# Survival Status and Predictors of Mortality in Severely Malnourished Children Admitted to Jimma University Specialized Hospital from 2010-2012, Jimma, Ethiopia

A Research Paper to be submitted to Department of Epidemiology and School of Graduate Study, College of Public Health & Medical Sciences, Jimma University; in Partial Fulfillment of the Requirements for Master Degree in Epidemiology

By: Habtemu Jarso (BSc.)

June 2013

Jimma, Ethiopia

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Advisors:

1. Dr. Fessahaye Alemseged (MD, MPHE)
2. Mr. Abdulhalik Workicho (BSc, MPHE)

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# Abstract

**Background:** Although community based treatment of severe acute malnutrition has been advocated for in recent years, facility based treatment of severe acute malnutrition is still required. Therefore, information on the treatment outcomes of malnutrition and potential predictors of mortality among severely malnourished children admitted to hospitals is critical for the improvement of quality care.

**Objective:** To assess survival status and predictors of mortality in severely malnourished children admitted to Jimma University Specialized Hospital from September 11, 2010 to September 10, 2012.

**Methods and materials:** Retrospective cohort study was conducted at Jimma University Specialized Hospital. Primary data were collected from September 11, 2010 to September 10, 2012 whereas secondary data were collected from February 20, 2013 to March 22, 2013. Data of 947 severely malnourished children admitted to the hospital during the study period whose cards were found were reviewed. Data were analyzed using SPSS version 16 for windows. Bivariate and multivariable analyses were performed by Kaplan-Meier and Cox regression.

**Result:** A total of 947 children were enrolled into the study giving response rate of 96.3%. A cure (improvement), death and abscond rate were 77.8%, 9.3% and 12.9% respectively. The median duration from admission to death was 7 days. The average length of stay in the hospital and average weight gain were 17.4 days and 10.4 g/kg/day respectively. The main predictors of earlier hospital deaths were age less than 24 months (AHR = 1.9, 95% CI [1.2-2.9]), hypothermia (AHR = 3.0, 95% CI [1.4-6.6]), impaired consciousness level (AHR = 2.6, 95% CI [1.5-4.5]), dehydration (AHR = 2.3, 95% CI [1.3-4.0]), palmar pallor (AHR = 2.1, 95% CI [1.3-3.3]) and co-morbidity/complication at admission (AHR=3.7, 95% CI [1.9-7.2]).

**Conclusion and recommendation:** The treatment outcomes (improvement rate, death rate, average length of stay in the hospital and average weight gain) were better than most reports in the literatures and in agreement with minimum international standard set for management of severe acute malnutrition. Any intervention to further reduce earlier deaths needs to focus on children with the main predictors identified in this study.



**Key terms:** survival status, predictors of mortality, severe malnutrition, children, hospital

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## List of Acronyms and Abbreviations

**$^0$C** – Degree Celsius

**AHR –** Adjusted Hazard Ratio

**AIDS** – Acquired Immune Deficiency Syndrome

**BSc** – Bachelor of Science

**CFR** – Case Fatality Rates

**CTR** – Capillary Refill Time

**Df** – Degree of freedom

**EDHS** – Ethiopian Demographic and Health Survey

**ENGINE** – Empowering New Generations to Improve Nutrition and Economic opportunities

**g/kg/day** – gram per kilogram per day

**HIV** – Human Immunodeficiency Virus

**HR** – Hazard Ratio

**hrs** – hours

**IU** – International Unit

**IV** – Intravenous

**JUSH** – Jimma University Specialized Hospital

**KDH** – Kilifi District Hospital

**MDGs** – Millennium Development Goals

**MNH** – Muhimbili National Hospital

**MUAC** – Mid-Upper Arm Circumference

**NCHS** – National Center for Health Statistics

**NGT** – Naso-Gastric Tube

**NRUs** – Nutritional Rehabilitation Units

**PEM** – Protein-Energy Malnutrition

**RUTF** – Ready to Use Therapeutic Food

**SAM** – Severe Acute Malnutrition

**Sept.** – September

**SNNPR** – Southern Nation, Nationality and People Region

**SPSS** – Statistical Package for Social Sciences

**SS** – Supplemental Suckling

**TB** – Tuberculosis

**TFCs** – Therapeutic Feeding Centers

**UNICEF** – United Nations Children's Fund

**US** – United States

**USAID** – United States Agency for International Development

**W/H** – Weight for Height

**W/L** – Weight for Length

**WHO** – World Health Organization

# 1 Introduction

## 1.1 Background

Adequate nutrition is a basic human right and a pre-requisite for good health (1). Malnutrition is a broad term commonly used as an alternative to under-nutrition but technically it also refers to over-nutrition (2). In this study the term malnutrition refers to under-nutrition.

Severe malnutrition is both a medical and a social disorder. That is, the medical problems of the child result, in part, from the social problems of the home in which the child lives. Malnutrition is the end result of chronic nutritional and frequently emotional deprivation by care takers, who because of poor understanding, poverty or family problems, are unable to provide the child with the nutrition and care he or she requires (2,3).

Poor nutrition has both short and long term effects on children and the nation as a whole. Children who are malnourished tend to have increased morbidity and mortality secondary to increased risk of serious infections and severe electrolyte disturbances. Severe and repeated attacks of malnutrition during childhood can negatively impact the physical and mental development, school performance and intellectual achievement of the child (1).

Therefore, reducing malnutrition and its effects is both a global and development goal as presented by the Millennium Development Goals (MDGs). Reduction of malnutrition entails prevention of malnutrition and treatment of the undernourished children. There are two ways to treat severely malnourished children: inpatient and community based. In inpatient care, severely malnourished children fulfilling admission criteria are admitted to the health facility and treated as per the management protocol of the facility.

Jimma University Specialized Hospital (JUSH) has been admitting and treating severely malnourished children for a couple of years. Admission, treatment and discharge were as per the Protocol for the Management of Severe Acute Malnutrition, Ethiopia – Federal Ministry of Health, March 2007 which is the update of guideline for the management of severe malnutrition endorsed by the Ministry of Health in May 2004. However, treatment outcome was not assessed.

## 1.2 Statement of the problem

Malnutrition remains one of the most common causes of morbidity and mortality among children throughout the world and more commonly in sub-Saharan Africa and south Asia (2). According to United Nations Children's Fund (UNICEF) report of 2009, stunting affected one third (approximately 195 million) of under 5 children in the developing world. Africa and Asia have high stunting rates – 40% and 36% respectively. More than 90% of the world's stunted children live in these two continents. One fourth (estimated 129 million) of under 5 children in the developing world are underweight and 10% are severely underweight. The prevalence of underweight among children is higher in Asia than in Africa with rates of 27% and 21% respectively. An estimated 68 million (13%) of under 5 children in the developing world are wasted and estimated 26 million (5%) are severely wasted. A number of African and Asian countries have wasting rates that exceed 15% (4). Despite the continued progress in all developing countries, it is still predicted that there will be 128-155 million underweight children by the year 2020 with 35% of these children to be from sub-Saharan Africa (5).

Many nutritional studies have demonstrated that malnutrition in Ethiopia is serious problem (1). The most important documented forms of malnutrition in Ethiopia are protein energy malnutrition and vitamin A, iodine, iron and zinc deficiencies (6). According to the Ethiopian Demographic and Health Survey (EDHS) 2005 report, the national stunting, under weight and wasting rates among under five year old children were 47%, 38% and 11% respectively (7) whereas according to the Ethiopian Demographic and Health Survey (EDHS) 2011 report, the national stunting, under weight and wasting rates among under five year old children were 44%, 29% and 10% respectively which is little improvement within five years (8).

Malnutrition is an underlying factor in over 50% of 10-11 million children under 5 years of age who die each year of preventable causes worldwide (9). Under-nutrition is associated with >50% of all childhood mortality in developing countries for which infection is the underlying cause (10–13), and the risk of mortality being 5-8 fold among severely compared to moderately malnourished children (12). In Ethiopia it is estimated that malnutrition contributes to an estimated 270,000 deaths of under-five children each year (1).

Among the principal causes of death in young children, 60.7% of deaths as a result of diarrhea, 52.3% of deaths as a result of pneumonia, 44.8% of deaths as a result of measles, and 57.3% of deaths as a result of malaria are attributable to under-nutrition (13). The risk of dying from any cause increases 8 times in a child with severe underweight (11). Because of this high risk of death, many children with severe acute malnutrition are managed in hospitals. Unfortunately, many of them die anyway (12).

In many health facilities the mortality rate from severe malnutrition at present is over 20% which is unacceptable (3). Even at university hospitals case-fatality rates may presently be over 30% (14). No hospital study in sub-Saharan Africa has demonstrated a reduction of the case fatality to an acceptable international level of <5%. Unfortunately, the number of children hospitalized with severe malnutrition continues to rise in Sub-Saharan Africa (12).

The risk of mortality in acute malnutrition is directly related to severity: moderate wasting is associated with a mortality rate of 30-148 per 1000 children per year and severe wasting is associated with a mortality rate of 73-187 per 1000 children per year. This equates to over 1.5 million child deaths associated with moderate wasting and 3.5 million with severe wasting every year. These numbers do not include children who die of oedematous malnutrition (kwashiorkor), and probably, therefore, underestimate the total number of child deaths directly associated with acute malnutrition (9). Other factors contributing to the high case fatality in children hospitalized with severe malnutrition include acute bacterial infections, electrolyte imbalance, micronutrient deficiencies, and faulty management particularly inappropriate administration of blood and intravenous fluids (15–20).

Although community based treatment of severe acute malnutrition has been advocated for in recent years, facility based treatment of severe malnutrition is still required. Unfortunately, adequate information on treatment outcome is not available to enable improvement of inpatient treatment of severe acute malnutrition and pay attention to children having characteristics suggestive of mortality.

# 2 Literature Review

Studies conducted at different areas on treatment outcome of severely malnourished children admitted to treatment institutions have reported different findings. Socio-demographic characteristics, anthropometry and type of malnutrition, underlying co-morbidity/complications, clinical conditions at admission, and type of treatments given were some of predictors of mortality identified by these studies.

## 2.1 Treatment outcomes

Study conducted at Mulago Hospital, Uganda, reported 24% death rate (29% in the first 48 hrs and 71% by the end of the first week), 49% discharge on achieving a target weight of 85% weight for height; and 27% self-discharge before target. The median duration from admission to death was 4 days (12). Study conducted at three tertiary academic hospitals in Johannesburg, South Africa, reported 11.5% death rate and 46% of deaths had occurred within 48 hrs of admission (15). Study conducted at Kilifi District Hospital, Kenya, reported death rate of 19% where 33% died within 48 hrs and 41% died within 72 hrs of admission (16).

Study conducted in Southern Nation, Nationality and People Region (SNNPR) reported the average cure and death rate of 87% and 3.6% respectively whereas 9.1% were defaulters (left before completing treatment) and non respondents (did not respond after 40 days on treatment). The average length of stay in the therapeutic feeding centers (TFCs) was 25 days for children with severe wasting and 21 days for children with oedematous malnutrition. The average weight gain was 14 g/kg/day for children with severe wasting and 13.4 g/kg/day for children with oedematous malnutrition (10).

Study conducted at St. Luke Catholic Hospital, Wolisso, Ethiopia, reported mortality rate of 7.1% where 28.6% of deaths occurred in the first 48 hrs of admission (early mortality) and 71.4% died after 48 hrs of admission (late mortality); in some cases, after 1 week of beginning nutritional treatment. Discharge with improvement (recovery rate) was 88.4% and self-discharges before improvement was 4.5%. The overall average hospital stay was 12.5 days (11). Study conducted at Gondar University hospital revealed overall case fatality rate of 18.4% while 9.1% abandoned treatment and 72.5% of the children were discharged improved (17). A study conducted at Zewditu Memorial Hospital, Ethiopia, reported death rate of 21.3% (21).

Study conducted at St Paul's Hospital, Nchelenge district, north-eastern Zambia, reported 25.8% hospital death, 22.4% abscond, 50.8% discharge, and 1% unknown outcome of the treatment (14). Study conduted at Sipetu Hospital and Mary Theresa Hospital, South Africa, revealed that case fatality rates (CFR) at Sipetu and Mary Theresa hospitals were 28% and 50% respectively. The average weight gain was 2 g/kg/day and average stay was 15.4 days (22).

## 2.2 Factors associated with mortality in severely malnourished children

### *2.2.1 Socio-demographic characteristics*

Study conducted in SNNPR reported that cure rate increased and death rate decreased with age (10). Study conducted in Turbo, Colombia, revealed that 88.4% of admitted children were younger than age 2 years. Children with kwashiorkor were significantly younger than the children with marasmus and mixed malnutrition (18). In a study carried out at two hospitals in East Africa (Kilifi District Hospital in Kenya and Muhimbili National Hospital in Tanzania), 55% of the children were male (19). In a study conducted at Zambia University Teaching Hospital's stabilization centre, sex was found to have significant effect on survival status (20).

### *2.2.2 Anthropometry and type of malnutrition*

In the study conducted in Kenya at Kilifi District Hospital, a multivariable logistic regression model adjusted for age and sex showed that Mid-upper Arm Circumference (MUAC), visible severe wasting, and kwashiorkor were all independently associated with inpatient death (23).

Study conducted at St. Luke Catholic Hospital, Wolisso, Ethiopia, reported that 80% of children died in 48 hrs of admission had severe marasmus with W/H ratio much lower than 60% (11). Study conducted at Kilifi District Hospital, Kenya, showed greatest mortality in children presenting with marasmus compared to those with oedematous malnutrition alone and oedema complicated by marasmus (16). Study conducted at St. Paul's Hospital, Nchelenge district, north-eastern Zambia found that marasmic kwashiorkor group had a higher mortality (28.0%) than marasmus (17.8 %) or kwashiorkor (13.4 %) groups which is statistically significant (14). Study conducted at Gondar University hospital revealed a statistically significant risk of death in children having marasmic kwashiorkor (17).

In a study conducted at two hospitals in East Africa (Kilifi District Hospital in Kenya and Muhimbili National Hospital in Tanzania), high fatality rates were observed among children with

oedematous malnutrition. About 46% of oedematous children with co-infections died compared to only 19% of non oedematous children with co-infections (19). In a study conducted at Zambia University Teaching Hospital's stabilization centre, those with marasmic-kwash on admission were found to have 2.2 times odds of death compared to those with marasmus (20).

### *2.2.3 Underlying co-morbidities*

In a study conducted at Mulago Hospital in Uganda, the main causes of death included septicemia (19%) and severe pneumonia (15.4%). Out of 80.8% children died in the first week, 41% were positive for HIV-1 infection whereas 14% had unknown HIV status (12). In southern and eastern Africa, much of excess mortality has also been attributed to concurrent HIV infection (15). Study conducted at three tertiary academic hospitals in Johannesburg, South Africa, indicated that HIV status was a significant predictor of death. Survival analysis has also confirmed a difference between HIV-positive and -negative children (15). In a study conducted at Kilifi District Hospital, Kenya, co-morbidities such as gastroenteritis (16%), malaria (8%), anaemia (12%), and pneumonia (8%), were found complicating early deaths. However, gastroenteritis (26%), bacteraemia (17%), and pneumonia (7%) were found complicating late deaths (16).

Study conducted in St. Luke Catholic Hospital, Wolisso, Ethiopia, reported that 10% of children died in 48 hrs of admission had congestive heart failure, 30% had severe rickets, 20% were HIV positive and 30% had underlying Tuberculosis (TB) (11). In a study conducted at St Paul's Hospital, Nchelenge district, north-eastern Zambia, the leading identified causes of death were pneumonia, measles, diarrhoea with dehydration, hypothermia and septicaemia (14). In a study conducted at two hospitals in East Africa (Kilifi District Hospital in Kenya and Muhimbili National Hospital in Tanzania), high fatality rates were observed among children with co-morbidities. At Muhimbili National Hospital (MNH), 86% of children died had co-morbidities. At Kilifi District Hospital (KDH), septicaemia was the most common cause of death followed by TB and HIV/AIDS (19). In a study conducted at Turbo, Colombia, the most common cause of death was sepsis (11 deaths), followed by heart failure (4 deaths) (18).

In a study conducted at Gondar University hospital, a statistically significant risk of death was observed in those with diarrhea with severe dehydration (17). Study conducted at Zewditu Memorial Hospital, Ethiopia, reported diarrhea as predictor of death outcome (21). In a study

conducted at Zambia University Teaching Hospital's stabilization centre, HIV status and diarrhea were found to be significant predictors of mortality (20).

### *2.2.4 Clinical conditions at admission*

Study conducted at St. Luke Catholic Hospital, Wolisso, Ethiopia, reported that children died in 48 hrs of admission were in critical condition when they came to attention. All of them had symptoms and signs of concomitant systemic infection and respiratory distress (11). In a study conducted at three tertiary academic hospitals in Johannesburg, South Africa, hypothermia (axillary T°≤35°C), Shock (cold periphery, prolonged capillary refill time (CRT)), Pallor and Corneal ulcers were found to be poor prognostic factors for mortality. However, pallor and shock were found to be the only predictors of mortality in Cox regression (15).

Study conducted at Kilifi District Hospital, Kenya, identified four admission features associated with early case fatality: bradycardia, CRT > 2 seconds, weak pulse volume, and impaired consciousness level (prostration or coma). The presence of two or more features was associated with an odds ratio of 9.6 for early fatality (16). In a study conducted at Gondar University hospital, a statistically significant risk of death was observed in those with altered level of consciousness (17). Study conducted at Zewditu Memorial Hospital, Ethiopia, reported oedema as a predictor of death outcome (21).

### *2.2.5 Type of treatments given*

Study conducted at Mulago Hospital in Uganda indicated that, 46% of severely malnourished children who received blood transfusion were died where 71% of them died within first 48 hrs after transfusion and median time from transfusion to death was 1 day. Likewise, 42% of children who received intravenous fluid were died where 56.8% of deaths occurred within first 48 hrs from the time of infusion and median time from infusion to death was 1 day. The adjusted relative risk of the fatality for transfusion was 3.3. Similarly, the adjusted relative risk of the fatality for infusion was 2.2 (12). Study conducted at three tertiary academic hospitals in Johannesburg, South Africa, indicated that blood transfusion was found to be a predictor of mortality (15).

## 2.3 Conceptual framework

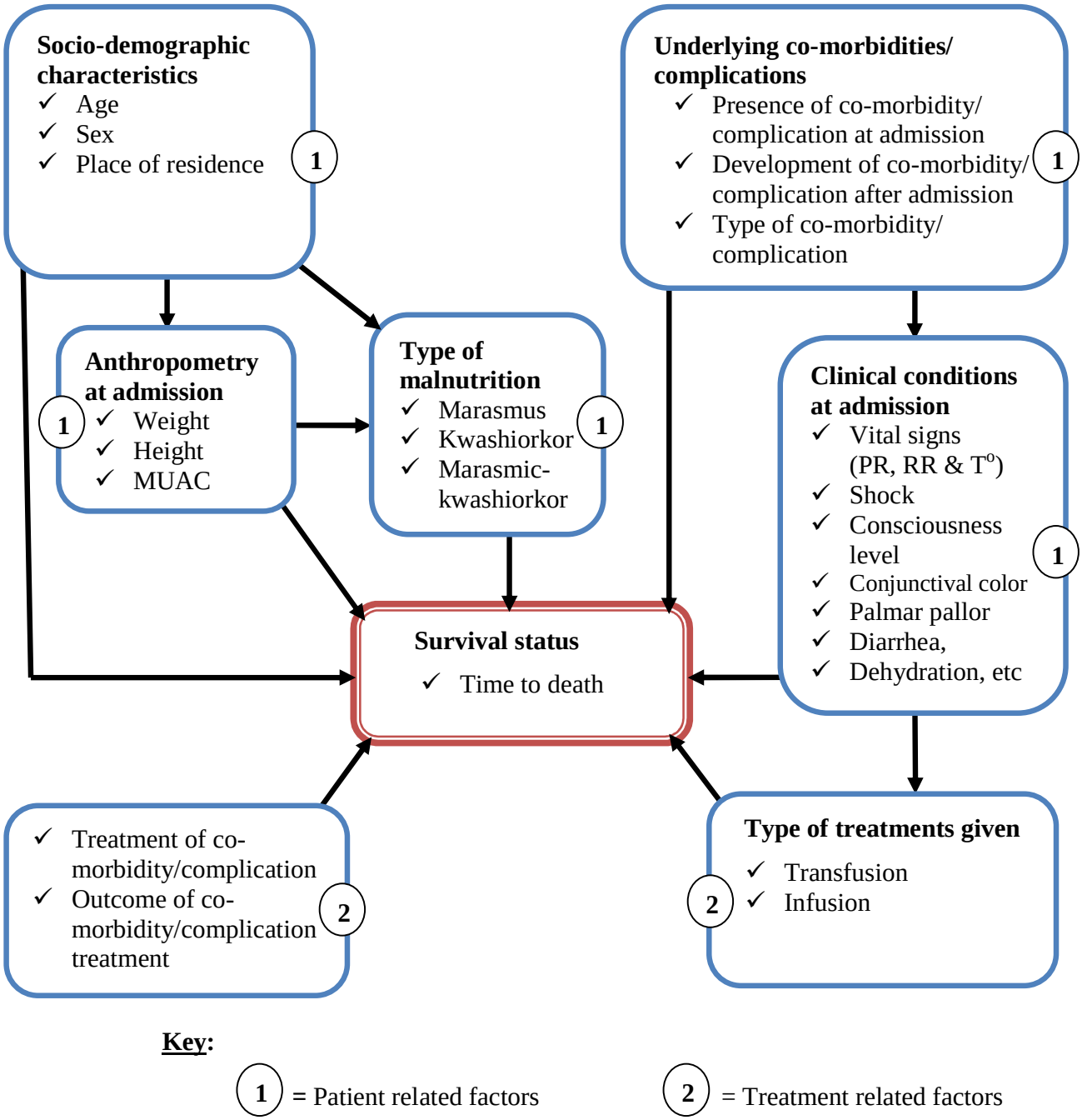


Figure 1. Conceptual framework of factors affecting survival status of severely malnourished children admitted to the hospital (adapted from reviewed literatures).

## 2.2 Significance of the study

Information on the outcome of malnutrition treatment and the potential predictors of mortality in severely malnourished children admitted to hospitals is critical for the improvement of quality care. However, very few studies have tried to evaluate the outcome of severely malnourished children admitted to African hospitals and reported fatality rates are still very high.

JUSH was treating severely malnourished children as inpatient for couple of years. Nevertheless, treatment outcome of severely malnourished children admitted to the hospital was not assessed. Therefore, the aim of this study is to generate information that explains outcome of malnutrition treatment and the potential predictors of mortality in severely malnourished children admitted to JUSH.

The results of the study will be used by health personnel, health service managers and policy makers for best practices in the management of severely malnourished children at Nutritional Rehabilitation Units (NRUs). The findings may also be used by organizations like UNICEF and World Food Programme which have special interest in the health of children as part of evidence for coming up with strategies that would help to improve management of severely malnourished children. The results are also expected to be used by Ministry of Health and other relevant stakeholders.

# 3 Objective

## 3.1 General objective

- To assess survival status and predictors of mortality in severely malnourished children admitted to Nutritional Rehabilitation Unit at Jimma University Specialized Hospital, Jimma, southwestern Ethiopia.

## 3.2 Specific objectives

1. To describe clinical profile of severely malnourished children admitted to JUSH.
2. To assess treatment outcome of severely malnourished children admitted to JUSH.
3. To identify patient related predictors of mortality in severely malnourished children.
4. To assess treatment related predictors of mortality in severely malnourished children.

# 4 Methods and Materials

## 4.1 Study area

Study was conducted at Jimma University Specialized Hospital (JUSH); the only teaching and referral hospital in the southwestern part of Ethiopia. Some of the professionals being trained in first degree program at the hospital include Nurses, Health Officers, General Practitioners, Anesthesiologists, Clinical Pharmacists and Laboratory Technicians whereas in postgraduate program include Internists, Surgeon, Pediatricians, Gynecologists and Obstetricians, Ophthalmologist, Clinical Pharmacists and Laboratory Technicians.

The hospital has bed capacity of 450 and a total of more than 750 staffs (both supportive and professionals). It provides services for approximately 9000 inpatient and 80000 outpatient attendances a year coming to the hospital from the catchment population of about 15 million people. Pediatric ward is one of the wards in the hospital while NRU is one of the units in the pediatric ward. Severely malnourished children are directly admitted to NRU and treated by different professionals including Interns (Medical and Health Officer), Nurses, Residents and Pediatricians. In the last two years (September 11, 2010 to September 10, 2012), a total of 997 severely malnourished children were admitted to the hospital.

## 4.1 Study period

Study period was from September 11, 2010 to September 10, 2012 when primary data were collected from children whereas secondary data were collected from registers and records from February 20, 2013 to March 22, 2013.

## 4.2 Study design

Institution based retrospective cohort study design was employed. Children's records from the date of admission until abscond/death/discharge were reviewed. Death and time to death were considered as event and outcome of interest respectively.

## 4.3 Population

### *4.3.1 Source population*

Source population consists of all severely malnourished children admitted to Nutritional Rehabilitation Unit (NRU) of Pediatric Ward, Jimma University Specialized Hospital, from

September 11, 2010 to September 10, 2012. There were a total of 997 severely malnourished children admitted to the hospital during the study period.

### *4.3.2 Study population*

Study population consists of all severely malnourished children admitted to NRU of Pediatric Ward, Jimma University Specialized Hospital, from September 11, 2010 to September 10, 2012 who fulfilled inclusion criteria.

### *4.3.3 Inclusion and exclusion criteria*

- Children with unknown treatment outcome were excluded from the study.

## 4.4 Sample size determination and sampling technique

Out of total 997 severely malnourished children admitted to the hospital during the study period, 983 who fulfilled inclusion criteria were included into the study. Therefore, the power of the study was 80.7% by considering 95% confidence level, 43.5% & 34.6% deaths among children with oedematous and non oedematous types of malnutrition respectively, 1.26 RR and 1:1 oedematous (exposed) to non oedematous (unexposed) ratio (20).

## 4.5 Variables

***a) Dependent variable***

- Survival status
  - ✓ Time to death

***b) Independent variables***

- Socio-demographic characteristics
  - ✓ Age
  - ✓ Sex
  - ✓ Place of residence
- Anthropometry at admission
  - ✓ Height
  - ✓ Weight
  - ✓ MUAC
- Type of malnutrition
  - ✓ Marasmus
  - ✓ Kwashiorkor
  - ✓ Marasmic kwashiorkor

- Underlying co-morbidities/complications
  - ✓ Co-morbidity/complication at admission
  - ✓ Type of co-morbidity/complication at admission
  - ✓ Co-morbidity/complication developed after admission
  - ✓ Type of co-morbidity/complication developed after admission
  - ✓ Treatment of co-morbidity/complication and its outcome
- Clinical conditions at admission
  - ✓ Vital signs (PR, RR & $T^o$)
  - ✓ Shock
  - ✓ Consciousness level
  - ✓ Conjunctival color
  - ✓ Palmar pallor
  - ✓ Diarrhea
  - ✓ Vomiting
  - ✓ Dehydration, etc
- Type of treatments given
  - ✓ Transfusion
  - ✓ Infusion

## 4.6 Data collection process

Data were collected after permission to conduct the study and necessary resources were obtained. Data were collected by 5 BSc nurses who had experience in data collection. Data were extracted first from children's registers and then from records (card and multi-chart). Cards of severely malnourished children admitted to the hospital during study period were identified from other cards on the shelf by card room workers of JUSH. Pre-tested and modified English checklist was used to collect data.

## 4.7 Data quality control

One day training was given for data collectors and supervisor to ensure common understanding on the checklist. Data collection instrument was pre-tested and modified in terms of order and content. Collected data were sorted and checked for errors and completeness onsite daily. Reviewed cards were boldly marked to avoid re-review. Overall activities were supervised by Supervisor and Principal Investigator.

## 4.8 Data processing and analysis

Data were edited, entered into EpiData 3.1, exported to SPSS version 16 for windows and cleaned to check for completeness, extreme and missing values. All statistical analyses were done using SPSS version 16 for windows. Univariate (descriptive) analyses were performed and presented by tables and graphs. Kaplan-Meier and Cox regression was used to assess the association of independent variable with outcome. Multi-collinearity among independent variables was checked. The possibilities of interactions (effect measure modification) among independent variables were explored by including interaction terms in the multivariable Cox regression. Cox regression model assumption of proportional hazard was checked by Kaplan-Meier hazard plots and testing an interaction of covariate with time.

During modeling, multivariable Cox regression was preceded by bivariate Cox regression. P-value of less than 0.2 was used to identify candidates for multivariable analysis. Multivariable Cox regression was run using Forward Wald method to identify best independent predictors of death. P-value of less than 0.05 was considered as a statistical significance to identify independent predictors of earlier death in multivariable analysis. Hazard ratio (HR) was used as a measure of association (effect).

## 4.9 Ethical considerations

Permission to proceed with the study was obtained from the ethical clearance committee of College of Public Health and Medical Sciences, Jimma University. Permission to use the data was obtained from JUSH and department of Pediatrics, Jimma University. Confidentiality was assured by collecting data anonymously using just card number of the records.

## 4.10 Plan for data dissemination

The findings of the study will be presented to the Jimma University Scientific Community and submitted to the department of Epidemiology, College of Public Health and Medical Sciences, Jimma University. Recommendations were forwarded to hospital staffs and other stakeholders based on the findings of the study. Efforts will be made to publish the findings on national and international scientific journals.

## 4.11 Operational definitions

- **Co-morbidity/complication at admission** – co-existence of other disease(s) with severe malnutrition when the patient is admitted to the hospital or manifestation of new disease(s) on the underlying severe malnutrition during the first 48 hrs of patient's admission to the hospital.
- **Co-morbidity/complication after admission** – manifestation of new disease(s) on the underlying severe malnutrition after the first 48 hrs of patient's admission to the hospital.
- **Infusion –** administration of intravenous fluid for severely malnourished child with severe dehydration.
- **Kwashiorkor** – type of malnutrition in the Well-come classification of malnutrition where children have weight-for-age percentage (%) of National Center for Health Statistics (NCHS) 60-79 and oedema.
- **Marasmic kwashiorkor** – type of malnutrition in the Well-come classification of malnutrition where children have weight-for-age percentage (%) of National Center for Health Statistics (NCHS) < 60 and oedema.
- **Marasmus** – type of malnutrition in the Well-come classification of malnutrition where children have weight-for-age percentage (%) of National Center for Health Statistics (NCHS) < 60 but not oedema.
- **Severe acute malnutrition** – weight-for-height z scores (WHZs) of less than or equal to -3 or less than or equal to 70% of the reference median of US National Center for Health Statistics (NCHS)/WHO reference values (severe wasting) or symmetrical oedema involving at least the feet (oedematous malnutrition, kwashiorkor) (WHO definition).
- **Survival –** the chance that severely malnourished child does not die until lost from follow up or improved/cured and discharged from the hospital.
- **Transfusion –** administration of whole blood or blood products for severely malnourished child with severe anemia.
- **Vital sign classification –** Categorical variables for respiratory rate and pulse rate were created from admission measures using cut-offs defined by levels that would imply a definite need for urgent therapeutic intervention (24) (annex 3).

# 5 Result

Out of total 997 severely malnourished children admitted to Pediatric Ward of JUSH during the study period (Sept 11, 2010 – Sept 10, 2012), 947 were enrolled into the study giving response rate of 96.3%. Fourteen (3.7%) children with unknown treatment outcome were excluded and records for 36 eligible children registered on the register were not found.

## 5.1 Socio-demographic characteristics

More than half (58.6%) of the children enrolled into the study were males and 68.1% were in the age group of 6-59 months with median age of 24 months (figure 2). Most (95%) of the children were from Jimma zone and the rest were from Ilu Ababor zone (1.1%), SNNPR (3.6%) and Gambela (0.3%).

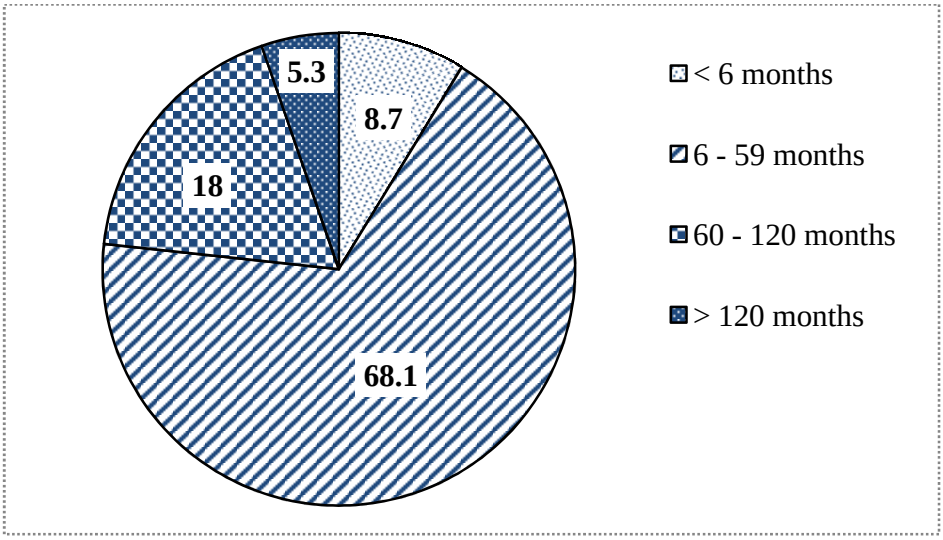


Figure 2. Age distribution of severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012

## 5.2 Anthropometry and type of malnutrition

Majorities (60.8%) of the children enrolled into the study had oedematous malnutrition (kwashiorkor or marasmic-kwashiorkor). Larger proportion (83.8%) of marasmus (non oedematous malnutrition) was observed among 0-59 months old children than oedematous malnutrition (72.2%) (figure 3).

More than half (58.5%) of the children in the age group of 6-60 months had MUAC less than 11.5 cm; the cutoff point for severe acute malnutrition.

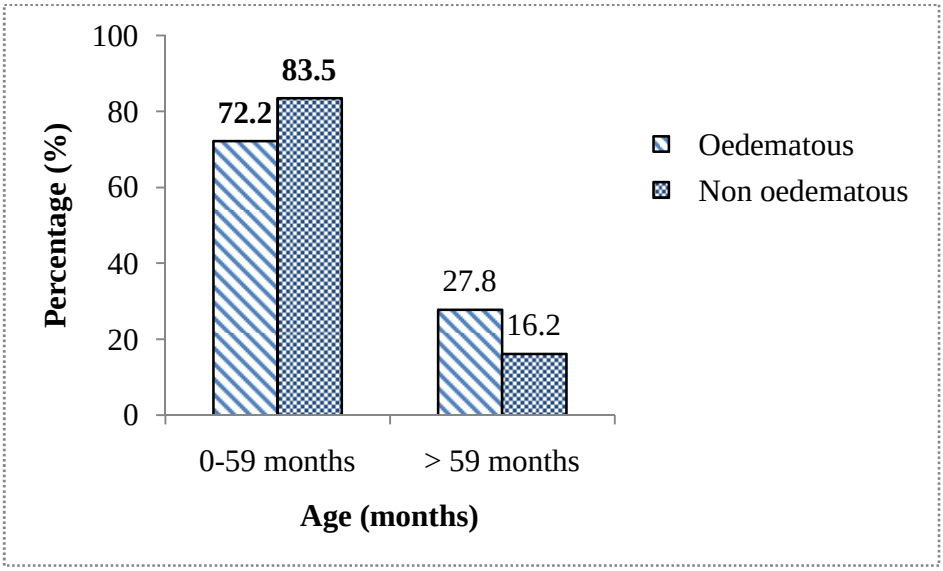


Figure 3. Distribution of type of malnutrition by age of severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012

## 5.3 Clinical profile

Regarding clinical conditions of children at admission, most of them were not in critical condition when they came to attention except for tachypnea, diarrhea and vomiting. Out of total 947 children, 1.8% were hypothermic (axillary temperature $\leq 35^{o}C$), 69.2% had deranged respiratory rate and 21.8% had deranged pulse rate. Pale conjunctiva and palmar pallor were present in 23.6% and 18% of the children respectively. Dehydration was present in 11.8% of the children of which 67.9% were severely dehydrated. Shock was present in 6.4% of the children. Children with impaired level of consciousness (lethargic or comatose) account for 12.5% of total children. Majority (66.0%) and more than half (51.6%) of the children had diarrhea and vomiting respectively where 88.8% had watery diarrhea. Skin lesion was present in 31.3% of the children (table 1).

Table 1. Clinical characteristics of severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012

| Clinical characteristics | Category | Number | Percentage |
|---|---|---|---|
| Vital signs | | | |
| a) Hypothermia (axillary $T^o \leq 35^oC$) | Yes | 17 | **1.8** |
| | No | 930 | 98.2 |
| b) Respiratory rate | Slow breathing (bradypnea) | 85 | **9.0** |
| | Fast breathing (tachypnea) | 570 | **60.2** |
| | Normal | 292 | 30.8 |
| c) Pulse rate | Bradycardic | 113 | **11.9** |
| | Tachycardic | 94 | **9.9** |
| | Normal | 740 | 78.1 |
| Conjunctival color | Pale | 224 | **23.6** |
| | Pink | 723 | 76.3 |
| Palmar pallor | Present | 170 | **18.0** |
| | Absent | 777 | 82.0 |
| Dehydration | Present | 112 | **11.8** |
| | Absent | 835 | 88.2 |
| Shock | Present | 61 | **6.4** |
| | Absent | 886 | 93.6 |
| Consciousness level | Impaired | 118 | **12.5** |
| | Conscious* | 829 | 87.5 |
| Diarrhea | Present | 625 | **66.0** |
| | Absent | 322 | 34.0 |
| Vomiting | Present | 489 | **51.6** |
| | Absent | 458 | 48.4 |
| Skin lesion | Present | 296 | **31.3** |
| | Absent | 651 | 68.7 |

* = COTPP (conscious, oriented to time, place and person), alert, irritable, apathetic

Concerning distribution of clinical conditions by type of malnutrition, majority of children with deranged respiratory rate, pale conjunctiva, palmar pallor, dehydration and shock were children with non oedematous type of malnutrition whereas most of children with hypothermia, deranged pulse rate, impaired consciousness level, acute gastroenteritis (diarrhea or vomiting) and skin lesion were children with oedematous type of malnutrition (table 2).

Table 2. Distribution of clinical characteristics by type of malnutrition among severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012

| Clinical characteristics | Type of malnutrition | | Total |
|---|---|---|---|
| | Non edematous | Edematous | |
| | Nº (%) | Nº (%) | Nº |
| Vital signs | | | |
| a) Hypothermia (axillary $T^o \leq 35^oC$) | 6 (35.3) | 11 (**64.7**) | 17 |
| b) Respiratory rate | | | |
| i. Bradypnic | 60 (**70.6**) | 25 (29.4) | 85 |
| ii. Tachypnic | 303 (**53.2**) | 267 (46.8) | 570 |
| c) Pulse rate | | | |
| i. Bradycardic | 49 (43.4) | 64 (**56.6**) | 113 |
| ii. Tachycardic | 43 (45.7) | 51 (**54.3**) | 94 |
| Pale conjunctiva | 153 (**68.3**) | 71 (31.7) | 224 |
| Palmar pallor | 116 (**68.2**) | 54 (31.8) | 170 |
| Dehydration | 64 (**57.1**) | 48 (42.9) | 112 |
| Shock | 32 (**52.5**) | 29 (47.5) | 61 |
| Impaired consciousness level | 47 (39.8) | 71 (**60.2**) | 118 |
| Diarrhea | 199 (31.8) | 426 (**68.2**) | 625 |
| Vomiting | 212 (43.4) | 277 (**56.6**) | 489 |
| Skin lesion | 54 (18.2) | 242 (**81.8**) | 296 |

Regarding co-morbidity/complications at admission, majority (69.5%) of the children had co-morbidity/complications at admission. More than half (54.9%) of children with co-morbidity at admission were children with oedematous type of malnutrition. Pneumonia (20.1%), anemia (15.2%) and disseminated TB (9.8%) were the leading co-morbidities/complications at admission (table 3). Twenty three (2.4%) of the children were reactive for HIV test and HIV status was not known for 37% of the children.

Table 3. Distribution of co-morbidities/complications at admission among severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012

| S.Nº | Co-morbidities/complications | Number | Percent |
|---|---|---|---|
| 1 | Pneumonia | 214 | 20.1 |
| 2 | Anemia | 162 | 15.2 |
| 3 | Disseminated TB | 104 | 9.8 |
| 4 | Conjunctivitis | 65 | 6.1 |
| 5 | Rickets | 58 | 5.5 |
| 6 | Urinary tract infection (UTI) | 46 | 4.3 |
| 7 | Pulmonary tuberculosis (PTB) | 41 | 3.9 |
| 8 | Oral thrush | 41 | 3.9 |
| 9 | Acute febrile illness (AFI) | 34 | 3.2 |
| 10 | Retroviral infection (RVI) | 23 | 2.2 |
| 11 | Acute abdomen | 23 | 2.2 |
| 12 | Tinea capitis | 22 | 2.1 |
| 13 | Heart disease | 19 | 1.8 |
| 14 | Otitis media | 14 | 1.3 |
| 15 | Intestinal parasitosis | 13 | 1.2 |
| 16 | Tungiasis | 12 | 1.1 |
| 17 | Down syndrome | 11 | 1.0 |
| 18 | Cellulitis | 11 | 1.0 |
| 19 | Gastrointestinal (GI) onset sepsis | 10 | 0.9 |
| 20 | Others | 140 | 13.2 |
| | Total | 1063 | 100 |

Concerning co-morbidity/complications after admission, 15.6% of the children had developed co-morbidity/complication after admission regardless of their co-morbidity/complication status at admission. Pneumonia (34.6%) and hypovolumic shock (12%) were the leading co-morbidities/complications after admission (table 4). Majority (74.3%) of children who developed co-morbidity after admission were also children with oedematous type of malnutrition.

Table 4. Distribution of co-morbidities/complications developed after admission among severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012

| S.Nº | Co-morbidities/complications | Number | Percent |
|---|---|---|---|
| 1 | Pneumonia | 66 | 34.6 |
| 2 | Hypovolumic shock | 23 | 12.0 |
| 3 | Oral thrush | 17 | 8.9 |
| 4 | Urinary tract infection (UTI) | 14 | 7.3 |
| 5 | Anemia | 11 | 5.8 |
| 6 | Conjunctivitis | 6 | 3.1 |
| 7 | Septic shock | 6 | 3.1 |
| 8 | Acute gastro-enteritis (AGE) | 5 | 2.6 |
| 9 | Chicken pox | 3 | 1.6 |
| 10 | Gastrointestinal (GI) onset sepsis | 3 | 1.6 |
| 11 | Otitis media | 3 | 1.6 |
| 12 | Others | 34 | 17.8 |
| | Total | 191 | 100 |

## 5.4 Treatment outcomes

Out of total 947 children whose records were reviewed, 737 (77.8%) were discharged with improvement, 88 (9.3%) died during treatment and 122 (12.9%) absconded (left the NRU before completing treatment). The number of died and absconded children was significantly (p = .022) reduced in the period September 12, 2011 to September 10, 2012 compared to the period September 11, 2010 to September 11, 2011 despite almost the same number (474 and 473 respectively) of admissions in the two periods (table 5).

Table 5. Treatment outcomes of severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012

| Year discharged/ died/absconded | Treatment outcomes | | | | $X^2$ (p-value*) |
|---|---|---|---|---|---|
| | Improved Nº (%) | Died Nº (%) | Absconded Nº (%) | Total Nº (%) | |
| Sept. 11, 2010 to Sept. 11, 2011 | 328 (73.9) | 48 (10.8) | 68 (15.3) | 444 | 7.6 (.022) |
| Sept. 12, 2011 to Sept. 10, 2012 | 409 (81.3) | 40 (8.0) | 54 (10.7) | 503 | |
| Total | 737 (77.3) | 88 (9.3) | 122 (12.9) | 947 | |

* = Pearson's chi-square

The average weight gain was 10.4 g/kg/day (12.9 g/kg/day for children with non oedematous and 7.6 g/kg/day for children with oedematous malnutrition). Out of total 737 children discharged with improvement, only 226 (30.6%) of the children were discharged on achieving a target weight of 85% weight for height. The average length of stay in the hospital was 17.4 days (16.7 for children with non oedematous and 17.9 for children with oedematous malnutrition).

Larger proportions of discharges had occurred in the second (35.8%) and third (24.0%) weeks of admission (figure 4). The mean and median duration from admission to discharge with improvement were 19.5 and 16 days respectively.

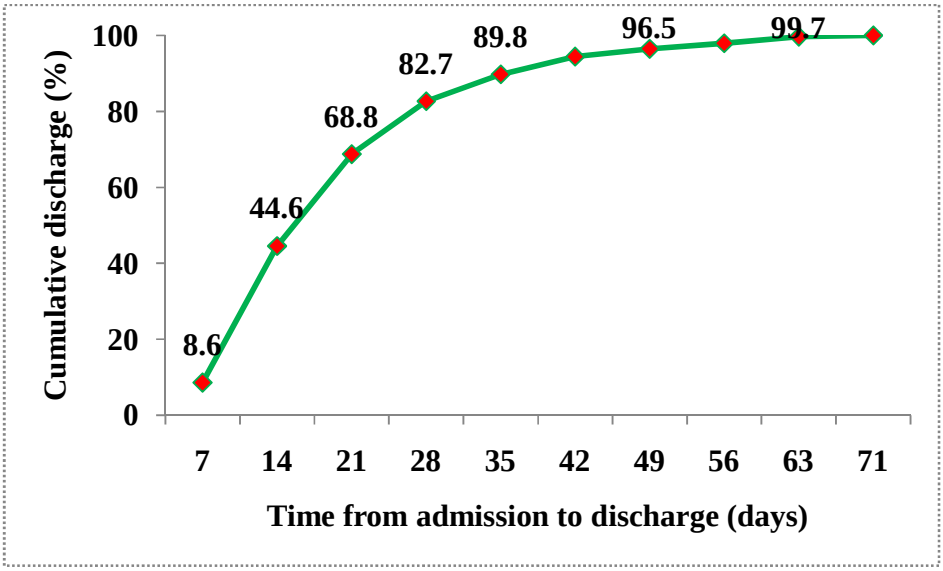


Figure 4. Time from admission to discharge for severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012

Larger proportions of deaths (60.2%) and absconds (43.4%) had occurred in the first week of admission (figure 5). The mean and median duration from admission to death were 9.5 and 7 days respectively whereas mean and median duration from admission to abscond were 10.6 and 8 days respectively.

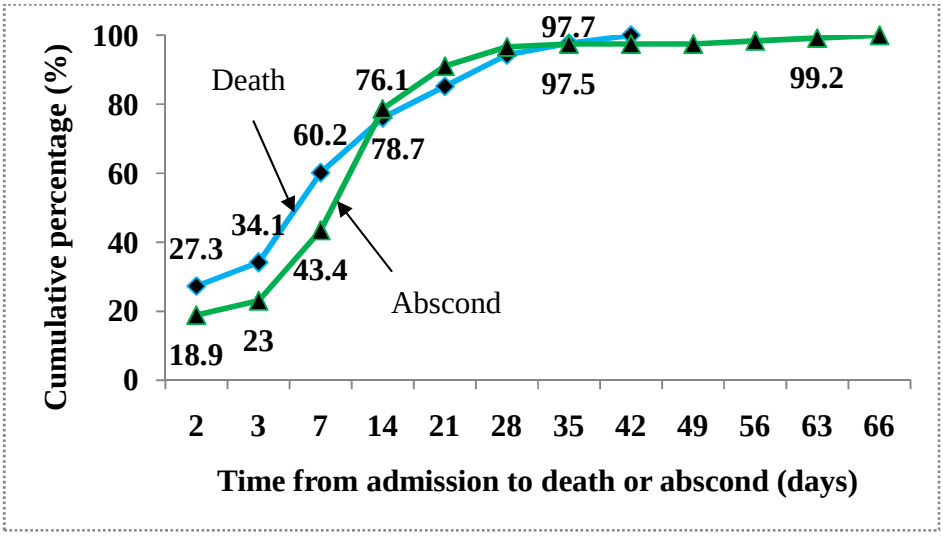


Figure 5. Time from admission to death or abscond for severely malnourished children admitted to JUSH, Sept.2010-Sept. 2012

Co-morbidities/complications were treated in 99% of admitted children and controlled (cured) in 88.9% of treated children. Out of total 947 children whose records were reviewed, 119 (12.6%) were infused (resuscitated with IV fluid) and 14 (1.5%) were transfused. Majority (66.7%) deaths of infused children occurred within first day of infusion (figure 6). The mean and median duration from infusion to death were 4.1 and 1 days respectively while from transfusion to death were 1.4 and 2 days respectively.

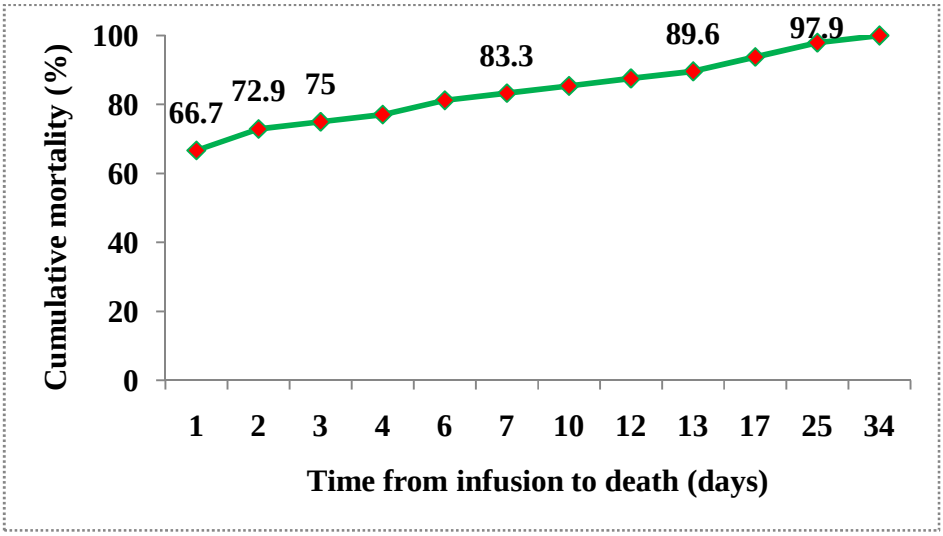


Figure 6. Time from infusion to death for severely malnourished children admitted to JUSH, Sept. 2010-Sept.2012

## 5.1 Factors associated with earlier death of severely malnourished children

### *a) Bivariate analysis*

Bivariate analysis was performed for the following independent variables using Kaplan-Meier and Cox regression: socio-demographic characteristics, anthropometry and type of malnutrition, underlying clinical conditions, co-morbidity/complication at admission and type of treatments given. In bivariate analysis with Kaplan-Meier, significant difference was observed between categories for age, MUAC, hypothermia, pulse rate, palmar pallor, dehydration, shock, consciousness level, vomiting, co-morbidity/complication at admission, HIV status and infusion (table 6).

Table 6. Bivariate analysis (Kaplan-Meier) of factors associated with earlier death in severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012

| Factors (variables) | Df | Chi-square | Log Rank (Mantel-Cox) p-value |
|---|---|---|---|
| **Socio-demographic characteristics** | | | |
| Age | 1 | 14.7 | < .001 |
| Sex | 1 | 0.1 | .794 |
| **Anthropometry and type of malnutrition** | | | |
| MUAC | 1 | 24.4 | < .001 |
| Type of malnutrition | 1 | 3.6 | .058 |
| **Clinical conditions at admissions** | | | |
| Vital signs | | | |
| a) Hypothermia (axillary $T^{o} \leq 35°C$) | 1 | 13.6 | < .001 |
| b) Respiratory rate | 2 | 1.0 | .606 |
| c) Pulse rate | 2 | 18.9 | < .001 |
| Conjunctival color | 1 | 1.8 | .186 |
| Palmar pallor | 1 | 7.9 | .005 |
| Dehydration | 1 | 32.1 | < .001 |
| Shock | 1 | 27.4 | < .001 |
| Consciousness level | 1 | 39.8 | < .001 |
| Diarrhea | 1 | 0.2 | .653 |
| Vomiting | 1 | 6.6 | .010 |
| Skin lesion | 1 | 1.5 | .224 |
| **Co-morbidity at admission** | | | |
| Admission co-morbidity | 1 | 13.8 | < .001 |
| HIV Status | 1 | 14.9 | < .001 |
| **Type of treatments given** | | | |
| Infusion | 1 | 29.9 | < .001 |
| Transfusion | 1 | 0.5 | .485 |

Before modeling bivariate Cox regression, Cox regression model assumption of proportional hazards was checked by Kaplan-Meier hazard plots and testing an interaction of covariate with time. Age, MUAC, type of malnutrition, hypothermia, pulse rate, conjunctival color, palmar pallor, dehydration, shock, consciousness level, oedema, vomiting, co-morbidity/complication at admission, HIV status and infusion were found to be candidates for multivariable analysis at p-value less than 0.2 (table 7).

Table 7. Bivariate analysis (Cox regression) of factors associated with earlier death in severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012

| Factors (variables) | Mean Survival Time (days) | HR | 95% CI | P-value |
|---|---|---|---|---|
| **Socio-demographic characteristics** | | | | |
| Age | | | | |
| < 24 months | 49.8 | 2.3 | 1.5-3.5 | < .001 |
| ≥ 24 months | 66.1 | 1 | | |
| Sex | | | | |
| Male | 61.4 | 1.1 | 0.7-1.6 | .794 |
| Female | 59.6 | 1 | | |
| **Anthropometry and type of malnutrition** | | | | |
| MUAC | | | | |
| < 11.5 cm | 58.3 | 5.3 | 2.5-11.0 | < .001 |
| ≥ 11.5 cm | 60.1 | 1 | | |
| Type of malnutrition | | | | |
| Oedematous | 62.4 | 0.7 | 0.4-1.0 | .060 |
| Non oedematous | 57.0 | 1 | | |
| **Clinical conditions at admissions** | | | | |
| Vital signs | | | | |
| a) Hypothermia (axillary $T^{o} \leq 35°C$) | | | | |
| Present | 33.4 | 3.9 | 1.8-8.4 | .001 |
| Absent | 62.1 | 1 | | |
| b) Respiratory rate | | | | |
| Bradypnea | 46.1 | 1.4 | 0.7-2.9 | .354 |
| Tachypnea | 62.2 | 1.0 | 0.6-1.6 | .931 |
| Normal | 58.7 | 1 | | |
| c) Pulse rate | | | | |
| Bradycardia | 41.0 | 2.6 | 1.6-4.2 | < .001 |
| Tachycardia | 56.9 | 0.6 | 0.2-1.5 | .284 |
| Normal | 61.7 | 1 | | |

| | | | | |
|---|---|---|---|---|
| Conjunctival color | | | | |
| Pale | 52.9 | 1.4 | 0.9-2.1 | .189 |
| Pink | 60.6 | 1 | | |
| Palmar pallor | | | | |
| Present | 49.6 | 1.9 | 1.2-3.0 | .006 |
| Absent | 62.0 | 1 | | |
| Dehydration | | | | |
| Present | 45.1 | 3.5 | 2.2-5.5 | < .001 |
| Absent | 63.0 | 1 | | |
| Shock | | | | |
| Present | 36.5 | 3.7 | 2.2-6.4 | < .001 |
| Absent | 62.6 | 1 | | |
| Consciousness level | | | | |
| Impaired | 42.9 | 3.8 | 2.4-5.9 | < .001 |
| Conscious* | 63.6 | 1 | | |
| Diarrhea | | | | |
| Present | 55.4 | 1.1 | 0.7-1.7 | .654 |
| Absent | 60.7 | 1 | | |
| Vomiting | | | | |
| Present | 58.6 | 1.8 | 1.1-2.7 | .011 |
| Absent | 62.7 | 1 | | |
| Skin lesion | | | | |
| Present | 59.3 | 1.3 | 0.8-2.0 | .227 |
| Absent | 61.7 | 1 | | |
| **Co-morbidity/complication at admission** | | | | |
| Admission **c**o-morbidity/complication | | | | |
| Present | 59.3 | 3.2 | 1.7-6.3 | < .001 |
| Absent | 62.5 | 1 | | |
| HIV Status | | | | |
| Positive | 38.6 | 4.3 | 1.9-9.7 | < .001 |
| Negative | 64.5 | 1 | | |
| **Type of treatments given** | | | | |
| Infusion | | | | |
| Yes | 43.3 | 3.7 | 2.2-6.1 | < .001 |
| No | 62.7 | 1 | | |
| Transfusion | | | | |
| Yes | 36.2 | 2.0 | 0.3-14.4 | .489 |
| No | 61.4 | 1 | | |

* = COTPP (conscious, oriented to time, place and person), alert, irritable, apathetic

***b) Multivariable analysis***

Multivariable Cox regression was run for variables found to be candidates in bivariate Cox regression. Before running regression, multi-collinearity among variables was checked and did not found any that was significant. During modeling, the possibilities of interactions (effect measure modification) among independent variables were explored by including all possible combinations of independent variables in the regression in separate block. Cox regression model assumption of proportional hazards was checked by testing an interaction of covariates with time. However, neither statistically significant interaction nor violation of proportional hazards assumption was found. Regression was run using Forward Wald (stepwise) method to identify best independent predictors of earlier death. P-value of less than 0.05 was used as statistical significance.

Age less than 24 months, hypothermia (axillary $T^{o} \leq 35^{o}C$), impaired consciousness level, palmar pallor, dehydration and co-morbidity/complication at admission were found to be independent predictors of earlier death in severely malnourished children admitted to the hospital. However, type of malnutrition, pulse rate, conjunctival color, shock, vomiting and infusion were not found to be independent predictors of earlier death (table 8).

Table 8. Multivariable analysis of factors associated with earlier death in severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012

| Factors (variables) | Mean Survival time (days) | AHR | 95% CI | P-value |
|---|---|---|---|---|
| **Socio-demographic characteristics** | | | | |
| Age | | | | |
| < 24 months | 49.8 | 1.9 | 1.2-2.9 | .006 |
| ≥ 24 months | 66.1 | 1 | | |
| **Clinical conditions at admissions** | | | | |
| Hypothermia (axillary $T^o \leq 35\ ^oC$) | | | | |
| Present | 33.4 | 3.0 | 1.4-6.6 | .005 |
| Absent | 62.1 | 1 | | |
| Impaired consciousness level | | | | |
| Impaired | 42.9 | 2.6 | 1.5-4.5 | < .001 |
| Conscious | 63.6 | 1 | | |
| Palmar pallor | | | | |
| Present | 49.6 | 2.1 | 1.3-3.3 | .003 |
| Absent | 62.0 | 1 | | |
| Dehydration | | | | |
| Present | 45.1 | 2.3 | 1.3-4.0 | .004 |
| Absent | 63.0 | 1 | | |
| Co-morbidity/complication at admission | | | | |
| Present | 59.3 | 3.7 | 1.9-7.2 | < .001 |
| Absent | 62.5 | 1 | | |

Adjusting for other variables, it was found that children with age less than 24 months were 1.9 (95% CI [1.2-2.9]; p = 0.006) times more likely to die earlier than children with age 24 and above months.

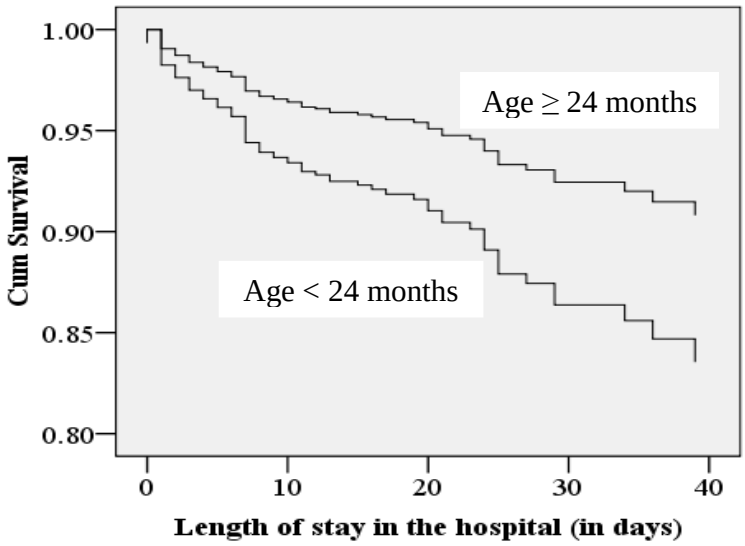


Figure 7. Cox regression survival curve at mean of covariates retained in the final multivariable model by age of severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012.

Risk of earlier death for hypothermic children was found to be 3.0 (95% CI [1.4-6.6]; p = 0.005) times higher than children without hypothermia.

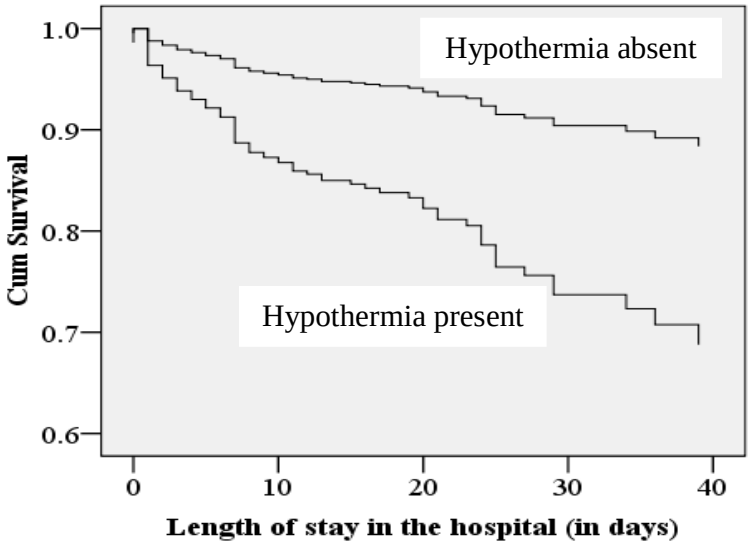


Figure 8. Cox regression survival curve at mean of covariates retained in the final multivariable model by hypothermia of severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012.

Children with impaired consciousness level (lethargy or coma) were 2.6 (95% CI [1.5-4.5]; p < .001) times more likely to die earlier than conscious children.

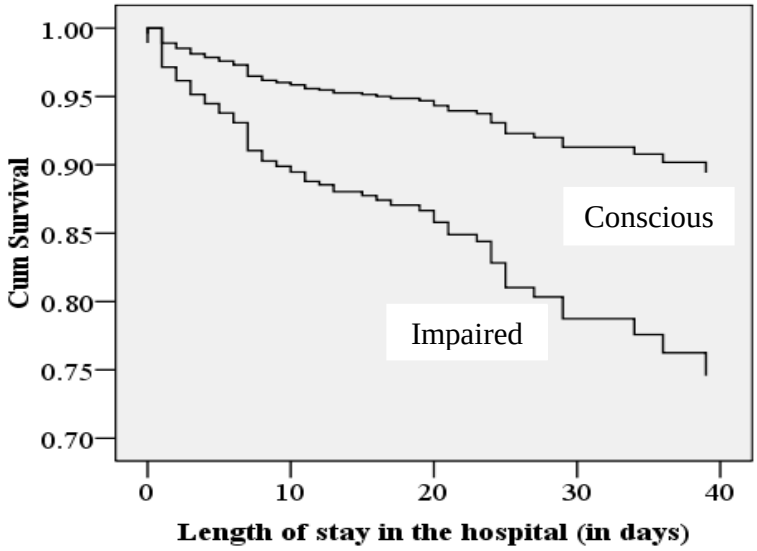


Figure 9. Cox regression survival curve at mean of covariates retained in the final multivariable model by consciousness level of severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012.

Risk of earlier death for children with palmar pallor was 2.1 (95% CI [1.3-3.3]; p = 0.003) times higher than children without palmar pallor.

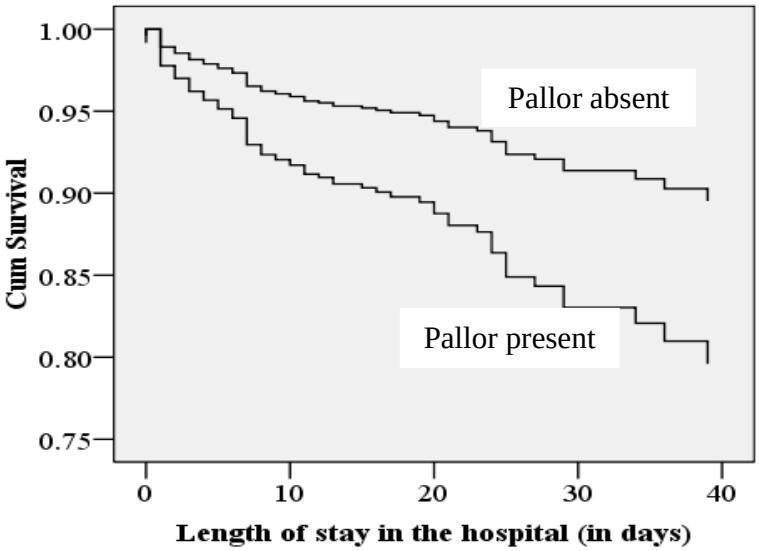


Figure 10. Cox regression survival curve at mean of covariates retained in the final multivariable model by palmar pallor of severely malnourished children admitted to JUSH, Sept 2010-Sept 2012.

Dehydrated children were found to be 2.3 (95% CI [1.3-3.9]; p = 0.004) times more likely to die earlier than children who were not dehydrated.

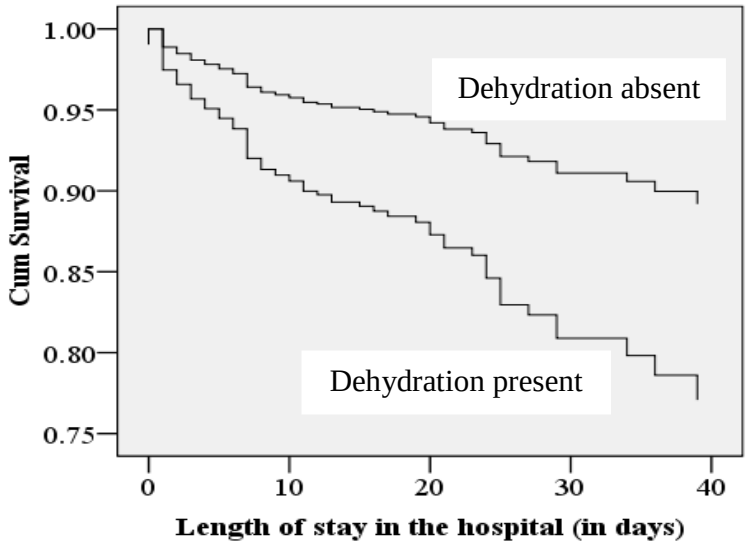


Figure 11. Cox regression survival curve at mean of covariates retained in the final multivariable model by dehydration of severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012.

Children with co-morbidity/complication at admission were found to be 3.7 (95% CI [1.9-7.2]; p < 0.001) times more likely to die earlier than children without co-morbidity/complication at admission.

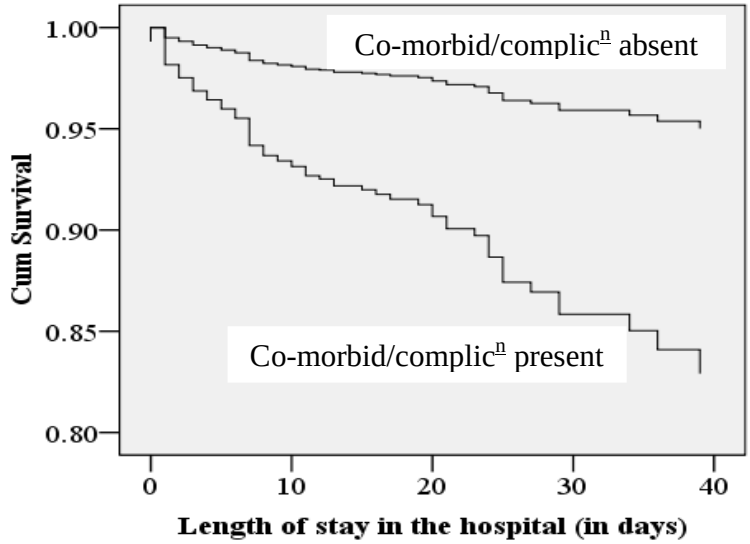


Figure 12. Cox regression survival curve at mean of covariates retained in the final multivariable model by co-morbidity/complication of severely malnourished children admitted to JUSH, Sept. 2010-Sept. 2012.

# 6 Discussion

Study on survival status and predictors of mortality in severely malnourished children admitted to Jimma University Specialized Hospital (JUSH) was conducted from September 2010 to September 2012. Out of total 947 children included in the study, 737 (77.8%) were discharged with improvement, 88 (9.3%) died during treatment and 122 (12.9%) absconded. The average weight gain was 10.4 g/kg/day. The average length of stay in the hospital was 17.4 days. The main predictors of earlier hospital deaths for severely malnourished children admitted to JUSH include age less than 24 months, hypothermia, impaired consciousness level, palmar pallor, dehydration and co-morbidity/complication at admission.

Regarding distribution of age and type of malnutrition, similar to the reports from Southern Nation, Nationality and People Region (SNNPR) and Gondar University hospital, majority (68.1%) of admitted children were in the age group of 6-59 months due to higher risk factors for malnutrition in this age group (10,17). Majorities (60.8%) of the children enrolled into the study had oedematous malnutrition (kwashiorkor or marasmic-kwashiorkor) which was in line with the finding of studies conducted at SNNPR, St. Luke Catholic Hospital, Wolisso, and Turbo, Colombia (10,11,18). However, it was different from the finding of study conducted at Kilifi District Hospital, Kenya (16). This could be due to the differences in the causes of malnutrition in various parts of the world (10). Larger proportion (83.8%) of marasmus (non oedematous malnutrition) was observed among 0-59 months old children than edematous malnutrition (72.2%). This is because marasmus is more frequent in children younger than 5 years because this period is characterized by increased energy needs and increased susceptibility to viral and bacterial infections. Weaning, which occurs during this period, is often complicated by factors such as geography (e.g. drought, poor soil productivity), economy (e.g. illiteracy, unemployment), hygiene (e.g. access to quality water), and culture and dietetics (e.g. intra-family distribution of high-nutrition foods) (25). This finding was in line with the report from Zewditu Memorial Hospital (21). However, it was different from the finding of study conducted at Turbo, Colombia (18). This might also be due to differences in the causes of malnutrition in different age groups in various parts of the world (10).

In this study, 9.3% death rate (27.3% in the first 48 hrs and 60.2% by the end of the first week) was found. This finding was in line with minimum international standard set for management of severe acute malnutrition which is death rate of less than 10% (10) and lower than the findings of studies conducted at Mulago Hospital, Uganda, three tertiary academic hospitals in Johannesburg, South Africa, Kilifi District Hospital, Kenya, Gondar University hospital, Zewditu Memorial Hospital, St Paul's Hospital, Nchelenge district, Zambia, and Sipetu Hospital and Mary Theresa Hospital, South Africa (12,14–17,21,22) which implies better treatment outcome of severe malnutrition at JUSH. This could be due to difference in patient load, patient profile, management protocol, management team and medical supplies. However, it was higher than the finding of studies conducted at SNNPR and St. Luke Catholic Hospital, Wolisso (10,11). This could be due to the fact that treatment at SNNPR was community based and children admitted to centers might not be as medically complicated as children admitted to JUSH. The case of St. Luke Catholic Hospital, Wolisso, could be due to close follow up of the children with strict adherence to WHO guidelines for the purpose of the study as the purpose of study was to evaluate treatment outcome of severely malnourished children treated according to UNICEF 2004 guidelines.

The average cure rate of this study was 77.8%. This finding was in agreement with minimum international standard set for management of severe acute malnutrition which is cure rate of at least 75% (10) but lower than the finding of studies conducted at SNNPR and St. Luke Catholic Hospital, Wolisso (10,11). This could be due to the fact that treatment at SNNPR was community based and children admitted to centers might not be as medically complicated as children admitted to JUSH. The case of St. Luke Catholic Hospital, Wolisso could be due to close follow up of the children with strict adherence to WHO guidelines for the purpose of the study as the purpose of study was to evaluate treatment outcome of severely malnourished children treated according to UNICEF 2004 guidelines. However, it was higher than the finding of studies conducted at Gondar University hospital and St Paul's Hospital, Nchelenge district, Zambia (14,17) which implies better treatment outcome of severe malnutrition at JUSH. This difference could be due to differences in patient load, patient profile and medical supplies.

The average length of stay in the hospital was 17.4 days (16.7 days for children with severe wasting and 17.9 days for children with oedematous malnutrition) which was in line with minimum international standard set for management of severe acute malnutrition which is average length of stay less than 30 days (10). This finding was shorter than the finding of study conducted at SNNPR (10). This could be due to the fact that the primary aim of hospital treatment of severe malnutrition is to stabilize underlying medical condition and then refer the patient to nearby health facility to complete management of severe malnutrition. In the case of study conducted at SNNPR, children are expected to stay at treatment center until at least achievement of target weight as the set up is community based. However, the overall average length of stay in the hospital was longer than the finding of studies conducted at St. Luke Catholic Hospital, Wolisso and Sipetu Hospital and Mary Theresa Hospital, South Africa (11,22) which could be due to differences in underlying medical condition of children.

The average weight gain was 10.4 g/kg/day (12.9 g/kg/day for children with severe wasting and 7.6 g/kg/day for children with oedematous malnutrition) which was in agreement with minimum international standard set for management of severe acute malnutrition which is average weight gain of 8 g/kg/day (10). This finding was lower than the finding of study conducted at SNNPR (10) which could due the longer stay of children at the facility in case of SNNPR. However, it was far higher than the finding of study conducted at Sipetu Hospital and Mary Theresa Hospital, South Africa (22) which could be due to differences in length of stay in the hospital or differences in study setting. Out of total 737 children discharged with improvement, only 226 (30.6%) of the children were discharged on achieving a target weight of 85% weight for height. This finding was lower than the finding of study conducted at Mulago Hospital, Uganda (12) which could be due to differences in patient load whereby children might be referred to the nearby health facility (health center or health post) for completion of malnutrition management after stabilization of medical co-morbidities at JUSH. Besides, overall findings indicate that the treatment outcome of severe malnutrition at JUSH was acceptable and better than most reports in the literatures.

Regarding predictors of mortality, adjusting for other variables, children with age less than 24 months were 1.9 (95% CI [1.2-2.9]; p = 0.006) times more likely to die earlier than children with age 24 and above months. This was in agreement with report from SNNPR where death decreased as age increases. This could be because of depressed immunity, increased risk of infection and suffer from insufficient feeding practices in younger children (10). Nevertheless, it was different from finding of study conducted at Mulago Hospital, Uganda (12) which might be due to the differences in study settings.

Risk of earlier death for hypothermic children was found to be 3.0 (95% CI [1.4-6.6]; p = 0.005) times higher than children without hypothermia. This was different from the finding of study conducted at three tertiary academic hospitals in Johannesburg, South Africa (15) where hypothermia was found to be predictor of earlier death in bivariate Cox regression but multivariable Cox regression. This could also be due to differences in study settings.

Children with impaired consciousness level (lethargy or coma) were 2.6 (95% CI [1.5-4.5]; p < .001) times more likely to die earlier than conscious children. This was similar to the finding of study conducted at Kilifi District Hospital, Kenya where malnourished children with impaired consciousness level (prostration or coma) were at higher risk of early death (OR = 2.6, 95% CI [1.2 - 5.6]; p = 0.02) (16).

Risk of earlier death for children with palmar pallor was 2.1 (95% CI [1.3-3.3]; p = 0.003) times higher than children without palmar pallor. This was in line with the finding of studies conducted at three tertiary academic hospitals in Johannesburg, South Africa, (HR = 5.1, 95% CI [1.1-24]; p = 0.04) and district of Maradi, Niger (OR = 2.25, 95% CI [1.25-4.05]) (15,26).

Dehydrated children were found to be 2.3 (95% CI [1.3-4.0]; p = 0.004) times more likely to die earlier than children who were not dehydrated. This might be because of misdiagnosis and mistreatment of dehydration in severely malnourished children where even dehydrated children can quickly go from having a depleted circulation to over-hydration with fluid overload and cardiac failure (2).

Similarly, children who had co-morbidity/complication at admission were found to be 3.7 (95% CI [1.9-7.2]; $p < 0.001$) times more likely to die earlier than children without co-morbidity/complication at admission. This could be due to fact that co-morbidities/complications further increase nutrient loss and nutrient requirement by the body on one hand and decrease nutrient absorption and utilization on the other hand (2).

Treatment related factors like infusion and transfusion were not found to be independent predictors of death in severely malnourished children admitted to JUSH. This was different from the finding of study conducted at Mulago Hospital, Uganda where transfusion and infusion were found to be predictors of mortality (12). It was also different from the finding of study conducted at three tertiary academic hospitals in Johannesburg, South Africa where transfusion was found to be predictor of death (15). This could be due to inappropriate use of transfusions and infusions which contributed significantly to case fatality at Mulago Hospital, Uganda (12). It might also be due to differences in study settings.

## Strength and limitation of the study

**a) Strengths**

- Because potential predictors were measured before the outcome occurs, the study established that predictors preceded the outcome. This time sequence strengthens the inference that the predictor may be a cause of the outcome.
- The study guarantees that the measurement of predictor variables was not biased by knowledge of which subjects had the outcome of interest.

**b) Limitations**

- Potential bias associated with missed cards of some children and lack of control over the quality of the measurements that were made might be the threats to this study.

# 7. Conclusion and recommendation

## 7.1 Conclusion

Most of the severely malnourished children admitted to JUSH were not in critical condition when they came to attention. Treatment outcomes (improvement rate, death rate, average length of stay and average weight gain) of severely malnourished children admitted to JUSH were better than most reports in the literatures. They were also in agreement with minimum international standard set for management of severe acute malnutrition. The main predictors of earlier hospital deaths for severely malnourished children admitted to JUSH include age less than 24 months, hypothermia, impaired consciousness level, palmar pallor, dehydration and co-morbidity/complication at admission. However, infusion and transfusion were not found to independent predictors of death.

## 7.2 Recommendations

**a) To Jimma University Specialized Hospital (JUSH)**

- JUSH should keep up this achievement in the management of SAM and share the experience with other institutions in the country and outside.
- Health personnel involved in the management of severely malnourished children admitted to JUSH should give special attention to children with younger age, hypothermia, impaired consciousness level, palmar pallor, dehydration and co-morbidity/complication at admission.

**b) To Health service managers and policy makers**

- Health service managers and policy makers should be curious in decisions concerning management of severely malnourished children at NRUs.

**c) To Ministry of Health and NGOs**

- Ministry of Health and organizations like UNICEF and World Food Programme which have special interest in the health of children should come up with better strategies that would help to improve management of severely malnourished children.

**d) To Researchers**

- Broad range of socio-demographic characteristics, biochemical findings and patient management related factors like availability of medical supplies and skill of professionals were not considered in this study. Therefore, prospective studies which fill this gap should be conducted to further identify predictors of mortality in severely malnourished children admitted to the hospital.

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# Annexes

**Annex 1. Checklist**

## Jimma University

## College of Public Health & Medical Sciences

## Department of Epidemiology

**Checklist for collecting information on survival status and predictors of mortality in severely malnourished children admitted to JUSH from 2010-2012, Jimma, Ethiopia**

I am conducting study on survival status and predictors of mortality in severely malnourished children admitted to JUSH from 2010-2012 in collaboration with School of Post Graduate Study, College of Public Health and Medical Sciences, Jimma University. Therefore, this checklist is prepared for collecting information on survival status and predictors of mortality in severely malnourished children admitted to JUSH from 2010-2012, Jimma town. Information will be collected from children' registries and records. Information collected will be used only for academic purpose and improvement of patient care.

1. **Data collector's** Name_____

   Signature_____

   Date _____

2. **Checked by supervisor**: Name _____

   Signature_____

   Date _____

## A. BASELINE DATA (DATA AT ADMISSION)

### Part I: Background information

**101.** Admission date _____

**102. Card number _____**

### Part II: Socio demographic characteristics

| Code | Question | Response | Remark |
|---|---|---|---|
| 201 | Age (in months) | _____ | |
| 202 | Sex | 1. Male 2. Female | |
| 203 | Place of residence | _____ | |

### Part III: Clinical conditions at admission

| Code | Question | Response | Remark |
|---|---|---|---|
| 301 | Diarrhea | 1. Present 2. Absent | If 2, go to **303** |
| 302 | Type of diarrhea | 1. Watery 2. Mucoid<br>3. Dysentery | |
| 303 | Vomiting | 1. Present 2. Absent | |
| 304 | $T^o$ (in $^oC$) | _____ | |
| 305 | RR (in count per minute) | _____ | |
| 306 | PR (in count per minute) | _____ | |
| **307** | BP (in mmHg): SBP/DBP | _____ | |
| 308 | Conjunctival color | 1. Pink 2. Pale<br>3. Very pale | |
| 309 | Sclera | 1. Icteric 2. Unicteric | |
| 310 | Consciousness level | 1. Conscious 2. Lethargic<br>3. In coma | |
| 311 | Edema | 1. Present 2. Absent | If 2, go to **313** |
| 312 | Grade of edema | 1. + 3. +++<br>2. ++ 4. ++++ | |

| | | | |
|---|---|---|---|
| 313 | Palmar pallor | 1. Present 2. Absent | |
| 314 | Skin lesion | 1. Present 2. Absent | |
| 315 | Dehydration | 1. Present 2. Absent | If 2, go to **317** |
| 316 | Degree of dehydration | 1. Some 2. Severe | |
| 317 | Patient in shock | 1. Yes 2. No | |

**Part IV: Anthropometry, type of malnutrition and underlying co-morbidities**

| Code | Question | Response | Remark |
|---|---|---|---|
| 401 | Height (in cm) | _____ | |
| 402 | Weight (in kg) | _____ | |
| 403 | MUAC (in cm) | _____ | |
| 404 | Type of malnutrition | 1. Non edematous (Marasmus)<br>2. Edematous<br>1. Kwashiorkor<br>2. Marasmic kwashiorkor | |
| 405 | Co-morbidity | 1. Present 2. Absent | If 2, go to **501** |
| 406 | Type of co-morbidity(ies) | 1. Tuberculosis<br>2. Pneumonia<br>3. Bronchial asthma<br>4. HIV/AIDS<br>5. Heart disease<br>6. Others (specify) _____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____ | |

**B. NON BASELINE DATA**

**Part V: Treatment and follow up**

| Code | Question | Possible responses | Remark |
|---|---|---|---|
| 501 | HIV status | 1. Reactive 2. NR<br>3. Unknown | |
| 502 | Co-morbidity developed after admission | 1. Yes 2. No | If 2, go to **504** |
| 503 | Type of co-morbidity(ies) developed after admission | 1. Tuberculosis<br>2. Pneumonia<br>3. Bronchial asthma<br>4. HIV/AIDS<br>5. Heart disease<br>6. Others (specify) _____<br>_____ | |
| 504 | Co-morbidity(ies) treated (at/after admission co-morbidities) | 1. Yes 2. No | If 2, go to **506** |
| 505 | Co-morbidity(ies) controlled or cured | 1. Yes 2. No | |
| 506 | Patient transfused | 1. Yes 2. No | If 2, go to **508** |
| 507 | Date transfused | _____ | |
| 508 | Patient infused (resuscitated with IV fluid) | 1. Yes 2. No | If 2, go to **601** |
| 509 | Date infused | _____ | |

**Part VI: Discharge conditions**

| Code | Question | Response | Remark |
|---|---|---|---|
| 601 | Outcome | 1. Cured 2. Dead<br>3. Absconded 4. Transfer<br>5. Medical referral | |
| 602 | If died, possible cause of death | _____<br>_____ | |
| 603 | If cured, weight at discharge | _____ | |
| 604 | Target weight | _____ | |
| 605 | Date discharged/died/absconded/ referred/ transferred | _____ | |
| 606 | Length of stay in the hospital | _____ | |

**Annex 2. Summary of treatment protocol for severely malnourished children at JUSH**

**a) Admission criteria**

Children are admitted to the hospital as per the following criteria (3).

- **Infants less than 6 months or less than 3 kg being breast-fed**
  - ✓ Too weak or feeble to suckle effectively (independent of weight-for-length)

    **Or**
  - ✓ W/L (Weight-for-Length) less than 70%

    **Or**
  - ✓ Presence of bilateral oedema

- **Children 6 months to 18 years**
  - ✓ W/H or W/L < 70%

    **Or**
  - ✓ MUAC < 110 mm with a Length > 65 cm

    **Or**
  - ✓ Presence of bilateral pitting oedema

**b) Management of Severe Acute Malnutrition**

- **Infants less than 6 months or less than 3 kg being breast-fed**

Since the aim is to stimulate breast-feeding and to supplement the child until breast milk is sufficient to allow the child to grow properly, the child is put to the breast as often as possible by Supplemental Suckling (SS) technique. Between one half and one hour after a normal breast-feed, maintenance amounts of F100 diluted is given using the supplementary suckling technique divided in 8 meals (3).

There are no separate phases in the treatment of infants with the SS technique and there is no need to start with F75 and then switch to F100 diluted unless the infant has oedema. Children less than 6 months, with oedema, should be started on F75 and not on F100 diluted. When the oedema has resolved and they are suckling strongly they should be changed to F100 diluted or infant formula (3).

In addition to F75 or F100, children should be given vitamin A (50,000UI) at admission only, folic acid (2.5mg (1tab)) in one single dose, ferrous sulphate (when the child suckles well and starts to grow) and antibiotics (Amoxycillin (from 2kg): 30mg/kg 2 times a day in association with Gentamycin) (3).

- **Children 6 months to 18 years**

Children should be admitted directly to the NRU and treated in three phases (3).

**Phase 1**

Children are fed F75 eight feeds per day in this phase. Naso-gastric tube (NGT) feeding is used not for more than three days when a patient is taking less than 75% of the prescribed diet per 24 hours, has pneumonia with a rapid respiration rate, painful lesions of the mouth, cleft palate or other physical deformity and disturbances of consciousness (3).

In this phase, children are also given vitamin A (100000 IU for children 6-11 months, 200000 IU for children 12 months and above), folic acid (for children with clinical signs of anaemia), and routine antibiotics (amoxicillin, chloramphenicol, gentamycin) and ani-fungals (3).

Children progress from phase 1 to transition phase when appetite returns and ooedema begin to loss and no IV line and no NGT (3).

**Transition Phase**

This phase prepares the children for phase 2 treatment. Children are fed F100 or RUTF in this phase. The number of feeds, their timing and volume of the diet given remains exactly the same in transition phase as it was in phase 1. Routine antibiotics should be continued for 4 more days after Phase 1 or until transferred to Phase 2 as an out-patient. The phase lasts between 1 and 5 days (3).

**Phase 2**

Children are fed F100 mixed with Iron or RUTF in this phase. Albendazole or Mebendazole is given at the start of Phase 2 for children 1 and above years to deworm (3).

**c) Discharge criteria**

Children are discharged from the hospital as per the following criteria (3).

- **Infants less than 6 months or less than 3 kg being breast-fed**
  - ✓ When it is clear that the child is gaining weight on breast milk alone after the Supplemented Suckling technique has been used.
  - ✓ When there is no medical problem
  - ✓ When the mother has been adequately supplemented with vitamins and minerals

**Note**: there are no anthropometric criteria for discharge of the fully breast-fed infant who is gaining weight.

- **Children 6 months to 18 years**
  - ✓ W/L≥85% or W/H≥85% on more than one occasion (two days)

    **And**
  - ✓ no oedema for 10 days (In-patient) or 14 days (out-patient)

**Annex 3. Vital sign classification**

American Pediatric Advanced Life Support [PALS] guidelines classify vital signs as indicated in the following tables using cut-offs defined by levels that would imply a definite need for urgent therapeutic intervention (24).

Table 1. Respiratory rate by age

| Age (years) | Respiratory rate (breaths per minute) |
|---|---|
| <1 | 30–40 |
| 1–2 | 25–35 |
| 2–5 | 25–30 |
| 5–12 | 20–25 |
| >12 | 15–20 |

Table 2. Pulse rate by age

| Age (years) | Heart rate (beats per minute) |
|---|---|
| <1 | 110–160 |
| 1–2 | 100–150 |
| 2–5 | 95–140 |
| 5–12 | 80–120 |
| >12 | 60–100 |