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The Effect of Therapeutic Formulae on the Weight Gain of Malnourished Children under Two in River Nile State, Sudan

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Abstract: ***This is a nutritional hospital - based study. The study was conducted on 220 children (110 males and 110 females), among whom were 40 children at the age between (0-6 months), 60 children at the age between (7-12 months), 60 children at the age between (13-18 months) and 60 children at the age between (19-23 months) respectively. The study samples were selected from Sudan- River Nile State's Major Hospitals (Aldamer, Atbara and Shendi) to assess the effect of therapeutic nutritional formulae on malnourished children under two. Primary data was collected using a questionnaire which was filled by children mothers and secondary data was collected from different books, journals, internet and other related research publications. The primary data was analyzed using Statistical Package for Social Science (SPSS). In this study most malnourished inpatient children suffered from diarrhea (42.7%), Vomiting (27.3%), and nausea (0.9%) and edema. (11.8%). The therapeutic formulae that were taken by malnourished children during stabilization, rehabilitation and transition phase were F75, F100, RUTF and Control formulae. The percentage weight gains at 7 days' hospital stay were a minimum of 1.37% by F-75 formula and a maximum of 8.32% by RUTF formula, compared to percentage weight gain of 5.75% by F-100 and 5.59% by the Control sample respectively. These percentage weight gain were significantly greater than that of the children weights at the time of admission (p<0.05). RUTF therapeutic formula gave weight gains more than F-100, Control and F-75 respectively. Based on the findings, it was highly recommended that the use of RUTF therapeutic formula should be encouraged and further studies and research focusing on malnutrition among children under five years of age should be addressed.***

Keyword: Therapeutic Formulae; Weight Gain; Gender; Age group and Malnourished Children

1. Introduction

Children Malnutrition is a term most commonly used to indicate protein energy malnutrition (PEM) that is related to under nutrition. According to the World Health Organization (WHO, 2000), malnutrition is the cellular imbalance between supply of nutrients and energy and the body's demand for them to ensure growth, maintenance and specific functions. It is the greatest risk factor for illness and death worldwide among children. It is due to state of deficiency of energy, protein and other nutrients and leads to measurable adverse effects on tissues, body function, appearance and clinical outcomes (Dimosthenopoulos, 2010). PEM is an important public health issue particularly for children under five years' old who have a significantly higher risk of mortality and morbidity than well-nourished children in low and middle income countries where it is linked with poverty. New research estimates that the risks related to stunting and severe wasting are linked to 2.2 million deaths and 21% of disability-adjusted life years worldwide for children under five years old. Sub-optimum breast feeding, particularly for infant less than six months, is also a leading factor in childhood morbidity and mortality (Robert, 2008). Children with severe malnutrition are at risk of several life-threatening problems like hypoglycemia, hypothermia, serious infections and sever electrolyte disturbances. Because of this vulnerability, they need careful assessment, special treatment and management, with regular feeding and monitoring. Their treatment in hospital should be well organized and given by specially trained staff. As recovery may take several weeks, their discharge from hospital should be carefully planned in order to provide outpatient care to complete their rehabilitation and to prevent relapse (WHO, 2000).

2. Statement of Problem

Malnutrition is serious health problem that threatens children's life. The early years in child's life are critical because the child in state of rabid growth. This rabid growth involves tissue and organ maturation that mean energy and nutrient requirements are high relative to body size during the first years of life. Good nutrition is an essential component of good health. Malnutrition is a known contributing factor to disease and death in the developing world. Malnutrition affects approximately 800 million people (WHO, 2003), greater than 340 million of whom are children under the age of five, over six million of these children die every year from malnutrition related causes. (UNS-SCN, 2004).

Justification for the work

In Sudan, Protein-Energy Malnutrition (PEM) is believed to lead to an increased susceptibility to infection, or cause impaired immunity. Infection, occurring with malnutrition, is a major cause of morbidity in all age groups and is responsible

for two-thirds of all death under five years of age in developing countries (WHO, 2008). Malnutrition is increasingly recognized as a prevalent and important health problem in many developing countries including Sudan. This problem has serious long-term consequences for the child and adversely influences their development.

General objective

The main objective of this study was to assess the effect of different therapeutic formulae on inpatient malnourished children attending major hospitals in River Nile State, Sudan.

Specific objectives:

- To assess the diet therapy (F-75, F-100, RUTF and Control) formulae on body weights of inpatient malnourished children of age 0-23 months.
- To assess the response to treatment during the periods of stay in hospitals in both the stabilization and rehabilitation phases.

3. Materials and Methods

- **Study Area:** Major Hospitals (Aldamer, Atbara, Shendi) in River Nile State (RNS), Sudan.
- **Study population:** Malnourished children of (0-23) months admitted to (RNS) major Hospitals.
- **Sample size:** The sample size was determined according to the available subjects who were admitted to hospitals during 2015 to 2018 (220 children; 110 males and 110 females who were admitted and stayed for one week).
- **Inclusion Criteria:** All children suffering from malnutrition of the age 0-23month and had less than the normal weight for their ages and showed other clinical symptoms of malnutrition.
- **Control Group:** All children suffering from malnutrition of the age 0- 23 month, and had normal weights for their ages but had other clinical symptoms of malnutrition.

Types of Therapeutic Formulae:

*** Control Sample:**

Ingredients	
Dried whole milk	110 g
Sugar	50 g
Vegetable oil	30 g
Minerals mix	20ml/l
Composition of minerals mix solution	
Potassium chloride	89.5 g
Tri potassium chloride	32.4 g
Magnesium chloride	30.5 g
Zinc acetate	3.3 g
Copper Sulphate	0.56 g
Water	1000 ml

*F-75 as described by (WHO, 1999**)**.
*F-100 as described by (WHO, 1999**)**.
*RUTF as described by (WHO, 1999**)**.

Duration of formulae intakes:

7 days

Age Classification:

*0-6 month
*7-12 month
*13-18 month
*19-23 month

Data collection: Primary data was collected by using a questionnaire, designed to recall information on demographic and socio-economic characteristics of malnourished patients and their dietary patterns. An assessment of patient's bodies including weight for height was conducted to determine their nutritional status and weight change during the period of staying in hospital. The secondary data was collected by reviewing the available literature.

Data analysis: The data was analyzed by using SPSS program version 20, level of significant was chosen on ($p \leq 0.05$). Data was entered in SPSS (Statistical Package for social science) version 20.0.

$$\text{Percentage weight gain} = \frac{W2\text{-}W1}{W1} \times 100$$

W1 =weight at start of formula diet.
W2 =weight at discharge while on formula diet.
Daily weight gains of >10gm/kg/day has been taken as adequate.

Admission Criteria: Admission Criteria for inpatient Care for Children 0-23 Months was upon bilateral pitting edema +++, or any grade of bilateral pitting edema with severe wasting, or Sever Acute Malnutrition (SAM) (bilateral pitting edema + or ++ or severe wasting) with any of the following complications: Anorexia, Poor appetite, Intractable vomiting, Convulsions, Lethargy, not alert, Unconsciousness, Hypoglycemia, High fever, Hypothermia, Severe diarrhea, Lower respiratory tract infection, Severe anemia, Eye signs of vitamin A deficiency and Dehydration

Anthropometrics Measurement

* Weight (kg)

4. Results and Discussion

As shown in Table (1) the main symptoms of the majority of the malnourished children were diarrhea (42.7%) followed by vomiting (27.3%) and nausea (0.9%). One of the sings related to malnutrition was edema where (11.8%) of the children did suffer from noticeable edema. All these complications that could threaten child life were treated during the stay period in hospital following WHO Integrated Management of Childhood Illness (IMCI) (WHO, 2013)

Table 1: Condition and Symptoms of the child at admission

		N	%
Child sufferings	Diarrhea	94	42.7
	Vomiting	60	27.3
	Nausea	2	0.9
	No	64	29.1
Group Total		220	100.0
Edema	Yes	26	11.8
	No	194	88.2
Group Total		220	100.0

The results in Table (2) show that more than half of the study participants 142 representing (64.5%) received their nutritional support by Naso- Gastric Tube (NGT) route and the remaining did receive their feeding orally. This protocol did agree with Leleiko and Chao, (2006) who reported that if the child cannot eat or drink orally the other alternative route of administration such as NG tube will be useful to give the child the prescribed amount of feeding.

Table 2: Administration Route of feeding

Administration rout of feeding	N	%
Orally	78	35.5
NGT feeding	142	64.5
Total	220	100.0

Table (3) shows that the majority of the respondents' mothers (80.5%) had vaccinated their children. Full coverage of child vaccination as done by the majority of respondent's mothers reflected a good practice.

Vaccination is one of the most important practice that must be done to the child from delivery till age of five years. Vaccination ensures prevention of the child against vast number of childhood diseases and infections. (Fawsi, 2000).

The results also show that the majority of the respondents' mothers (90.5%) did give their children diet supplements with breast feeding.

Nutritional education for mother represents the corner stone in combating malnutrition and associated disorders (SHHS, 2006).

Table 3: Vaccination and Supplements

		N	%
Vaccination	Yes	177	80.5
	No	43	19.5
Group Total		220	100.0
Vitamin and mineral supplements	Yes	199	90.5
	No	21	9.5
Group Total		220	100.0

As shown in Table (4) the therapeutic formulae taken by malnourished children during stabilization, rehabilitation and transition phase were F75, F100, RUTF and Control. Percentage weight gains at 7days hospital stay were a minimum of 1.37% for F-75 formula and a maximum of 8.32% for RUTF formulae respectively. These percentage weight gains were significantly greater than the original weights at the time of admission ($p<0.05$), compared to the percentage weight gains of 5.75% for F-100 and 5.59% for the Control respectively. Diop *et al*., (2003) reported a 10.1 g/kg/day as an average weight gain among children suffering from SAM. On the other hand, Yebyo *et al*., (2013) reported a 6.30 g/kg/day as an average weight gain among children suffering from SAM on F-100milk.

Children with severe acute malnutrition and life-threatening complication require short-term inpatient care for treatment of infections, fluid and electrolyte imbalances, and metabolic abnormalities. Initial dietary management relies on low-lactose, milk-based, liquid formulae but semi-solid or solid foods can be started as soon as appetite permits, after which children can be referred for ambulatory treatment (Rytter et al., 2014).

Again these results did agree with the protocol of the (WHO, 2009). RUTF formula was used for rehabilitation and transition phases since it contained high calories and high protein than the others formulae. The F-100 formula was used as a catch-up formula after the children conditions improved and started to gain weight gradually. The F-75 formula should be used just for stabilizing the condition and resolving edema rather than to gain weight.

Table 4: Types of formula feeding and weight gain at day0 and day7 of Hospital stay

Formulae	Admission mean weight (kg) ±SD	Discharge mean weight (kg) ±SD	Percentage weight gain at day 7
F-75	5.12±1.4	5.19±1.44	1.37 %
F-100	5.22±1.55	5.52±1.68	5.75 %
RUTF	6.13±1.01	6.64±1.21	8.32 %
Control Sample	5.19±1.44	5.48±1.64	5.59 %

It is clear from Table (5) that the percentage weight gain per day in our study was a minimum percentage in day1 of (-0.2%), day 2 (0.2%), day3 (0.6%), day4 (0.9%), day5 (0.2%), day6 (0.4%), and day7 (0.4%) by F-75 formula and a maximum percentage weight gain by RUTF formula in day1 of (0.1%) day2 (1.3%) day3 (1.6%) day4 (1.1%) day5 (1.2%) day6 (.9%) and day7 (.9%) respectively. These percentage weight gains were significantly greater than that of the initial weights at the time of admission ($p<0.05$), compared to percentage weight gains in day1 of (1.7%), day2 of (0.4%), day3 of (1.1%), day4 of (0.9%), day5 of (0.7%), day6 of (0.4%), day7 of (0.4%) by F-100 and day1 of (-0.2%), day2 of (0.2%), day3 of (0.6%), day4 of (0.2%), day5 of (.2%), day6 of (0.0%) and day7 of (.4%) by the Control respectively.

Table 5: Types of formula feeding and weight gain during the 7 days' hospital stay

formula	F75		F100		RUTF		Control	
Duration intakes	Weight means(kg) ±SD	Weight gain%	Weight means (kg) ±SD	Weight gain%	Weight means (kg) ±SD	Weight gain%	Weight means (kg) ±SD	Weight gain%
Day0	5.12±1.4	0.0	5.22±1.55	0.0	6.13±1.01	0.0	5.12±1.4	0.0
Day1	5.11±1.39	-0.2%	5.31±1.56	1.7%	6.19±1.03	0.1%	5.11±1.39	-0.2%
Day2	5.12±1.41	0.2%	5.33±1.58	0.4%	6.27±1.07	1.3%	5.12±1.4	0.2%
Day3	5.15±1.41	0.6%	5.39±1.6	1.1%	6.37±1.01	1.6%	5.15±1.41	0.6%
Day4	5.16±1.42	0.2%	5.44±1.65	0.9%	6.44±1.14	1.1%	5.16±1.42	0.2%
Day5	5.17±1.43	0.2%	5.48±1.64	0.7%	6.52±1.16	1.2%	5.17±1.42	0.2%
Day6	5.17±1.43	0.0	5.5±1.68	0.4%	6.58±1.19	0.9%	5.17±1.43	0.0
Day7	5.19±1.44	0.4%	5.52±1.68	0.4%	6.64±1.21	0.9%	5.19±1.44	0.4%

As shown in Table (6) the malnourished children responded well to the feeding with the tested therapeutic formulae during their 7 days stay in the hospitals. Males responded better with an increase in weight gain compared to the females. They suffered more from kwashiorkor and were more stunted compared to females. A similar finding was reported by Berkley et al, (2005). Statistical analysis revealed a highly significant relation between weight gain and gender (x2=0, p-value =1.000, df =3).

Table 6: Comparison of weight gain and gender during 7 days' hospital stay using different feeding formulae

Sex	Formula	Admission mean weight (kg) ±SD	Discharge mean weight (kg)± SD	Percentage weight gain at 7 days
Males	F-75	5.01±1.54	5.09±1.60	1.6%
	F-100	5.25±1.78	5.62±1.90	7.0%
	RUTF	5.91±.1.00	6.39±1.18	8.1%
	Control	5.09±1.60	5.4±1.83	6.0%
Females	F-75	5.23±1.23	5.29±1.27	1.1%
	F-100	5.29±1.27	5.56±1.44	5.1%
	RUTF	6.31±1.00	6.82±1.22	8.0%
	Control	5.19±1.29	5.4±1.42	4.0%

As shown in Table (7) the age group of children between (19-23 months) and (13-18 months), responded well to the feeding with the tested therapeutic formulae during their 7 days stay in the hospitals more than age groups (0-6 months) and (7-12 months) respectively. This result did agree with (Berkley et al., 2005).

Table 7: Comparison of percentage weight gain with age at day 0 and day7 using different feeding formulae

formula	0-6months			7-12months			13-18months			19-23months		
	Weight (kg)		Weight gain (7days)	Weight (kg)		Weight gain (7days)	Weight (kg)		Weight gain (7days)	Weight (kg)		Weight gain (7days)
	Day0	Day7	%	Day0	Day7	%	Day0	Day7	%	Day0	Day7	%
F-75	5.59 ±1.5	5.65 ±1.6	1.1%	4.85 ±1.4	4.91 ±1.4	1.2%	4.85 ±1.2	4.92 ±1.2	1.4%	5.18 ±1.5	5.28 ±1.5	1.9%
F-100	5.65 ±1.6	5.93 ±1.6	5%	4.9 ±1.4	5.15 ±1.6	5.1%	4.92 ±1.2	5.2 ±1.4	5.7%	5.28 ±1.5	5.64 ±1.8	6.8%
RUTF	6.12 ±.9	6.59 ±1.1	7.7%	6.24 ±1.3	6.72 ±1.5	7.7%	5.95 ±.9	6.43 ±1.2	8%	6.24 ±.9	6.82 ±1	9.3%
Control	5.17 ±1.3	5.29 ±1.3	2.3%	3.62 ±1.4	3.74 ±1.4	3.3%	5.82 ±.9	6.18 ±.9	6.2%	6.28 ±1.2	6.84 ±1.2	8.9%

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