed to the sub-standard and inconsistent SAM admission practices by health care workers.

Severe acute malnutrition is classified based on clinical presentation as either severe wasting or oedematous SAM. On admission, 62% of children presented with severe wasting / non-oedematous SAM and 34% with oedematous SAM. This is in agreement with other studies, which found severe wasting / non-oedematous SAM to be more prevalent than oedematous SAM in India and Ghana respectively.[22-24] Severe wasting is defined as a WHZ < -3 SD and/or a MUAC ≤ 115 mm.[25] In this study, 40% of children admitted had a WHZ < -3 SD and 12% a MUAC ≤ 115 mm. However, it should be noted that the MUAC was grossly disadvantaged

in this study secondary to a large proportion (83%) of children not having MUAC measurements on admission. This further highlighted the lack of adherence to the current recommended WHO SAM in-patient admission criteria.

The relationship between SAM and infections cannot be disputed. Severe acute malnutrition increases susceptibility to common infectious diseases owing to its associated role in the degradation of the immune system.[9] In this study, common infections accompanying SAM included: pneumonia, diarrhoea, sepsis and tuberculosis in sequential order. The findings correlate well with other retrospective studies, which also found pneumonia, diarrhoea, sepsis, and tuberculosis as frequently escorting infections of SAM.[26,27] A total of 72% of the children survived to the point of transfer. According to the WHO recommendation, children with SAM qualify for transfer to an out-patient facility when medical complications, in the inclusion of oedema, are resolved, they have a good appetite, and are clinically well and alert.[7] At the time of transfer, majority of children (99%) had oedema resolved. However, only 67% a good appetite and 44% had recovered from admission infections.

The SPHERE acceptable international standards set for the management of SAM in children is a death rate of ≤ 10%, cure rate ≥ 75% and a minimum daily weight gain of > 8g/kg/day.[28] The mortality rate of children treated for SAM in the study hospital was 28%. The average LOS was 17 days, which was within the internationally accepted maximum of 30 days.[28] A similar study conducted in Ghana reported an even lower LOS of 11 days.[24] Given the high risk of nosocomial infections and increased healthcare costs associated with prolonged hospital stay,[29] the study LOS can be deemed as reasonable. However, a shortened LOS may have disadvantaged the time allocated towards a more comprehensive treatment approach. This may ultimately increase the risk of relapse and mortality following transfer/discharge.[30] The average rate of weight gain of this study was 5.4g/kg/day, which was less than the acceptable range of the global SPHERE standards of > 8g/kg/day. The average daily weight gain found in this study was comparable to other studies.[24,31] An average weight gain less than the global SPHERE standards is highly indicative of poor response to treatment and possible premature discharge.[6]

In comparison to the SPHERE standards, a mortality rate of 28% is unacceptably high. Two regional studies conducted in Zambia in 2011 and 2015 exposed even higher mortality rates of 40.5% and 46% respectively.[32,33] This is not surprising as case-fatality rates ranging between 20% to 50% have been reported in many sub-Sahara countries.[34] According to the WHO, children with SAM have an increased mortality risk due to profound physiological and metabolic disturbances.[7] Despite the recognized risk of mortality, high case mortalities are also attributed to inappropriate case management and poor health worker knowledge.[14] In this study, the poor SAM admission practices and the lack of specific SAM hospital protocols cannot be overlooked as a potential aggravating factor. Additionally, the high mortality rate could have been linked to the study hospital being a referral hospital and being recipient to mainly critically ill SAM cases.

The results showed that 56% of deaths occurred in children with oedematous SAM. The presence of oedematous SAM on admission was significantly associated with an increased risk of mortality (P=0.045). Even though the results are not in agreement with other studies,[35,36] they corroborate with other studies which also found an increased risk of mortality in children presenting with oedematous SAM.[24,37] Fluid overload typical of oedematous SAM is thought to escalate the risk of cardiac failure.[38] In addition, electrolyte shifts encountered such potassium depletion and sodium retention are also thought to be accountable for the increased

risk of mortality.[38] Further analysis of results also indicated that a WHZ < -3 SD and a MUAC ≤ 115 mm on admission did not increase the risk of mortality. Dissimilar to these results, some studies found that an admission MUAC ≤ 115 mm significantly increased the risk of death [24, 39-40] The small sample size of this study and poor capturing of anthropometric measurements, in particular the MUAC could potentially account for the disparities seen. Moreover, the influence of oedema on the accuracy of the MUAC and WHZ cannot be disregarded.

The retrospective design of the study proved a major strength as it reflected unaltered practice, thereby depicting actual practice. To date, no studies pertaining to the management of SAM have been conducted in Botswana. Results will, therefore, add value to Botswana's research base, and hopefully, catalyse the birth of more research in this area.

The main limitations of the study were the record-keeping system and clinical practices encountered at the study hospital. A good proportion of potentially qualifying medical records was missing and untraceable, thereby reducing the sample size. In addition, most located medical records had vital information missing thereby increasing the risk of unintentional bias. The use of multiple hospitals rather than one hospital would have proved beneficial through increasing the validity and objectivity of results achieved.

CONCLUSION

In conclusion, SAM admission and transfer practices encountered at the study hospital communicated a lack of adherence to the WHO recommendations. The MUAC was not captured in over 80% of children, despite the WHO recommending its usage as an independent criterion. The mortality rate and mean weight gain of the study were not within the SPHERE acceptable standards. Oedema on admission was associated with increased mortality risk. Owing to the results obtained from the study, there is a need for the finalization of both national and hospital SAM guidelines to better serve as references for health workers in Botswana. In addition, similar studies extended to other hospitals would better enrich the SAM evidence base for Botswana and contribute to the greater body of research to inform the WHO on the extent of implementation of the current WHO recommendations on the management of SAM.

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CHAPTER 4 GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

4.1 Introduction

The current chapter, which serves as the concluding chapter, provides a brief overview of the study, main findings, conclusion and recommendations. It also proposes considerations for future research.

The aim of this sub-study was to evaluate the association between the admission and transfer criteria and clinical outcomes of infants and children admitted for the in-patient management of severe acute malnutrition (SAM) in one referral hospital in Botswana. This was achieved through the use of a retrospective data collection process using medical records of infants and children aged 0 – 59 months admitted with SAM between January 2013 and May 2018. In 2009, Botswana adopted the community-based management (CMAM) approach of SAM in infants and children (Botswana IMAMU, 2015). However, by the time of this study, there were no endorsed SAM guidelines available both at the study hospital and nationally. Secondary to the lack of guidelines, the current World Health Organization (WHO) guidelines served as reference pertaining to the management of SAM in infants and children at the study hospital. Severe acute malnutrition admission and transfer criteria employed at the hospital were assessed and associations between admission and transfer criteria and clinical outcomes were tested using logistic regressions.

4.2 Summary of main findings

Severe acute malnutrition is a common in-patient paediatric admission in the hospital. The study found that the majority of children admitted were in the 6 – 59 months age group. This was in agreement with current expectations in which SAM in infants < 6 months is considered as uncommon. Severe acute malnutrition has traditionally been associated with challenges related to the complementary feeding phase (WHO, 2013:11). Expectations are that nutritional requirements of infants < 6 months can be solely attained through breast milk (WHO, 2013:11). However, due to decreasing exclusive breastfeeding practices, SAM in this vulnerable age group is increasingly being noted (Kerac *et al*., 2011:1009-1010).

The current WHO guidelines recommend the use of both weight-for-height z-score (WHZ) and mid-upper-arm-circumference (MUAC) as independent criteria in the diagnosis of children with SAM (WHO, 2013:20). The sole use of either criterion has been shown to potentially exclude some children with SAM from treatment (Berkley *et al*., 2005:593-594; Fernandez *et al*.,

2010:e196-e198; Laillou *et al*., 2015:2-3). Anthropometric practices showed that weight (100%) and height (90%) were diligently measured on admission. Calculation of WHZ was done in just over half (54%) of children. Even though the use of the MUAC has gained popularity and is recommended as an independent criterion by the WHO, only 12% of children had a MUAC measurement on admission. An admission criteria using a WHZ < -3 SD was used on 40% of the children, whilst 12% were admitted using a MUAC ≤ 115 mm. Oedematous SAM was the criteria of admission in 34% of the children. The results obtained were suggestive of potentially missed SAM diagnoses secondary to reliance on WHZ as the main admission criteria. Regardless of the current WHO recommendations serving as guidelines, observed SAM admission criteria practised at the hospital were not aligned to the current WHO recommendations. The lack of hospital SAM guidelines may have contributed to the incongruent practices observed at the hospital.

Hospital transfer practices on transfer showed that the MUAC was measured in only one child and WHZ was not calculated for any of the children. On transfer oedema had resolved in all the children who presented with oedematous SAM, 67% had a good appetite and infections had resolved in 44% of the children. The WHO, recommending transferral based on resolution of clinical conditions and an established good appetite status and not on specific anthropometric outcomes such as MUAC or WHZ (WHO, 2013:20). This insinuates that the transfer criteria of the children were not determined by the resolution of medical complications and full return of appetite, suggesting poor transfer practices.

Treatment outcomes of interest included the length of hospital stay (LOS), growth (weight gain and changes in MUAC) and mortality. The average LOS of 17 days was less than the maximum set standard of 30 days as per the Global SPHERE standards (SPHERE, 2011). Given the high risk of nosocomial infections and healthcare costs associated with prolonged hospital stay, a short LOS is often the preferred option by clinicians (Chisti *et al*., 2014:5). However, it may disadvantage time allocation reserved for holistic in-patient hospital treatment, ultimately increasing the risk of relapse and mortality following transfer / discharge. Several studies have reported high rates of SAM relapses and mortalities following normal standard hospital discharge (Chisti *et al*., 2014:4; Kerac *et al*., 2014:1). This implies that shortened LOS may not be best practice due to associated poorer outcomes and increased healthcare costs in the long-term. Growth was measured by changes in z-scores and weight gain. Even though no changes in z-scores were found, the average daily weight gain was 5.4 g/kg/day. According to the SPHERE standards, an average weight gain < 8 g/kg/day is considered unacceptable (SPHERE, 2011). According to Saaka *et al*. (2015:6), poor weight gain in children with SAM is highly symbolic of poor response to treatment and inadequate

treatment time. In this study, both premature transfer/discharge and poor weight gain can also be attributed to the lack of adherence to the recommended WHO SAM admission and transfer criteria.

Severe acute malnutrition in-patient mortalities of 40.5% and 46% have been reported in two similar studies conducted in sub-Sahara Africa (Irena *et al*., 2011:3; Munthali *et al*., 2015:4). No previous SAM in-patient mortality rates have been reported in Botswana. Results of this study revealed a mortality rate of 28%. Even though better than other regional studies, the mortality rate found in this study is still unacceptably high when compared to the global SPHERE standards. According to the SPHERE standards, a mortality rate > 10% is considered unacceptable and reflective of unsatisfactory management of children with SAM (SPHERE, 2011). In this study, the poor SAM admission criteria encountered could have also contributed to the high mortality rate. Further analysis of the study results also showed that the presence of oedema on admission was associated with an increased risk of mortality (P = 0.045). According to Grover & Ee, (2009:1060), increased fluid overload and electrolyte shifts typical of oedematous SAM increase the risk of mortality.

Several studies have demonstrated that a MUAC < 115 mm is a better predictor of mortality than WHZ < -3 SD on admission (Grellety *et al*., 2015:2-3; Sachedva *et al*., 2016:2516). However, in this study, both a MUAC < 115 mm and a WHZ < -3 SD on both admission and transfer were not significantly associated with an increased risk of mortality. However, it should be noted that the sample size of this study was small in comparison to the studies which established associations. Furthermore, a good proportion of the sample presented with oedematous SAM. The fluid retention and additional weight characteristic of oedematous SAM may have also distorted the accuracy of both the MUAC and WHZ, thereby potentially influencing the results obtained.

4.3 General conclusion

The admission criteria employed at the hospital are not aligned to the current WHO recommendations. This is despite the WHO recommendations serving as the main reference to the management of SAM due to the lack of approved hospital and national guidelines in Botswana. Weight-for-height z-score and the presence of oedema were the most frequently utilized indicators for admission. In comparison to the global SPHERE standards, the average daily weight gain of 5.4 g/kg/day and mortality rate of 28% found in the study were not within acceptable levels. Oedema was the only admission criterion associated with an increased risk of mortality. None of the transfer criteria were found to have influenced the LOS, growth or

mortality. Owing to the substandard results found, the urgent finalization of SAM guidelines in Botswana is imperative.

4.4 Recommendations

In view of the conducted study and obtained results, the following are the recommendations made:

- Results obtained from this study exposed the urgent need of approved hospital and national guidelines pertaining to the management of SAM in children. This will contribute immensely to the delivery of quality health care services in Botswana.
- In light of the poor average daily weight gain and high mortality rate seen in this study, there is a need for improvements in the current health system set up. The hospital being a referral hospital is recipient to mostly critically ill cases referred from district and primary hospitals.
- Secondary to Botswana being a lightly populated country, the use of multiple hospitals and hence larger sample sizes would help demonstrate more accurate practices pertaining to the management of children with SAM.
- In follow up to these results, it would be of uttermost importance to explore the barriers leading to the poor implementation of the recommended WHO in-patient admission and transfer criteria.
- Regular health workers training on current WHO recommendations would help ensure adoption and implementation of current recommended international practice.

4.4.1 Future research

This study focused on describing the association between admission and transfer criteria and clinical outcomes. Further research on the role of the current Botswana health system in the occurrence, management and overall treatment outcomes of children with SAM would be of benefit in the future.

4.5 Strengths of the study

No studies to date have been conducted in Botswana which evaluated the in-patient admission and transfer criteria of children with SAM. Therefore this study is a major milestone achievement for research in Botswana. In addition, the retrospective design of the study reflected unaltered practice, thereby depicting actual practice.

4.6 Limitations of study

The major limitation of the study was the small sample size, which was influenced by factors beyond the control of the study. A good proportion of files were missing, thereby introducing an element of unintentional bias. Furthermore, the study was restricted to only one hospital. The use of data from multiple hospitals would have helped to increase the objectivity of the results.

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ANNEXURES

ANNEXURE A: AUTHOR'S GUIDELINES FOR THE SOUTH AFRICAN MEDICAL JOURNAL (SAMJ)

1. Focus and scope

The *SAMJ* is a monthly, peer-reviewed, internationally indexed, general medical journal publishing leading research impacting clinical care in Africa. The Journal is not limited to articles that have 'general medical content' but is intending to capture the spectrum of medical and health sciences, grouped by relevance to the country's burden of disease. This will include research in the social sciences and economics that is relevant to the medical issues around our burden of disease**.** The journal carries research articles and letters, editorials, clinical practice and other medical articles and personal opinion, South African health-related news, obituaries, general correspondence, and classified advertisements.

2. Manuscript preparation

To ensure a fair and unbiased review process, all submissions are to include an anonymised version of the manuscript. The exceptions to this are Correspondence, Book reviews and Obituary submissions.

Submitting a manuscript that needs additional blinding can slow down your review process, so please be sure to follow these simple guidelines as much as possible:

- An anonymous version should not contain any author, affiliation or particular institutional details that will enable identification.
- Please remove title page, acknowledgements, contact details, funding grants to a named person, and any running headers of author names.
- Mask self-citations by referring to your own work in the third person.

3. General article format/layout

Accepted manuscripts that are not in the correct format specified in these guidelines will be returned to the author(s) for correction, which will delay publication.

General:

- Manuscripts must be written in UK English.
- The manuscript must be in Microsoft Word format. Text must be single-spaced, in 12-point Times New Roman font, and contain no unnecessary formatting (such as text in boxes).

- Please make your article concise, even if it is below the word limit.
- Qualifications, ***full*** affiliation (department, school/faculty, institution, city, country) and contact details of ALL authors must be provided in the manuscript and in the online submission process.
- Abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.
- Include sections on Acknowledgements, Conflict of Interest, Author Contributions and Funding sources. If none is applicable, please state 'none'.
- Scientific measurements must be expressed in SI units except: blood pressure (mmHg) and haemoglobin (g/dL).
- Litres is denoted with an uppercase L e.g. 'mL' for millilitres).
- Units should be preceded by a space (except for % and ºC), e.g. '40 kg' and '20 cm' but '50%' and '19ºC'.
- Please be sure to insert proper symbols e.g. µ not u for micro, a not a for alpha, b not B for beta, etc.
- Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160.
- Quotes should be placed in single quotation marks: i.e. The respondent stated: '...'
- Round brackets (parentheses) should be used, as opposed to square brackets, which are reserved for denoting concentrations or insertions in direct quotes.
- If you wish material to be in a box, simply indicate this in the text. You may use the table format –this is the *only* exception. Please DO NOT use fill, format lines and so on.

4. Preparation notes by article type

Research

Guideline word limit: 4 000 words

Research articles describe the background, methods, results and conclusions of an original research study. The article should contain the following sections: introduction, methods, results, discussion and conclusion, and should include a structured abstract as per below:

The introduction should be concise – no more than three paragraphs – on the background to the research question, and must include references to other relevant published studies that clearly lay out the rationale for conducting the study. Some common reasons for conducting a study are: to fill a gap in the literature, a logical extension of previous work, or to answer

an important clinical question. If other papers related to the same study have been published previously, please make sure to refer to them specifically.

Describe the study methods in as much detail as possible so that others would be able to replicate the study should they need to.

Results should describe the study sample as well as the findings from the study itself, but all interpretation of findings must be kept in the discussion section, which should consider primary outcomes first before any secondary or tertiary findings or post-hoc analyses.

The conclusion should briefly summarise the main message of the paper and provide recommendations for further study.

Select figures and tables for your paper carefully and sparingly. Use only those figures that provided added value to the paper, over and above what is written in the text. Do not replicate data in tables and in text.

Structured abstract

This should be 250-400 words, with the following recommended headings:

- Background: why the study is being done and how it relates to other published work.
- Objectives: what the study intends to find out
- Methods: must include study design, number of participants, description of the intervention, primary and secondary outcomes, any specific analyses that were done on the data.
- Results: first sentence must be brief population and sample description; outline the results according to the methods described. Primary outcomes must be described first, even if they are not the most significant findings of the study.
- Conclusion: must be supported by the data, include recommendations for further study/actions.
- Please ensure that the structured abstract is complete, accurate and clear and has been approved by all authors.
- Do not include any references in the abstracts.

Main article

All articles are to include the following main sections: Introduction/Background, Methods, Results, Discussion, Conclusions.

The following are additional heading or section options that may appear within these:

- Objectives (within Introduction/Background): a clear statement of the main aim of the study and the major hypothesis tested or research question posed

- Design (within Methods): including factors such as prospective, randomisation, blinding, placebo control, case control, crossover, criterion standards for diagnostic tests, etc.

- Setting (within Methods): level of care, e.g. primary, secondary, number of participating centres.

- Participants (instead of patients or subjects; within Methods): numbers entering and completing the study, sex, age and any other biological, behavioural, social or cultural factors (e.g. smoking status, socioeconomic group, educational attainment, co-existing disease indicators, etc.) that may have an impact on the study results. Clearly define how participants were enrolled, and describe selection and exclusion criteria.

- Interventions (within Methods): what, how, when and for how long. Typically for randomised controlled trials, crossover trials, and before and after studies.

- Main outcome measures (within Methods): those as planned in the protocol, and those ultimately measured. Explain differences, if any.

Results

- Start with description of the population and sample. Include key characteristics of comparison groups.
- Main results with (for quantitative studies) 95% confidence intervals and, where appropriate, the exact level of statistical significance and the number need to treat/harm. Whenever possible, state absolute rather than relative risks.
- Do not replicate data in tables and in text.
- If presenting mean and standard deviations, specify this clearly. Our house style is to present this as follows:
- E.g.: The mean (SD) birth weight was 2 500 (1 210) g. Do not use the ± symbol for mean (SD).

Leave interpretation to the Discussion section. The Results section should just report the findings as per the Methods section.

Discussion

Please ensure that the discussion is concise and follows this overall structure – sub-headings are not needed:

- Statement of principal findings
- Strengths and weaknesses of the study
- Contribution to the body of knowledge
- Strengths and weaknesses in relation to other studies
- The meaning of the study – e.g. what this study means to clinicians and policymakers
- Unanswered questions and recommendations for future research

Conclusions

This may be the only section readers look at, therefore write it carefully. Include primary conclusions and their implications, suggesting areas for further research if appropriate. Do not go beyond the data in the article.

Editorials

Guideline word limit: 1 000 words

These opinion or comment articles are usually commissioned but we are happy to consider and peer review unsolicited editorials. Editorials should be accessible and interesting to readers without specialist knowledge of the subject under discussion and should have an element of topicality (why is a comment on this issue relevant now?) There should be a clear message to the piece, supported by evidence.

Please make clear the type of evidence that supports each key statement, e.g.:

- expert opinion
- personal clinical experience
- observational studies
- trials
- systematic reviews.

CME (by invite only)

CME is intended to provide readers with practical, up-to-date information on medical and related matters. It is aimed at those who are not specialists in the field.

From January 2016, all CME articles will be printed in full in the *SAMJ*. Please try to adhere strictly to the guidelines on word count as we have a page limit for the print issue of the *SAMJ*. We reserve the right to place some tables and reference lists online if this is necessary for space.

In practice, this means that each CME topic usually covers two issues of the print issue of the *SAMJ*.

The guest editor, in consultation with the editor, is responsible for convening a team of authors, deciding on the subjects to be covered and for reviewing the manuscripts submitted. The suggestion is for 4 - 5 articles, although there is some room for flexibility contingent on discussions with the editor.

For queries about these guidelines please feel free to contact the CME editor, Dr Bridget Farham, by email (ugqirha@iafrica.com) or telephone (+27 (0)21 789 2331).

Review process

The guest editor reviews the articles and returns them to the CME editor for review and final approval.

Guest editorials

Guideline word limit: 1 000 words

- Include the guest editor's personal details (qualifications, positions, affiliation, e-mail address, and a short personal profile (50words)).
- If possible, include a photograph of the author(s) at high enough resolution for print. It is preferable to provide two guest editorials, one for each issue, so that the content of the articles in each issue is covered.

Articles

Guideline word limit: 2 000 - 3 000 words

- Each article requires an abstract of ±200 words.
- The editor reserves the right to shorten articles but will send a substantially shortened article back for author approval.

Personal details

Please supply: Your qualifications, position and affiliations and MP number (used for CPD points); Address, telephone number and fax number, and your e-mail address; and a short personal profile (50 words) and a few words about your current fields of interest.

In Practice

Guideline word limit: 2 000 - 3 000words

This section includes articles that would previously have been accepted into the Forum section, and case reports.

In practice articles are those that draw attention to specific issues of clinical, economic or political interest regarding medicine and healthcare in southern Africa. They are assigned to a topic:

- Case report
- Clinical practice
- Clinical alert
- Issues in medicine
- Issues in public health
- Healthcare delivery
- Medicine and the environment
- Medicine and the law
- Cochrane corner

An In Practice article should follow the following format – sub-headings are not necessary, but may be used for clarity:

- Author affiliations and qualifications: to be the same as for Research. Provide all authors' names and initials, qualifications and full affiliations, and corresponding author.
- Short abstract: does not need to be structured, but should capture the essential features of the article
- Introduction: the reason for the article and the issue being addressed
- Recent research, discussion, local policy around the issue – include your own research where appropriate
- All statements should be referenced and, if opinion only, this should be stated
- Discussion: how this article adds to the discussion around a particular topic
- If a clinical practice or policy point is at issue, this needs to be emphasised, using a box with highlights if appropriate.

Essentially In practice is an opportunity for a more discursive approach to topics of clinical, economic or political importance in southern African health systems. It is not an opportunity to put forward unsubstantiated opinions!

Case reports

The *SAMJ* has recently started to accept case reports. The cases must come from Africa, preferably southern Africa unless the condition is common to all African countries, and must

be either a completely new description of a clinical condition or result (use Google!) or a case that highlights important practice or management issues.

Please use the following format for case reports:

- Title of case: do not include the words ‘a case report’ in the title
- Summary/abstract: up to 150 words summarising the case presentation and outcome
- Background: why is this case important and why did you write it up?
- Case presentation: presenting features, medical, social, family history as appropriate
- Case management: should be according to best practice, and if not, please explain why
- Investigations, if relevant: save space by simply saying ‘normal’ if, for example, renal function was completely normal, rather than listing normal results, highlight the abnormal – or indeed the normal if this is clinically significant
- Differential diagnosis, if relevant
- Treatment, if relevant
- Outcome and follow-up
- Discussion – a VERY BRIEF review of similar published cases
- Teaching points: 3 - 5 bullet points
- References: as per the *SAMJ* house style
- Tables and figures: keep to a minimum. Use clinical images where relevant – we need hi-res versions for print, and identifiable persons must have a consent form
- Patient consent: please include a statement about patient consent to a written case report. This should be uploaded as a supplementary file.

Clinical trials

Guideline word limit: 4000 words

As per the recommendations published by the International Committee of Medical Journal Editors (ICMJE), clinical trial research is any research that assigns individuals to an intervention, with or without a concurrent comparison/control group to study the cause-and-effect relationship between the intervention and health outcomes. All clinical trials should be registered with the appropriate national clinical trial registry (or any international primary register, if relevant), and the trial registration number should be cited at the end of the abstract. Since 1st December 2005, all clinical trials conducted in South Africa have been required to be registered in the South African National Clinical Trials Register. The *SAMJ* therefore requires that clinical trials be registered in the relevant public trials registry at or before the

time of first patient admission as a condition for publication. The trial registry name and registration number must be included in the manuscript.

Please refer to the general guidelines for all papers at the top of this article for additional requirements with respect to ethics approval, funding, author contributions, etc. The format of original research articles should be followed for reporting of clinical trial results.

Review articles

Guideline word limit: 4 000 words

These are welcome, but should be either commissioned or discussed with the Editor before submission. A review article should provide a clear, up-to-date account of the topic and be aimed at non-specialist hospital doctors and general practitioners.

Please ensure that your article includes:

- Abstract: unstructured, of about 100-150 words, explaining the review and why it is important
- Methods: Outline the sources and selection methods, including search strategy and keywords used for identifying references from online bibliographic databases. Discuss the quality of evidence.
- When writing: clarify the evidence you used for key statements and the strength of the evidence. Do not present statements or opinions without such evidence, or if you have to, say that there is little or no evidence and that this is opinion. Avoid specialist jargon and abbreviations, and provide advice specific to southern Africa.
- Personal details: Please supply your qualifications, position and affiliations and MP number (used for CPD points); address, telephone number and fax number, and your e-mail address; and a short personal profile (50 words) and a few words about your current fields of interest.

Correspondence (Letters to the Editor)

Guideline word limit: 500 words

Letters to the editor should relate either to a paper or article published by the SAMJ or to a topical issue of particular relevance to the journal's readership

- May include only one illustration or table
- Must include a correspondence address.

Book reviews

Guideline word limit: 400 words

Should be about 400 words and must be accompanied by the publication details of the book. Provide a hi-res image of the cover if possible (with permission from the copyright holder).

Obituaries

Guideline word limit: 400 words

Should be offered within the first year of the practitioner's death, and may be accompanied by a photograph.

Guidelines

Guidelines should always be discussed with the Editor prior to submission.

Because of the intensive review process required to ensure Guidelines are independent, evidence-based and free from commercial bias, they are usually published as a supplement to the *SAMJ*, the costs of which must be covered by sponsorship, advertising or payment by the guideline authors/association. We will provide a quote based on the expected length of the guideline and whether it is to appear online only, or in print, which must be accepted by the body putting the guidelines together before submitting the work to the SAMJ.

The Editor reserves the right to determine the scheduling of supplements. Understandably, a delay in publication must be anticipated dependent upon editorial workflow.

All guidelines should include a clear, transparent statement about all sources of funding and an explicit, clear statement of conflicts of interest of any of the participants in the guidelines about industry funding for lectures, research, conference participation etc.

All guidelines should be structured according to Agree II.

Please access this website before putting the guidelines together, download the Agree 11 instrument and use this to put the guidelines together.

All submitted guidelines will be sent to the local Agree II appraisal committee for review and must be endorsed by an appropriate body prior to consideration and all conflicts of interest expressed.

A structured abstract not exceeding 400 words (recommended sub-headings: *Background, Recommendations, Conclusion*) is required. Sections and sub-sections must be numbered

consecutively (e.g. 1. Introduction; 1.1 Definitions; 2.etc.) and summarised in a Table of Contents.

5. Illustrations/photos/scans

- If illustrations submitted have been published elsewhere, the author(s) should provide consent to republication obtained from the copyright holder.
- Figures must be numbered in Arabic numerals and referred to in the text e.g. '(Fig. 1)'.
- Each figure must have a caption/legend: Fig. 1. Description (any abbreviations in full).
- All images must be of high enough resolution/quality for print.
- All illustrations (graphs, diagrams, charts, etc.) must be in PDF or jpeg form.
- Ensure all graph axes are labelled appropriately, with a heading/description and units (as necessary) indicated. Do not include decimal places if not necessary e.g. 0; 1.0; 2.0; 3.0; 4.0 etc.
- Scans/photos showing a specific feature e.g. *Intermediate magnification micrograph of a low malignant potential (LMP) mucinous ovarian tumour. (H&E stain).* –include an arrow to show the tumour.
- Each image must be attached individually as a 'supplementary file' upon submission (not solely embedded in the accompanying manuscript) and named Fig. 1, Fig. 2, etc.

6.Tables

- Tables should be constructed carefully and simply for intelligible data representation. Unnecessarily complicated tables are strongly discouraged.
- Large tables will generally not be accepted for publication in their entirety. Please consider shortening and using the text to highlight specific important sections, or offer a large table as an addendum to the publication, but available in full on request from the author
- Embed/include each table in the manuscript Word file - do not provide separately as supplementary files.
- Number each table in Arabic numerals (Table 1, Table 2, etc.) and refer to consecutively in the text.
- Tables must be cell-based (i.e. not constructed with text boxes or tabs) and editable.
- Ensure each table has a concise title and column headings, and include units where necessary.
- Footnotes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || then ** †† ‡‡ etc.

Do not: Use [Enter] within a row to make ‘new rows’:

Rather:

Each row of data must have its own proper row:

Do not: use separate columns for *n* and %:

Rather:

Combine into one column, *n* (%):

Do not: have overlapping categories, e.g.:

Rather:

Use <> symbols or numbers that don't overlap:

7. References

NB: *Only complete, correctly formatted reference lists in Vancouver style will be accepted. Reference lists must be generated manually and not with the use of reference manager software. Endnotes must* ***not*** *be used.*

- Authors must verify references from original sources.
- Citations should be inserted in the text as superscript numbers between square brackets, e.g. These regulations are endorsed by the World Health Organization,[2] and others.[3,4-6]
- All references should be listed at the end of the article in numerical order of appearance in the Vancouver style (not alphabetical order).
- Approved abbreviations of journal titles must be used; see the List of Journals in Index Medicus.
- Names and initials of all authors should be given; if there are more than six authors, the first three names should be given followed by et al.
- Volume and issue numbers should be given.
- First and last page, in full, should be given e.g.: 1215-1217 **not** 1215-17.
- Wherever possible, references must be accompanied by a digital object identifier (DOI) link). Authors are encouraged to use the DOI lookup service offered by CrossRef:
- On the Crossref homepage, paste the article title into the 'Metadata search' box.
- Look for the correct, matching article in the list of results.
- Click Actions > Cite
- Alongside 'url =' copy the URL between { }.

- Provide as follows, e.g.: https://doi.org/10.7196/07294.937.98x

8. Authorship

Named authors must consent to publication. Authorship should be based on: (*i*) substantial contribution to conceptualisation, design, analysis and interpretation of data; (*ii*) drafting or critical revision of important scientific content; or (*iii*) approval of the version to be published. These conditions must all be met (uniform requirements for manuscripts submitted to biomedical journals; refer to www.icmje.org)

If authors' names are added or deleted after submission of an article, or the order of the names is changed, all authors must agree to this in writing.

Please note that co-authors will be requested to verify their contribution upon submission. Non-verification may lead to delays in the processing of submissions.

Author contributions should be listed/described in the manuscript.

9. Conflicts of interest

Conflicts of interest can derive from any kind of relationship or association that may influence authors' or reviewers' opinions about the subject matter of a paper. The existence of a conflict – whether actual, perceived or potential – does not preclude publication of an article. However, we aim to ensure that, in such cases, readers have all the information they need to enable them to make an informed assessment about a publication's message and conclusions. We require that both authors and reviewers declare all sources of support for their research, any personal or financial relationships (including honoraria, speaking fees, gifts received, etc.) with relevant individuals or organisations connected to the topic of the paper, and any association with a product or subject that may constitute a real, perceived or potential conflict of interest. If you are unsure whether a specific relationship constitutes a conflict, please contact the editorial team for advice. If a conflict remains undisclosed and is later brought to the attention of the editorial team, it will be considered a serious issue prompting an investigation with the possibility of retraction.

10. Research ethics committee approval

Authors must provide evidence of Research Ethics Committee approval of the research where relevant. Ensure the correct, full ethics committee name and reference number is included in the manuscript.

If the study was carried out using data from provincial healthcare facilities, or required active data collection through facility visits or staff interviews, approval should be sought from the relevant provincial authorities. For South African authors, please refer to the guidelines for submission to the National Health Research Database. Research involving human subjects must be conducted according to the principles outlined in the Declaration of Helsinki. Please refer to the National Department of Health's guideline on Ethics in Health research: principles, processes and structures to ensure that the appropriate requirements for conducting research have been met, and that the HPCSA's General Ethical Guidelines for Health Researchers have been adhered to.

ANNEXURE B: NORTH-WEST UNIVERSITY ETHICS APPROVAL

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

Private Bag X6001, Potchefstroom,
South Africa, 2520

Tel: (018) 299-4900
Faks: (018) 299-4910
Web: http://www.nwu.ac.za

Research Ethics Regulatory Committee
Tel: +27 18 299 4849

Email : Ethics@nwu.ac.za

ETHICS APPROVAL CERTIFICATE OF STUDY

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

Study title: Evaluation of admission criteria and treatment guidelines of African infants and children (0-59 months) diagnosed with severe acute malnutrition – the SAMAC-study

Study Leader/Supervisor: Dr MJ Lombard
Student:

Ethics number:

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

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

Application Type: Large Study

Commencement date: 2018-01-19 **Risk:** Minimal

Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.

Special conditions of the approval (if applicable):

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

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

General conditions:

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

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

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

Yours sincerely

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

ANNEXURE C: BOTSWANA MINISTRY OF HEALTH ETHICS APPROVAL

PRIVATE BAG 0038
GABORONE
BOTSWANA
REFERENCE:

REPUBLIC OF BOTSWANA
MINISTRY OF HEALTH AND WELLNESS

TEL: (+267) 363 2500
FAX: (+267) 391 0647
TELEGRAMS: RABONGAKA
TELEX: 2818 CARE BD

REFERENCE NO: HPDME 13/18/1 **26 March 2018**

Health Research and Development Division

Notification of IRB Review: **New application**

Dr Martani Lombard
Private Bag X6001
North West University
Internal Box 594
Potchefstroom
2025

Dear Dr Martani Lombard

Protocol Title: **EVALUATION OF ADMISSION CRITERIA AND TREATMENT GUIDELINES OF SUB-SAHARA AFRICAN INFANTS AND CHILDREN (0-59 MONTHS) DIAGNOSED WITH SEVERE ACUTE MALNUTRITION – SAMAC-STUDY (20/02/2018)**

HRDC Approval Date:	26 March 2018
HRDC Expiration Date:	25 March 2019
HRDC Review Type:	Full Board
HRDC Review Determination:	Approved
Risk Determination:	Minimal risk

Thank you for submitting new application for the above referenced protocol. The permission is granted to conduct the study.

This permit does not however give you authority to collect data from the selected sites without prior approval from the management. Consent from the identified individuals should be obtained at all times.

The research should be conducted as outlined in the approved proposal. Any changes to the approved proposal must be submitted to the Health Research and Development Division in the Ministry of Health for consideration and approval.

Furthermore, you are requested to submit at least one hardcopy and an electronic copy of the report to the Health Research, Ministry of Health and Wellness within 3 months of completion of the study. Approval is for academic fulfillment only. Copies should also be submitted to all other relevant authorities.

Continuing Review

In order to continue work on this study (including data analysis) beyond the expiry date, submit a Continuing Review Form for Approval at least three (3) months prior to the protocol's expiration date. The Continuing Review Form can be obtained from the Health Research Division Office (HRDD), Office No. 7A.7 or Ministry of Health website: www.moh.gov.bw or can be requested via e-mail from Mr. Kgomotso Motlhanka, e-mail address: kgmmotlhanka@gov.bw As a courtesy, the HRDD will send you a reminder email about eight (8) weeks before the lapse date, but failure to receive it does not affect your responsibility to submit a timely Continuing Report form

Amendments

During the approval period, if you propose any change to the protocol such as its funding source, recruiting materials, or consent documents, you must seek HRDC approval before implementing it. Please summarize the proposed change and the rationale for it in the amendment form available from the Health Research Division Office (HRDD), Office No. 7A7 or Ministry of Health website: www.moh.gov.bw or can be requested via e- mail from Mr. Kgomotso Motlhanka, e-mail address: kgmotlhanka@gov.bw . In addition submit three copies of an updated version of your original protocol application showing all proposed changes in bold or "track changes".

Reporting

Other events which must be reported promptly in writing to the HRDC include:

- Suspension or termination of the protocol by you or the grantor
- Unexpected problems involving risk to subjects or others
- Adverse events, including unanticipated or anticipated but severe physical harm to subjects.

If you have any questions please do not hesitate to contact Ms S. Mosweunyane at smosweunyane@gov.bw Tel: 3632018 and Mr Kgomotso Motlhanka at kgmotlhanka@gov.bw at 3632751. Thank you for your cooperation and your commitment to the protection of human subjects in research.

Yours faithfully

Ms S. Mosweunyane
for/PERMANENT SECRETARY

MINISTRY OF HEALTH
RESEARCH DIVISION
2018 -03- 23
P/BAG 0038
GABORONE
REPUBLIC OF BOTSWANA

ANNEXURE D: PRINCESS MARINA HOSPITAL ETHICS APPROVAL

PLOT 1836 HOSPITAL WAY
TELEPHONE: 3621400
FAX: 3973776

RE PUBLIC OF BOTSWANA

PRINCESS MARINA HOSPITAL
P. O. BOX 258
GABORONE
BOTSWANA

REF: PMH 5/79(442-1-2018

April 12, 2018

Ms. Vera B Haamakala
North-West University – Potchestroom Campus

Dear Ms Haamakala

RE: Evaluation of Admission Criteria and Treatment Guidelines of Sub-Saharan African Infants and Children (0-59 months) Diagnosed with Severe Acute Malnutrition – The SAMAC - Study

1. The Research and Ethics Committee (REC) of Princess Marina Hospital met and discussed your request to conduct a study with the aforementioned title. Please obtain permission from head of department in the unit that you intend to do your research.
2. You will not change any aspect of your research without permission from the Research and Ethics Committee (REC).
3. You need to report any unforeseen circumstances including the termination of the study to the REC.
4. You must allow the REC access to the study at any time for purposes of auditing.
5. This permit is valid for a period of one year; from April 12, 2018 to April 11, 2019.
6. At the end of the study you should give the research and ethics committee a hard copy and a soft copy of your report

Thank you

Sincerely,

Gladness O. Tlhomelang
Secretary Research and Ethics Committee
For Hospital Superintendent

ANNEXURE E: SCREENING FORM

SAMAC Screening form: Botswana

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

INCLUDED: All questions are answered YES (Y).

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

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

(Medical problems NOT related to SAM: unspecified 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 are 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

ANNEXURE F: PARTICIPANT REGISTRY

SAMAC Participant register: Botswana

Participant number	Date	Hospital	File/ Medical record 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			
B-016			
B-017			
B-018			
B-019			
B-020			

ANNEXURE G: DATA EXTRACTION FORM

SAMAC Data extraction form

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

2. ADMISSION DATA (*Status of child at admission*)																				
2.1. Admission information documented by	Paediatrician		GP		House officer/ Intern		Dietician		Nutrition officer		Nurse									
	Others (Specify)																			
2.2. Date of admission	20	Y	M	D	2.3. Time of admission		2.4. Date of birth	20	Y	M	D	2.5. Current Age (months)								
2.6. Gender	Boy		Girl		2.7. When was SAM diagnosed	At admission		While admitted												
2.8. Date of SAM diagnosis while on admission	20	Y	M	D	2.9. New admission for SAM	Yes		No		2.10. Readmission for SAM	Yes		No							
2.11. Weight on admission (kg)	*Kg*				2.12. Height/length measurement (cm)	*cm*														
	Not recorded					Not recorded														

2.13. Which of the following was measured:			Height		Length		Not indicated				
2.14. MUAC (mm)			2.15. Recorded weight for height/ length Z score								
	Not recorded				Not Recorded						
2.16. Oedema grade	0		+ (mild)		++ (moderate)		+++ (severe)				
2.17. Clinical Signs	Irritability			Wasting		Eye signs		Diarrhoea			
	Dermatitis			Severe pallor		Shock		Vomiting			
	Convulsions			Irregular heartbeat		Weak pulse					
	Slow capillary fill (> 3 seconds)			Cold hands / feet		Fast pulse					
2.18. HIV/RVD status at admission	Positive			Negative			Unknown				
2.19. ARV/RVD treatment at admission	No			Yes, Prior to admission			Unknown				
2.20. List ARV/RVD medications at admission	Medication	Dosage	Medication	Dosage	Medication	Dosage					
2.21. TB status at admission	Positive		Negative		Unknown						
2. 22. TB treatment at admission	No		Yes, Prior to admission		Unknown						
2.23. List TB medications at admission	Medication	Dosage	Medication	Dosage	Medication	Dosage					
2.24. Other medications at admission	Medication	Dosage	Medication	Dosage	Medication	Dosage					
	Medication	Dosage	Medication	Dosage	Medication	Dosage					

2.25. Medical complication/diagnosis at admission												
Conscious	Not reported		Yes		No		Hypoglycaemia (< 3 mmol/L)	Not reported		Yes		No	
Dehydration	Not reported		Yes		No		Hypothermia (< 35 ^{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	
2.26. List other diagnosis at admission												

2.27. Did the patient receive any IV at admission/Casualty/Emergency				Yes		No					
2.28. If yes, Type of IV fluid received		Rate	____/____hrly	Total volume		Duration *(per hour)*:					
If yes, Type of IV fluid received		Rate	____/____hrly	Total volume		Duration *(per hour)*:					
If yes, Type of IV fluid received		Rate	____/____hrly	Total volume		Duration *(per hour)*:					
2.29. Did patient receive 10% glucose or sucrose solution within 30 minutes of admission						Yes		No			
Route	NGT		Oral		IV		Rate	____/____hrly	Total volume		Duration *(per hour)*	
2.30. Did the patient receive ReSoMal?										Yes	No	
Route	NGT		Oral		Rate		____/____hrly	Total volume		Duration *(per hour)*		
2.31. Did the patient receive other oral rehydration solutions at admission?				Yes		No		Name of ORS given			

Route		NGT		Oral		Rate	____/____hrly	Total volume		Duration *(per hour)*		
2.32 Did patient received any feed (s) within 30 minutes of admission										Yes		No	
2.33. What feed was given at admission													
Route		NGT		Oral		Rate	____/____hrly	Total volume		Duration *(per hour)*		

3. BED CHART INFORMATION (Information during hospital stay)									
Date	Time	Readings				Dehydration			
		Pulse/min	Temperature (°C)	Blood Glucose (mmol/L)	Heart Rate/min	Vomiting (Nr of Incidence /day)	Stool		Urine Output (Volume/day) ml
							Consistency (watery, loose, normal)	Nr of Incidence /day	

3. BED CHART INFORMATION (Information during hospital stay)									
Date	Time	Readings				Dehydration			
		Pulse/min	Temperature (°C)	Blood Glucose (mmol/L)	Heart Rate/min	Vomiting (Nr of Incidence /day)	Stool		Urine Output (Volume/day) ml
							Consistency (watery, loose, normal)	Nr of Incidence /day	

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

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

5. FEEDING (During hospital stay)													
5.1. Feeds prescribed by	Paediatrician		GP		House officer/Intern		Dietician		Nutrition Officer		Nurse		
	Others (Specify)												
5.2. When were feeds initiated	Date			Time			Not Recorded						

5.3. STARTER FEEDS													
Date	Feed (F75, Infant formula, Breast milk, others.)	Name of Product	Pre-mixed	Self-mixed	Route		Rate	Nr of feeds/day	Total volume prescribed /day (ml)	Total volume consumed/ day(ml)	Ward diet or solids given while on starter feeds		If Yes, which ward diet or solid feed was given
					NGT	Oral					Yes	No	
							____/____hrly						
							____/____hrly						
							____/____hrly						
							____/____hrly						
							____/____hrly						
							____/____hrly						
							____/____hrly						

5.4. For self-mixed recipes feeds record recipe

5. FEEDING (During hospital Stay)													
5.5. Feeds prescribed by	Paediatrician		GP		House officer/Intern		Dietician		Nutrition Officer		Nurse		
	Others (Specify)												
5.6. When were feeds transitioned	Date		Time		Not Recorded								

5.7. TRANSITION FEEDS													
Date	Feed (FI00, Infant formula, Breast milk, RUTF, others.)	Name of Product	Pre-mixed	Self-mixed	Route		Rate	Nr of feeds/day	Total volume prescribed /day (ml)	Total volume consumed/ day(ml)	Ward diet or solids given while on transition feeds		If Yes, which ward diet or solid feed was given
					NGT	Oral					Yes	No	
							____/____hrly						
							____/____hrly						
							____/____hrly						
							____/____hrly						
							____/____hrly						
							____/____hrly						
							____/____hrly						

5.8. For self-mixed recipes feeds record recipe

5. FEEDING (During hospital Stay)													
5.5. Feeds prescribed by	Paediatrician		GP		House officer/Intern		Dietician		Nutrition Officer		Nurse		
	Others (Specify)												
5.6. When were feeds transitioned	Date			Time			Not Recorded						

5.7. TRANSITION FEEDS													
Date	Feed (FI00, Infant formula, Breast milk, RUTF, others.)	Name of Product	Pre-mixed	Self-mixed	Route		Rate	Nr of feeds/day	Total volume prescribed /day (ml)	Total volume consumed/ day(ml)	Ward diet or solids given while on transition feeds		If Yes, which ward diet or solid feed was given
					NGT	Oral					Yes	No	
							____/____hrly						
							____/____hrly						
							____/____hrly						
							____/____hrly						
							____/____hrly						
							____/____hrly						
							____/____hrly						

5.8. For self-mixed recipes feeds record recipe

6. ELECTROLYTE AND TRACE ELEMENTS PRESCRIPTIONS																		
6.1. Prescribed by	Paediatrician		GP		House officer/Intern		Dietician		Nutrition officer		Nurse							
	Others (Specify)																	
6.2. Electrolyte and trace elements given during hospital stay																		
Date	Potassium Chloride sol			Trace element mix ($MgSO_4$ 280mg, Zn SO_4 36mg, $CuSO_4$ 0.1mg/1ml oral sol)			Oral Magnesium			$MgSO_4$ IM			Zinc (zinc sulphate, gluconate acetate, picolinate			Others	Others	
	Yes	No	Dosage	Yes	No	Dosage	Yes	No	Dosage	Yes	No	Dosage	Yes	No	Dosage	Dosage	Dosage	

7. MICRONUTRIENT																		
7.1. Prescribed by	Paediatrician		GP		House officer		Dietician		Nutrition officer		Nurse							
	Others (Specify)																	
7.2. Micronutrients given during hospital stay																		
Date	Vitamin A (If multiple administrations, indicate dosage and date			Folic acid			Multivitamin ……			Iron (Specify type of Fe given) ……			Others ……		Others ……		Others ……	
	Yes	No	Dosage	Yes	No	Dosage	Yes	No	Dosage	Yes	No	Dosage	Dosage		Dosage		Dosage	

8. MEDICAL TREATMENT	Did the patient receive any of the following:											
8.1 Prescribed by	Paediatrician		GP		House officer		Dietician		Nutrition officer		Nurse	
	Others (Specify)											

8.2. Medications given during hospital stay

Name of medication	Indication	Route				Date started	Date stopped	Dosage	Freq/day
		IM	IV	NG	Oral				
		IM	IV	NG	Oral				
		IM	IV	NG	Oral				
		IM	IV	NG	Oral				
		IM	IV	NG	Oral				
		IM	IV	NG	Oral				
		IM	IV	NG	Oral				
		IM	IV	NG	Oral				
		IM	IV	NG	Oral				
		IM	IV	NG	Oral				
		IM	IV	NG	Oral				

8. MEDICAL TREATMENT	Did the patient receive any of the following:									
							Date started	Date stopped	Dosage	Freq
8.3. Blood transfusion	Yes		No							
8.4. Plasma transfusion	Yes		No							
8.5. Was HIV treatment withheld	Yes		No		Date stopped		Date re-initiated		Duration without HIV medication	
8.6. Other medical diagnosis made while the child was on admission										

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

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

10. DISCHARGE DATA (*Status of child on date of discharge to home*)																
10.1. Date of discharge	20	Y	M	D	10.2. Date of Death	20	Y	M	D	10.3. Cause of death						
10.4. Weight (kg)	*Kg*				10.5. Height/length measurement (cm)					*cm*	Not indicated					
10.6. Which of the following was measured:					Height		Length				Not indicated					
10.7. MUAC (mm)			10.8. Weight for height Z score													
							Not Reported									
10.9. Oedema grade	0		+ (mild)				++ (moderate)				+++ (Severe)					
10.10.Tested for TB	Yes			10.11. Tested for HIV			Yes		10.12. Referred to outpatient clinic / facility		Yes					
	No						No				No					
	Unknown						Unknown				Unknown					
10.13. TB status	Positive			10.14. HIV status			Positive									
	Negative						Negative									
	Unknown						Unknown									
10.15.Good appetite	Yes		10.16. Infections resolved	Yes			10.17. Five-day consecutive weight gain				Yes					
	No			No							No					
	Unknown			Unknown							Unknown					
10.18. Other clinical information noted on Discharge																
10.19.Caregiver given nutrition and health education	Yes		No		If Yes, By whom											
10.20. Number of different health professionals who cared for patient during the hospital stay	Paediatrician		GP		Dietician		Nurse									
	House officer/ Intern			Nutrition officer				Others								

Declaration

This is to declare that I, Annette L Combrink, accredited language editor and translator of the South African Translators' Institute, have language-edited the mini-dissertation by

V.B. MOONGA

with the title

Association between admission and transfer criteria and clinical outcomes of infants and children (0 – 59 months) treated for severe acute malnutrition in Botswana-SAMAC study

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