NUTRITIONAL STATUS AND SURVIVAL IN THE SIEGE OF TURMANBURG-LIBERIA

A thesis presented in partial fulfillment for the degree of Masters of Science in International Nutrition

By

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DEDICATION

In memory of my dear Mother who died when I was doing this work. Rest In Peace Mum, I miss you.

Declaration

I declare that the following thesis has been put together entirely by myself, under the supervision of Professor MHN Golden, and has not been accepted in any previous application for a degree. The research and background work leading up to the thesis was carried out exclusively by myself. Quotations have been distinguished by quotation marks and all sources of information have been specifically acknowledged.

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List of abbreviations

ACF-Action Contre le Faim

ECOMOG- Economic Community of West African States, peace keeping soldiers

ECOWAS- Economic Community of West African States

FAO-WHO-UNU-Food and Agricultural Organisation-World Health Organisation-United Nations University

MUAC- Mid- Upper Arm Circunference

NCHS- National Centre for Health Statistics

ORS- Oral Rehydration Salt

TFC- Therapeutic Feeding Centres

TM- Therapeutic milk

WHO- World Health Organisation

Summary

A civil war erupted in Liberia between from 1989 to September 1996, involving 5 main warring factions. In August 1996, a cease-fire was signed between the warring factions, and ECOMOG force were sent by the Economic Community of West African States(ECOWAS) to monitor (actually enforce) peace.

In September 1996, a town, Tubmanburg, in Bomi County, 50km North of Monrovia (the Capital), which was totally besieged for 4 months was relieved by Ecomog forces. During the siege 19% of the population had died (57% of the children and 12% of adults). About 30% of the remaining population were severely malnourished.

Two therapeutic feeding centres were set up by ACF, in Tubmanburg, to cater for the large numbers of patients, most of them having oedema. The treatment period was restricted to 7-8 hours per day, and patients returned "home" at night without supervision or care. The standard treatment protocols had to be simplified and modified to the restricted time period.

It was observed that there were remarkably few deaths and the rate of recovery was excellent. To investigate this, clinical records of 918 consecutive patients were examined in detail.

The case fatality rate was very low compared with other centres with better facilities. Of 918 patients treated, only 16 died (CFR,1.7%). Prudhon's index was used to calculate the expected number of deaths. Only 4 infants, 4 children and 2 juveniles died; the expected number of deaths were 18,14 and 7 respectively ($p<0.05$ for each category). Six of 232 adults died.

The mean length of stay at the centre for all categories of patient was about 3 weeks. The growth rate of patients was between 10-16 g/kg/day for each group, despite the restricted

feeding period. Diarrhoea & vomiting and fever were uncommon, however, a significant number of patients had recorded hypothermia and anaemia.

The remarkable results of this study need to be replicated elsewhere to determine whether the simple and relatively cheap techniques used in Tubmanburg can lead to a reduced mortality in other circumstances.

Introduction

The major problems faced by people displaced by complex emergencies are insecurity and malnutrition. The Liberian civil war (December 1989-September 1996), was one of the major wars in Africa, South of the Sahara. Here health workers were confronted with managing large numbers of severely malnourished people in highly insecure conditions.

During the Liberian Civil War, Liberian refugees were spread all over the West African Sub-Region, in countries such as Guinea, Ghana, Cote d'Ivoire, and Nigeria. 'Refugee' has been defined under International convention as "any person who owing to well-founded fear of being persecuted…is outside the country of his nationality…"(Toole and Waldman, 1988). Concentrations of refugees are often characterised by low nutritional status and poor environmental conditions (overcrowding, inadequate water, and lack of sanitation), which promote the transmission of infectious diseases (Toole and Waldman, 1988).

The main causes of refugee death based on examination of the magnitude and the time trends of crude, age –specific and cause -specific mortality rates in three refugee emergencies in Somalia, Sudan and eastern Thailand are acute respiratory infections, diarrhoeal diseases, measles and undernutrition (Toole and Waldman, 1988).

Considering the main causes of refugee deaths in emergencies, the definition of technical principles for health interventions in refugee settings (Males S, 1996) are a multi-sectorial approach; involving the refugees; meeting specific needs of refugee children and women; instituting a simple and reliable health information system; and ensuring proper management and co-ordination among all partners. Males S, 1996, emphasised that health assistance in refugee situations takes place in a context which is complex and comprises many variables. In addition to their qualifications and experience, health professionals must also be aware of the global dynamics of a conflict situation. Their leading principle should be that all human beings have the right to appropriate health care.

One of the main causes of ill-health among refugees is malnutrition. Refugee camps have a rapidly expanding population with a high prevalence of malnutrition, stretched logistic services, poor kitchen, laboratory, sanitary and storage facilities, a shortage of skilled manpower and major security problems. Therefore complicated treatment protocols for severe child hood malnutrition which have been developed in metabolic wards of research units need to be adapted for use in refugee camps (Briend and Golden, 1993).The median case fatality rate of severely malnourished children treated in hospitals is 23.5%, a rate which has not changed for the last 50 years. This is probably related to the use of inappropriate or even unsafe treatment protocols (Desjeux DF et al, 1998) .
A review of literature that has appeared over the past five decades indicate that the median case fatality from severe malnutrition has remained unchanged over this period - is typically 20-30% with the highest levels(50-60%) being among those with oedematous malnutrition. A likely cause of this continuing high mortality according to Schofield and Ashworth, 1996, is faulty case management. A survey of treatment centres worldwide(n=79) by Schofield and Ashworth, 1996, indicate that for acutely ill children inappropriate diets that are high in protein, energy, and sodium, and low in micronutrients are common place. Brewster M and Manary M, 1995 also reported a case fatality rate of malnutrition of over 30% at the Balantyre hospital nutrition ward and compared this to their experience in the Gambia where the case fatality rate for 1078 cases of severe malnutrition was 19.6 %. The principles of standard treatment are well known, but are not being put into practice in many developing countries because of poor resources, support and initiative (Brewster M and Manary M, 1995). They concluded that improvement of hospital and clinic case management of severe malnutrition by standard treatment protocols is an essential first step to reducing the high case fatality rates of severe malnutrition.

This faulty case management of (oedematous) malnutrition (kwashiorkor) could be partly attributed to the failure to accept that protein deficiency does not cause kwashiorkor despite mounting evidence. This has led to the treatment with high protein diets .Oedematous malnutrition in the child or adult is not caused by protein deficiency and in kwashiorkor, the deficiency is more likely to be due to one or several type I nutrients, particularly those involved in anti-oxidant protection (Golden, 1998).

Schofield and Ashworth, 1996, have recommended the use of appropriate treatment regimens and updated treatment guidelines, which are practical and prescriptive rather than descriptive, through a comprehensive training programme to achieve low mortality levels from malnutrition.

1.1 Management of Severe malnutrition

Recommendations for the management of severe malnutrition are clearly spelt out (Golden, 1996; WHO,1999). The principles of management according to WHO, 1999 include:

a) Initial Treatment(Phase I)- to treat or prevent hypoglycaemia and hypothermia; to treat or prevent dehydration and restore electrolyte balance; to treat incipient or developed septic shock if present; to start to feed the child; to treat infection; to identify and treat any other problems including vitamin deficiency, severe anaemia and heart failure.
b) Rehabilitation(Phase II- to encourage the child to eat as much possible; to initiate and / encourage breast feeding as necessary to stimulate emotional and physical development and to prepare the mother or carer to continue to look after the child or patient after discharge.
c) Follow-up- to ensure complete rehabilitation and preventing the recurrence of severe malnutrition.

The treatment of severe malnutrition has therefore been divided into phases based on these management principles

Treatment protocols including therapeutic foods have been developed (WHO,1999; Desjeux DF et al, 1998) aimed at reducing case fatality rates of severe malnutrition especially during humanitarian crises . The therapeutic foods are F-75 and F-100. The F-75 (75 $Kcal_{th}$ or 315 kJ/100 ml) is used during the initial Phase of treatment, while the F-100 (100 $Kcal_{th}$ or 420 kJ/100 ml) is used during the rehabilitation phase, after the appetite has returned. The design of these formula diets have taken into account the fact that almost all severely malnourished children have infections, impaired liver and intestinal function and problems related to imbalance of electrolytes when first admitted to hospital. Because of these problems, they are unable to tolerate the usual amounts of dietary protein, fat and sodium.

In theory, low-protein diets are preferable at the beginning of treatment when there are signs of hepatic insufficiency, whereas higher protein ,energy –dense diets are needed during the recovery phase for rapid catch-up (Jackson and Golden,1987). For practical purposes of rehabilitation in refugee camps, a standard formula of 80g dried skimmed milk, 50g sugar and 60g oil per litre feed was recommended at a meeting in Paris, May 1993, on the treatment of severe childhood malnutrition amongst refugees, hosted by Medicins Sans Frontiere with Epicentre and the Institut National de la Sante et de la Recherche Medicale (INSERM Unit 290) (Briend and Golden, 1993). Its energy density of 1 kcal/ml , according to Briend and Golden, 1993 is sufficient for rapid catch- up growth and could be used for all phases of treatment. This is the F-100 diet.

Collins S et al, 1998, compared the effect of two diets differing primarily in protein content, on the nutritional rehabilitation of malnourished adults in the Concern Worldwide adult Therapeutic feeding centre, in Baidoa, the town at the Epicentre of the 1992 famine in Somalia. The response to treatment in 573 patients admitted to the center between November 1992 and March 1993 was studied. Mortality, appetite, rate of oedema loss and weight gain in two groups of patients receiving either a higher- protein (16.4% of energy from protein) or lower protein (8.5 % of energy from protein) diet were compared. Among oedematous patients the use of the lower protein diet during the initial phase of treatment was associated with a three fold decrease in mortality ($P<0.05$) and accelerated resolution of edema (P<0.05). Among marasmic patients, no differences in mortality or rate of weight gain were observed.. The large reduction in mortality associated with the use of lower protein diet in oedematous patients appeared to be due to the lower amount of dietary protein. However differences in the 2 diets other than or in addition to the protein content may have contributed. The data obtained by Collins S et al, 1998, therefore suggested that severely malnourished adults particularly those with oedema recover more successfully with a diet of lower protein content than usually recommended.

Collins S et al, 1998 have also reported that due the extreme levels of disruption and insecurity, the mean rate of weight gain (5-6 g/kg/day) during the recovery phase of rehabilitation probably represent the lower end of the spectrum of reasonable rates of weight gain in adults recovering from severe malnutrition. This rate of weight gain was compared to the rate of weight gain of severely malnourished ex-inmates of the Sanbostel concentration camp receiving 31.5 MJ and 297 g protein/day (PE 15.8%) and gained ~ 7.0g/kg/day.

However, in children recovering from severe malnutrition the maximum rate of weight gain reported is 10-20 g/kg/day (Waterlow,1993). WHO, 1999, has also reported a rate of weight gain of about 10- 15 g/kg/day. A child who does not gain at least 5 g/kg/day for 3 consecutive days is failing to respond to treatment

Graham et al, 1996 evaluated the adequacy of protein intakes now recommended as safe for infants and toddlers using malnourished infants aged 5.3 to 17.9 months, length age (LA) 2.5 to 6.4 months, weight age (WA) 1.5 to 5.2 moths, weight /length (WL) 78% to 100% of the National Centre for Health Statistics Data; and age 11.4 to 31.6 months, LA 6.1 to 17.9 months, WA 3.9 to 12.9 months, W/L 79 % to 99%.

Infants were assigned at random to formulas with 5.5% ,6.7%, or 8.0% energy as 60:40 whey:casein protein. The 5.5% was based on FAO-WHO-UNU safe protein and average energy for ages 2.5 to 6.0 months. Toddlers received 4.7 % (recommended for 6-18 months), 6.4 ,or 8.0%. intakes were adjusted weekly to reach, in 90 days, the 50^{th}

percentile or weight for a LA 3months greater than the initial one. The results obtained indicate that there were no significant protein-related differences in growth. In both infants and toddlers , high energy intake resulted in obesity, with lean body mass still deficient. Protein intakes two SD below the mean in the lowest protein/energy cells,1.5 g. kg^{-1}. d^{-1} for infants and 1.1 g times kg^{-1}. d^{-1} for toddlers should still be safe for nearly all children of comparable biological ages.

Earlier on Golden,1982 studied 6 different diets given to 103 children with oedematous malnutrition, and found out that the rate of loss of oedema was strongly correlated with the dietary energy intake(r=0.75) but not with the protein intake (r=0.03). 66 patients with a very low protein diet (2.5% protein energy) lost oedema as fast as those given 5 times as much protein. The energy intake above which oedema resolved and below which oedema accumulated was 245-270 KJ/kg/day. This energy level is approximately the basal metabolic rate of a malnourished child. If the intake falls below this the child cannot achieve energy balance by cessation of growth and activity. Many children after infection fail to achieve this reduced intake, so that, not withstanding the other components of the diet, they would be primed to develop oedematous malnutrition. Golden , 1982, explained that because energy deficiency is not invariably associated with oedema, it cannot be the only factor involved, and the other necessary dietary component(s) must therefore have been present in surfeit in all the therapeutic diets. This could be potassium together with factors necessary for its retention.

Between 1 February 1987 and 31 May 1988. Pecoul B. et al (1992) conducted an evaluation of a nutritional rehabilitation centre in Tahoua, Niger. Among the 381 children admitted to the centre, 61 (16%) had kwashiorkor and 347 (91.3%) were aged between 6 and 29 months. Recovery and death rates were 46.2% and 14.4%, respectively. The median duration of stay until recovery was 21 days. Sixty-two per cent of deaths occurred during the 1st week of hospitalization. Three risk factors for death were identified by the study: patients with kwashiorkor with a weight/height (W/H) less than -3 SD, those with marasmus with a W/H less than -5 SD, and those dehydrated with marasmus. Among children included in the follow-up study after leaving the centre, the risk of dying during the follow-up period among children who absconded was 7.1 times higher than the risk observed among children who recovered. Among the children who recovered, no relapse was observed 3-18 months after they left the centre. This investigation indicates the importance of intensive therapeutic feeding centres in areas with a high prevalence of malnutrition.

What criteria then, can be used to measure the adequacy of a diet as a whole?.Golden,1996, has tried to answer this question in using the type II nutrient concept to improve dietary supplementation. The gross inefficiency of supplementary diets is almost universal as reported by Beaten and Ghassemi,1982. Golden, 1996 explained that when a dietary supplement is given which does not contain all nutrients required for new tissue synthesis, the rate of growth and the efficiency of growth will be determined by the most limiting nutrient in the new diet(basic diet plus supplement), not in the original diet or in the supplement alone. If an unbalanced supplement is given the other nutrients in the supplement will be used inefficiently, just as a diet with protein which has an amino acid score of zero., because it lacks an essential amino acid, is totally useless and wasted. The degree of inefficiency is related to the magnitude of the imbalance between the actual limiting nutrient in the diet as a whole and the nutrient under consideration. When we observe an inefficient use of a nutrient or energy, we can infer that the diet may be imbalanced with respect to one of the type II nutrients that is limiting growth and efficiency, particularly potassium, magnesium, zinc and available phosphorus. As supplementation trials concentrate on supplying protein and energy while ignoring these type II nutrients e.g. potassium, magnesium, zinc and phosphorus it is therefore not surprising that these trials are characterised by gross inefficiency (Golden,1996).

Apart from growth promotion, Zn also plays a role in maintaining appetite. WHO,1999, has empasised that in the phases of treatment of severe malnutrition outlined above, the child's appetite and general condition are the determinants of the phase of treatment and

not the length of time since admission. Thus if the child's appetite improves, treatment has been successful and the initial phase of treatment end when the child becomes hungry. This also indicates that infection is under control, the liver is able to metabolise the diet and other metabolic abnormalities are improving.
During treatment, as whole tissue has been lost, all the components for the tissue to be resynthesised need to be given irrespective of the cause of the negative balance and weight loss (Golden, 1996).

Some relief foods for emergencies lack some of these type II nutrients. Analysis of relief food during the drought relief operation in Ethiopia, May-August 1985, showed that because of food refinement, 6 out of 10 samples of cereals contained too little potassium and magnesium (Machaelsen and Clause,1987). Potassium and Magnesium required for protein synthesis, growth and tissue repair, yet they are deficient in some relief foods.
Oedema
Dempster et al, 1995, employed bleomycin assay method for the quantitation of free or loosely bound iron in venous blood samples of 50 children on admission with kwashiorkor, 6 with marasmus and 12 healthy well nourished controls. Non protein bound iron was found in the plasma of 58% of the patients with kwashiorkor, but not in any of the other children. In further studies, Sive et al,1997 related the plasma concentration of 'free' iron to the degree of oedema in patients with kwashiorkor. The degree of oedema was made by a single observer and recorded as mild (+), moderate (++) or severe (+++). Patients with severe oedema had generalised swelling of the face and limbs. Finger pressure of the legs left an indentation of at least 0.5 cm in depth. Oedema was assessed as mild when pitting of the legs could just be detected whereas patients with moderate oedema had readily detectable oedema which was intermediate between mild and severe bleomycin-detectable-iron was significantly higher in the patients with severe oedema(20.5 v 6.75 umol/l whereas the albumin concentration were similar (16 v 17 g/l). Bleomycin-detectable-iron was no longer present in any patient 30 days after admission.. Sive et al,1996, therefore concluded that 'free' circulating iron may contribute to the oedema of kwashiorkor, and its sequestration could hasten recovery and decrease

morbidity and mortality. This study confirms the poor correlation between the plasma albumin concentration and the degree of oedema or plasma transferrin concentration . The oedema often resolves despite continued hypoalbuminaemia, during recovery. Leaky cell membranes, low capillary filtration rate, which appear to be unique manifestation of kwashiorkor, and free radicals which may increase the permeability of capillaries could all contribute to the oedema.

These data strongly support the hypothesis of Golden and Ramdath, 1987 of a dominant role for free radicals in the pathogenesis of kwashiorkor.

The lack of full understanding of the cause of oedema, has frequently led to faulty case management. Schofield and Ashworth, 1996, found out that practices such as prescribing diuretics for oedema were found to be widespread and could have fatal consequences.

1.2 Therapeutic foods

The evaluation of the use of F-100 containing 100 Kcal/100 ml with 10% of its energy derived from proteins, low in sodium and iron content but fortified with vitamins and minerals, indicates that standardised use of F100 can markedly reduce mortality of severely malnourished children (Desjeux DF et al, 1998). In refugee camps according to Desjeux DF et al, 1998, F-100 was used according to strict protocol and adapted to local conditions. Intakes started at 100 Kcal/kg/day and reached 200 Kcal/kg/day once appetite was restored. A model to assess the risk of death according to weight, height and oedema was developed, and the first results indicated mortality was below 5%.

1.3 Mortality risk assessment

Prudhon et al, 1996, showed that the risk of death among severely malnourished children treated in therapeutic feeding centres was related to their anthropometric status on admission assessed by a simple combination of weight and height (Optimal Ratio of Weight to power of Height or ORWH, weight(kg)/ height (m) $^{1.74}$) and Oedema. They compared different anthropometric indices based on weight and height to predict the risk of death among severely malnourished children. Anthropometric data of 1047 children who survived were compared with those of 147 children who died during treatment in therapeutic feeding centres set up in African countries in 1993. The optimal ratio of weight to height determined by logistic regression was weight (kg)/ height (m) $^{1.74}$ (95 % confidence interval β estimate 1.65-1.84).

Prudhon et al, 1996, also observed that anthropometric indices seem to have a better predictive value for mortality among children without oedema than those with oedema. This was attributed to the fact that metabolic abnormalities such as hepatic dysfunction, immuno- competence, and electrolyte disturbance are more commonly in oedematous children. Also the weight recorded on admission includes the weight of oedema fluid; thus, oedematous children are likely to have the severity of the tissue wasting underestimated to the extend that it is itself dependent upon the degree of oedema and hence to be highly variable.

The treatment of dehydration and infection in severely malnourished children in refugee camps has also been clearly stated (Briend & Golden 1993; WHO 1999).
In the treatment of the dehydration, the use WHO oral rehydration salt (ORS) solution was carefully considered. Because severely malnourished children are deficient in potassium and have abnormally high levels of sodium, the ORS solution should contain less sodium and more potassium than the standard WHO recommended solution. Magnesium, Zinc and copper should also be given to correct these deficiencies (WHO, 1999). The sodium content of WHO ORS (90 mmol/l) is sufficiently high to induce heart failure in severe malnutrition particularly the oedematous form of malnutrition and the

potassium concentration (20 mmol/l) is too low to match the stool output of severely malnourished children (Briend & Golden, 1993). Considering this, ReSoMal , ORS solution for severely malnourished is recommended. ReSoMal can also be made by diluting the standard WHO-recommended ORS in 2 litres of water, instead of 1 litre, and adding 50g of sucrose (25g/l) and 40 ml (20 ml/l) of mineral mix solution (WHO,1999). It is recommended that because of the difficulty in assessing dehydration in severely malnourished children particularly those with oedema, only those signs related to intra-vascular volume contraction should be used. Except in hypovolaemic shock, these children should only be rehydrated orally (Briend & Golden 1993; WHO 1999).

Nearly all malnourished children have infections and bacterial overgrowth of mucosal surfaces which are difficult to diagnose clinically. Therefore early treatment with antibiotics, appropriately prescribed for defined clinical infections, has an important role in decreasing mortality and improving the nutritional response to feeding (Golden & Briend, 1993)

Drug dosages for the treatment of infections have therefore been prescribed by WHO, 1999.

The extent to which these recommendations can be carried out, given the logistic, security and personnel constraints, as well as the initial state of the patients, determines the outcome of patients presenting to therapeutic feeding centres with severe malnutrition under such disaster and famine situations as occurred during the Liberian civil war.

1.4 Background to the situation in Liberia in 1996

In December 1989, civil war broke out in Liberia: involving 5 main factions: Charles Taylor's NPFL, Roosevelt John's ULIMO-J, Alhaji Kroma's ULIMO-K, Georges Boley's LPC and General Bowen's AFL, and continued, uninterrupted, for the ensuing 7 years.

In August 1996, after several years of violent fighting, a cease-fire was signed between the warring factions in Abuja, Nigeria. A transitional government (Council of State), was put in place including the 5 faction leaders, and Ruth Perry a former senator, was nominated as the chairperson. The Council of State was tasked with demobilising and dissolving the factions and to organise elections in May 1997.

During the transitional period, soldiers (ECOMOG force), were sent by the Economic Community of West African States (ECOWAS) to monitor (actually enforce) the peace process and progressively take control of the entire territory pending return to civilian rule.

In September 1996, a town, Tubmanburg, Bomi county, which had been totally besieged for over 4 months by the fighting forces was relieved by Ecomog forces. Initially, an assessment mission was conducted by a joint UN-NGO team in Tubmanburg, Bomi County. Tubmanburg is a city located 50 km North of Monrovia, the capital(Nabeth P et al,1997). The assessment team found very large numbers of severely malnourished children, adolescents and adults – with an initial assessment of over 1000 severely malnourished people in urgent need of care. Three therapeutic feeding centres were immediately established, two by Action Contre la Faim and one by Medcines Sans Frontiere. Whilst ACF and MSF established emergency treatment facilities an epidemiologist was engaged to do a detailed survey of the town to determine the extent of mortality from the siege and its effect upon the demographic profile. This was done by Dr Pierre Nabeth about 3 weeks after the start of the relief operation by ACF, between October 4 and October 10, 1996, and showed the extent of the privation that the citizens of Tubmanburg had suffered. Professor Michael Golden visited Tubmanburg from the 12 – 18th October 1996 to do a clinical assessment of the patients and the citizens of the town in order to investigate a report by Nabeth that there was epidemic Beriberi in the county. This turned out to be an incorrect interpretation by the epidemiological team, and the cause for the epidemic oedema was kwashiorkor.

The epidemiological assessment included drawing map of the city, interviews of citizens, demographic and mortality survey and assessing the nutrition situation. The mortality was assesses retrospectively over a 4 month period. Verbal autopsies were performed to calculate the proportional mortality due to violence, diarrhoea, fever and malnutrition. The age, sex, middle upper arm circumference (MUAC) and the presence of oedema were used to assess the nutritional status of the children (Nabeth and Michelet, 1996).

The main results according to Nabeth and Michelet, 1996, were as follows:

Initial Population size	22,338
Proportion of under 5 children	15.0%
Number of people per family	4.2
Proportion of displaced refugees	50.2%
Number who died in previous 4 months:	
Total	4160
Under 5	1916
Main Cause of death	Malnutrition
Global Malnutrition Prevalence	38.0%
Severe malnutrition prevalence	32.0%
Proportion of population admitted in nutrition facilities	32.0%

The security situation was particularly hazardous. The relief teams could only work in Tubmanburg from about 9 or 10 am until 4 p.m. due to the large numbers of road blocks on the route from Monrovia, the capital 50 km away and the necessity of travelling on a daily basis. The residents of the TFCs could not therefore be fed at night. The fighters invaded the TFCs when the expatriate staff had left and took any available food for themselves. Any residents who went home did not take any food with them because if it was known that they were carrying food then the fighters would attack them to get the provisions.

The role of military intervention by peace-keeping and peace-enforcement troops in the provision of humanitarian aid to Liberia during the armed conflicts is seriously questioned. The usefulness of military interventions in humanitarian emergencies is debated especially the context of the role of the de facto safe haven which peace-keeping and enforcing troops protected in Liberia between 1990 and 1996. It is argued that the safe haven enabled significant humanitarian achievements but also demonstrated fundamental failures. Central to these failures have been the absence of consent, under-resourcing and a loss of control of the safe haven to factional interests (Outram Q, 1997).

Given these circumstances, where very large numbers of patients had to be managed under conditions of extreme insecurity, it was observed that there were remarkably few deaths in comparison to patients treated in other parts of Africa, and the rate and extent of recovery were excellent. It is the objective of this project to examine the records of these patients in detail and to compare the outcome of the patients from Tubmanburg with those from other centres in Liberia and West Africa where much better facilities existed.

The clinical records of over 600 patients treated in ACF's therapeutic feeding centres after ECOMOG relieved the siege of Tubmanburg were transported back from Liberia to Aberdeen by the staff of ACF in Liberia and Paris.

1.5 Hypothesis

The mortality rate was significantly lower and the rates of recovery comparable to other centres which were able to provide 24h care in a more secure environment.

1.6 Aims/Objectives

It is the objective of this project to examine the records of these patients in detail and to compare the outcome of the patients from Tubmanburg with those from other centres in Liberia and West Africa where much better facilities existed.

2 Materials & Methods

2.1Patients

The study was carried out using 920 patient records from two therapeutic feeding centres in Tubmanburg (Bomi County, Liberia) from September 1996 to January 1997 .

2.2 The planned protocol and criteria were as follows:

2.2.1.Criteria for admission

The admission criteria generally used in the centres were 1) the weight/height index of < 70 percent of the median National Centre for Health Statistics (NCHS) standard 2) the presence of oedema in both feet or 3) a mid upper arm circumference (MUAC) of < 110 mm. For details see appendice 1-5

Patients who meet this citeria were registered and admitted .

The admission criteria used for the different categories of patients were:

i) Children < 5years

MUAC < 11cm and or weight/height < 70% of the median NCHS standard and or oedema(2+ or 3+ grades).). Identification: Red bracelet

ii) Children >5years

Weight/height < 70% of the median NCHS standard and or oedema(2+ or 3+ grades). Identification: Blue bracelet

iii) Adults

Marasmus or oedema(2+ or 3+ grades). Identification: green bracelet

iv) Lactating Mothers.

Mothers were admitted where they had a malnourished baby of less than 4 months.

v) Others

Brothers or sisters of severely malnourished children were admitted to the centre along with their mother – if they were malnourished they were treated as patients according to the above criteria, otherwise they were fed with porridge and family meals.

2.3Clinical Screening

All patients presenting to the centre were immediately screened by a trained local admitting officer or nurse to assess the degree of oedema, body temperature, dehydration, respiratory rate, anaemia, diarrhoea, vomiting, signs of chest infection, ascites and dysentry and have anthropometric measurements made.

2.4Anthropometry

Patients age, sex, weight, height, and MUAC were determined on admission. Daily weights were taken in phase one and on alternate days in phase two until discharge. Height and MUAC were also measured on discharge.

The daily weighing of adults, however could not be done because of the heavy workload on the staff and the lack of suitable scales and height measuring equipment in the centre at this time.

2.5Medical Treatment

A registration team made up of nurses and clinicians identified all very sick children e.g. with severe dehydration, diarrhoea and vomiting for priority treatment. Identification bracelets were given on registration to all categories of patients. Mothers of children admitted were briefed on how the TFC is run and also asked to identify newly admitted children and relapsed children due to bad follow up after discharge to complete rehabilitation

A protocol of treatment was followed for patients on admission. All children without oedema were given ORS SM (renamed ReSoMal by WHO, 1999)- (5ml/kg/hr) and children with oedema given water with sugar(5g sugar/100 ml water)- (5ml/kg/hr). This was done to prevent or treat hypoglycaemia or dehydration. All severely malnourished children are at risk of developing hypoglycaemic (blood glucose <54mg/dl or 3mmol/l), an important cause of death during the first 2 days of treatment(WHO,1999) or dehydrated on admission because they are often transported over long distances to treatment centres without being fed for 4-6 hours. Care was taken not to give children with oedema the ORS-SM, because salt in the ORS-SM can increase the oedema if the child has no history of diarrhoea

All patients on admission were dewormed, except those < 1 year using ***mebendazole*** (dewormer).For children 1-2 years, 2 tablets of mebendazole were given, once and for children > 2 years, 2 tablets per day for 3 days were administered.

2.6Diets

The diet of patients for phase I, II and III consisted mainly of F-100 Therapeutic Milk (TM) which were prepackaged into sachets (manufactured by Nutriset Company, France) and transported to Liberia by air freight. Each sachet of F100 contained 456 g of the dry F100 formula; it was manufactured from skim milk powder, vegetable fat, dextrin-maltose, and a mineral & vitamin complex.

The therapeutic milk was prepared for feeding by following the instructions on the sachets. The contents of each sachet of TM was added to 2 litres of boiled water, and mixed, to obtain 2.4 litres of F-100 for use in therapeutic feeding programmes.

The composition of the F100 was as follows:

Nutrient	Per 100 g Powder	Per litre of Prepared F100	Nutrient	Per 100 g Powder	Per litre of Prepared F100

Energy	520 kcal	988 kcal	Vitamin	1.8 µg	3.4µg
Protein	13.2 g	25.8 g	Biotin	65 µg	123µg
Lipids	29.2 g	55.5 g	Pantothenic acid	3.1 mg	5.9 mg
Vitamin A	900 µg	1710µg	Vitamin K	21 µg	40 µg
Vitamin D	16 µg	30.4µg	Sodium	<290 mg	<568 mg
Vitamin E	20 mg	38mg	Calcium	420 mg	825 mg
Vitamin C	53 mg	100 mg	Phosphorus	350 mg	690 mg
Vitamin B1	0.6 mg	1.1 mg	Magnesium	86 mg	168 mg
Vitamin B2	1.7 mg	3.2 mg	Zinc	11.8 mg	22.4 mg
Niacin	5.3 mg	10 mg	Iodine	80 µg	152 µg
Vitamin B6	0.6 mg	1.1 mg	Potassium	1100 mg	2156 mg
Folate	210 µg	400µg	Copper	1.4 mg	2.6 mg
			Selenium	25 µg	4.7 µg
			Iron	< 0.3 mg	< 0.6 mg

The F100 was used to feed patients in Phase I at an average frequency of 4 times / over 7 hours to achieve the following levels of energy intake per day.

Age Group	Body Weight(kg)	Energy Intake (Kcal/kg/day	Daily Energy Intake (Kcal/day)
6mon-6 yr.	10	100	1000
7-10 yr.	17	75	1300
11-14 yr.	30	60	1800
14-18 yr.	40	50	2000
>19 yr.	40	40	1600

The estimated quantities of F100 per feed to achieve these energy intake levels were 30ml, 200ml, 400ml, and 400ml for babies, children <5years,children >5 years and adults.

In Phase II Porridge meals (TH450 were used to supplement the TM. TH450 is a porridge with added mineral/vitamin pre-mix suitable for solving the likely nutritional problems of refugees and made to the specifications of the ACF scientific advisory committee (Golden et al, 1995). It was based upon oats/wheat with the protein source being dried skim milk (a similar porridge SP450, in which the DSM is replaced with roasted soya bean flour was planned to be used, and has been used extensively elsewhere, but TH450 was used in Tubmanburg(Appendix 1**.)**

Feeding was at the same frequency as in phase I but the amounts offered were doubled to give an estimated intake of F100 of 60ml, 400ml, 600ml, and 400ml for babies, children <5years,children >5 years and adults.

Age Group	Body Weight(kg)	Energy Intake (Kcal/kg/day	Daily Energy Intake (Kcal/day)
6mon-6 yr.	10	200	2000
7-10 yr.	17	150	2550
11-14 yr.	30	120	3200
14-18 yr.	40	100	4000
>19 yr.	40	80	3200

2.7Outcome measures

The outcome of the therapeutic feeding and treatment was categorised as cured, defaulter, dead or transferred.

2.7.1Cured

The target weight for discharge was –1.5 SD(85%) of the median NCHS/WHO reference value for Weight-for-Height, although this was sometimes not achieved because of the pressing nature of the large numbers of patients that had to be catered for. The children were weighed daily or on alternate days and the weights plotted on a graph incorporated into the fiche. All children who attained >80% of the median NCHS/WHO reference value for Weight-for-Height, however were considered "cured" and eligible for discharge provided that the weight was confirmed over 3 consecutive readings each on alternate days. By this time most patients had continued to gain weight to the target weight for discharge These criteria were to judge different categories of patients fit for discharge:

i)Children <5 years were considered cured if they attained a MUAC >11cm and Weight-for-Height >80% of the median NCHS standard (after 3 consecutive weights) and no oedema for at least 15 days.

ii)For children >5 years, they were considered cured if they attained Weight-for-Height >80% of the median NCHS standard (after 3 consecutive weights) and no oedema for at least 15 days.

iii) It was planned that adults who attained a body mass index (BMI) of 16 kg/m^2 and were able to walk was fit for discharge. However, the criteria were changed to absence of oedema for 15 days, good appetite, ability to walk strongly and showing obvious clear improvement clinically.

2.7.2Defaulters

A patient was considered a defaulter if he/she did not attend the TFC for 4 consecutive days. If he or she come back after 4 days he is readmitted as a new case with a new number.

2.7.3Dead

All deaths at the centres were recorded.The cause of death of all patients who died was also investigated and recorded.

2.7.4Transferred

All cases that needed special attention were referred to the Capital Monrovia and were considered transferred.

2.8 Follow up

When a patient was discharged from the Therapeutic Feeding Center, they were automatically admitted to the "Wet" Supplementary feeding centers (where all those residents of Tabmanburg who were not eligible for admission to the TFC were initially treated). At these centers they were given a daily ration of "family" food fortified with oil – this was eaten at the center because of the security situation. The patients from the TFC were "followed" whilst in the SFC (average stay was for about 2 months) and if they relapsed or deteriorated, they were readmitted to the TFC for further treatment.

2.9Patient Records

It was planned that data on age, sex, date of admission, weight, height, oedema would be recorded for all patients on day of admission. MUAC on admission and discharge, daily weight until discharge and height (on admission and discharge) were also recorded . The health status of patients was constantly monitored and recorded on the fiche from admission until discharge. In particular, diarrhoea, vomiting, body temperature, dehydration, respiratory rate and pallor of patients were monitored daily from admission until discharge.

2.10 Data Handling and Storage:

Data of patients admitted and treated at therapeutic feeding centres were collected on Action Contre la Faim (ACF) treatment cards for therapeutic feeding centers ("fiche"). The completed records were transported to the ACF base in Monrovia and brought back to Yvonne Grellety in Paris by the returning expatriate volunteers in order to monitor the progress of the center. They were then sent to Aberdeen for formal analysis and appraisal in the Department of Medicine and Therapeutics, University of Aberdeen by Professor Michael Golden.

2.11Statistical Analysis

Data from 920 records of patients admitted and treated at therapeutic feeding centres in Tubmanburg were entered into an Excel spreadsheet using a proforma format used in the Department for the analysis of data from other centres.

The main measures from the treatment cards entered were age, sex, date of admission and discharge, outcome (discharged, transferred, died, abandoned), number days of diarrhoea from admission, number of days of vomiting, body temperature measurements(< =35.5-hypothermia,>= 39-fever), number of days of dehydration, number of days of a rapid respiratory rate, number of days with pallor, days in phase one, days in phase two, care practices (IV fluids given, Use of NG tube, diets used e.g. F75, F100, porridge, breastfeeding etc.), oedema, MUAC on admission and discharge, daily weight until discharge and height (on admission and discharge). An additional record was made in the case of these data of the date of the first weight record taken, so that the extent of the missing data could be assessed.

From the Excel entries, Software programs had been written in RS1 relational database for the specific analysis of these data were used to generate the following variables:

Anthropometric variables, WHZ, HAZ, WAZ, on “admission” and at the time of minimum weight, maximum weight and at discharge.

Dmin1 - the first date that the minimum weight was recorded.

Dmin2 – the last date that the minimum weight was recorded.

Dmax – the date of the maximum weight

Dlst – the date of the last weight recorded (equivalent to the discharge weight).

wt0lr8 - value of weight at time of minimum weight using the constant from the regression equation of the weights measured over the subsequent 7 days (this technique was used to adjust “minimum” weight on the grounds that the actual lowest recorded reading is more like to have been an error).

rwglg8- rate of weight gain (g/kg/d) from day 0 to day 7 (8 points) calculated by linear regression analysis

P8- probability value for linear regression being significant (rate of weight gain reliable – values for the rate of weight gain assessed by linear regression where the line did not reach significance were not used in the analysis)

rwglr- rate of weight gain from day 0 to day 14 (15 points) calculated by linear regression analysis in a similar fashion to the assessment over the first 7 days.

rwgmax- rate of weight gain (g/kg/day) from minimum weight to maximum weight

rwglst- rate of weight gain (g/kg/day) from minimum weight to Last weight (Discharge).

cwg 0-21-cumulative weight gain on each day from minimum weight measured in g/kg. This is obtained by doing a linear interpolation of the weights for the alternate days so that a "weight" is present for each day after admission. The increment from the minimum weight is then taken and expressed in terms of grams gained per kilo of initial body weight. This procedure was repeated for each of the first 21 days from the minimum weight. It should be noted that this number is ten times the percentage weight gain since admission (i e grams per kilo instead of grams per 100 grams).

Pru_oa. - This program calculated the Prudhon's probability of death from the equations given in Prudhon et al (1997). The risk of death is higher in the presence of oedema. Thus, in order to obtain a conservative estimate of the number of children who would be expected to die, where the presence or absence of oedema is not recorded on the fiche, we have assumed that oedema was absent. In reality many of the patients had oedema and thus the computed prudhon's index represents the minimum number of expected deaths. The program also generates the 95% confidence intervals for the expected count of dead children assuming a Poisson distribution. Where the observed number of deaths lies outside these confidence intervals, this is thus significant at the 5% level.

Further statistical analysis was done using Systat and SPSS.

3.Results

3.1 The therapeutic feeding centers after the relief of Tubmanburg

When the ECOMOG forces relieved Tubmanburg, the population who had not died was in a critical state. The agencies ACF and MSF were faced with many thousands of malnourished individuals who had to be treated simultaneously. Some were transferred to Monrovia in the first day of relief before any system could be organised and the TFCs opened. There is some confusion about exactly how many were actually evacuated at this time – it is thought that about 30 were brought to Monrovia of whom about 8 died. Thereafter, a system of triage was established and the most critically ill patients admitted to temporary accommodation in existing buildings whilst structures were constructed to house the very large numbers of patients, simultaneously wet supplementary feeding programs and "kitchens" were established for the less critically ill.

Although the town of Tubmanburg itself had been "relieved", the Ecomog forces had a minimal presence. The surrounding countryside and much of the town still contained many "fighters" belonging to the factional forces. These fighters were themselves very short of food. The security situation was tense and very volatile. This had a direct effect upon the design of the relief effort. The way in which the protocols for treating the malnourished patients were initially adapted and modified subsequently, and also the amount and quality of information that could be recorded.

1. There were 2 expatriate nurses under the leadership of Isabelle Beauquesne and about 30 locally recruited staff for the ACF centres. The programme was adapted in Paris by Yvonne Grellety and Anne-Sophie Fournier.

2. The Expatriate nurses had to travel each morning from Monrovia during daylight and return each evening back to Monrovia. The journey involved negotiating many "checkpoints". For this reason the centres could only be run from 9 or 10 am to 4 p.m. and all treatment had to be given during this restricted period of 7 hours. 24 hour residential care was not possible

3.Although some of the mothers and patients stayed in the center overnight, most returned to their dwellings in the town of Tubmanburg at night for security reasons.

4.The mothers refused to take food home with them for overnight feeding of the patients. This is because they were concerned about being attacked by the fighters on their way home or in their houses at night and when there were no expatriate witnesses. If the fighters knew that the residents had food, they would have taken it for themselves. The result would have been that the patient did not get the food at any rate, all the family would have been exposed to intimidation and personal violence.

5.At the start of the operation the staff, locally recruited, were residents of Tubmanburg who could read and write and had had some formal education. They were very committed to learning and doing whatever they could for the starved community, and themselves received food for their services. Nevertheless it took some time for the staff to be trained in the organisation of a center and in the routine management of severe malnutrition, as well as the procedure that had to be followed, and those who had to do the teaching had many competing tasks and assessments to make. The protocols clearly had to be as simple as possible, and based upon pre-prepared or pre-packaged products as much as possible. There was a strict organisation and division of labour, so that each staff member had a clear description of the tasks that had to be performed.

6.At the beginning each patient was admitted on the basis of oedema and weight-for-height by an admitting officer. The patient was given a coloured bracelet with their name and registration number on it. A 'fiche' or recording chart was issued for that patient and they were admitted to the temporary structure to receive their first therapeutic food. Table 1 shows the number of patients that were admitted per day over the first 27 days of the centre and the cumulative total patients under the care of the nutrition team.

Table 1. Number of patients admitted per day and cumulative total over the first 27 days

Date	No. Admitted	Cumulative
18th September	154	154
19th September	119	273
20th September	108	381
21st September	30	411
22nd September	18	429
23rd September	53	482
24th September	25	507
25th September	3	510
26th September	12	522
27th September	23	545
28th September	6	551
29th September	2	553
30th September	0	553
1st October	12	566
2nd October	12	578
3rd October	6	584
4th October	0	584
5th October	0	584
6th October	1	585
7th October	0	585
8th October	11	596
9th October	3	599
10th October	3	602
11th October	1	603
12th October	1	604
13th October	5	609
14th October	3	612
Last date, 9th Dec 1996	-	920

It is clear that there was a sudden influx of patients – within 4 days over 400 patients had been admitted and their treatment started. This should be compared with many district hospitals which have about 400 patients who have arrived in a spaced way and are managed by at least 400 well trained staff.

7.Because of the order of priorities weights, heights and oedema were not recorded on the fiche for the first days after opening the centre. These data are therefore absent from the analysis and the "admission" weight has been taken as the first weight recorded. For this reason, many of the "admission" weights are equivalent to the recorded minimum weight.

Table 2 gives a record of the length of time that elapsed before data were recorded for the patients reported in this thesis. Thus, 162 patients had weights recorded from the day of admission, and in 59 cases the first recorded weight was on the 6^{th} day after admission. The table also gives the number of cases that left the centre before any measurements could be taken and recorded.

Table 2. Missing values for anthropometry

Days from admission (First Weight Taken on day)	Number of Patients with anthropometry taken					
	All Patients	Infants	Child	Juvenile	Adolescents	Adults
0	162	29	77	77	43	13
1	12	2	8	8	2	0
2	22	3	6	6	12	1
3	13	1	5	5	7	0
4	18	2	8	8	7	1
5	27	3	11	11	11	2
6	59	9	23	23	24	3
7	58	3	25	25	28	2
8	51	5	28	28	16	2
9	55	1	17	17	32	5
10	49	1	17	17	22	8
11	34	0	13	13	18	2
12	13	1	5	5	5	2
13	2	0	1	1	1	0
14	3	0	0	0	3	0
15	4	0	2	2	1	1

>15	3	0	0	0	3	0
No values for Anthropometry	335	9	49	29	16	232

8.The diets were based entirely on pre-packaged F100 diet, one packet could be opened and mixed with 200 ml of ambient temperature water to give 2.4 l of "Therapeutic milk". The subjects were also given a porridge TH 450 based upon the criteria for refugee feeding recommended by ACF Scientific committee (Golden, Briend , Grellety 1995). CSB Unimix and other products which do not contain the full range of minerals and vitamins required for the patients were not used.

9.In one important respect the protocol differed from that used previously in order to simplify the regimen. The patients were 'grouped' together by age category and the food was dispensed at set times giving a calculated set amount to each patient within an age group. This was calculated to give approximately 100 kcal/kg/day to each patient, assuming 70% weight- for -age (for the average age of the group of patients) in phase I and 200 kcal/kg/day for phase II of treatment. Iron was not added to the therapeutic milk, but was given separately after 15 days of treatment. The patients in phase II also received the porridge in addition to the therapeutic milk.

Under less stressed circumstances, the diet would be dispensed according to the weight class of the patient and there would have been the necessity to regularly weigh each patient and calculate the amount of the diet to be dispensed to that individual patient; each patient would thus potentially have to receive a different amount of food. Such a procedure, although desirable and more efficient for weight gain could have taken additional time both for the weighing and calculations and at the time of food distribution, and would have necessitated additional training for the staff. Such a procedure was tried in Burundi and it did not work (Yvonne Grellety, personal communication)

10. Only limited stocks of food and other products could be left at the centres overnight. There was one locked room where one or two days supply was stored, and it was and it was made clear to the leaders of the local fighters that this stock was very small, and if it was interfered with the operation would need to be suspended. However, this problem created the necessity to replenish stocks frequently and posed logistic difficulties.

3.2General statistics

The analysis reported here are from the first 920 patients treated in the ACF centres. 69 were infants aged 0-6 months (2.6 + 1.7), 295 children aged 7-60 months (34.6 ±18.3), 264 juveniles aged 6- 9 years (6.9 ±1.0), 58 adolescents aged 10-18 years (11.7±± 2.4) and 232 adults aged 20-96 years (57.5± 15.1). Two records had no age recorded and were considered blank and excluded from all analyses.

3.3Coverage Rate

The population of Tabmanburg was 22,338 and 32.0%(7,148) of the population was severely malnourished (Nabeth and Michelet, 1996). The proportion of severely malnourished people admitted at the ACF therapeutic feeding centres was 12.9 % (920) (see figures 1-17)

3.4Length of stay and timing of recovery

The average length of stay, from the date of admission to discharge, at the centres was about 3 weeks. The adults on the average stayed longer before discharge, with an average length of stay of about 21.9 days ±14.7. The mean length of stay at the therapeutic feeding centres before discharge or transfer to supplementary feeding centres was 21, 20, 19, 16 and 21 days for adults, adolescents, juveniles, infants and children respectively (table 3).

On average there was no weight taken for about 6 or 7 days. The minimum weight was then reached between 0.8 and 1.7 days after the first weight was recorded (table 4). Thereafter, the patients grew rapidly for between 10 and 14 days and then stabilised for one to 3 days before leaving the centre. These mean data could be misleading, however, as many of the patients were gaining weight before the first weight was taken.

Table 3 Mean length of stay at therapeutic feeding centres (admission date – discharge date)

Category of Patient	Average length of stay (days) ± SEM	Average length of stay (days) ± SD
Adults	21.9±1.0	21.9±14.7
Adolescents	20.5±1.8	20.5±13.7
Juveniles	19.3± 0.7	19.3±11.1
Infants	16.2 ± 1.7	16.2 ±14.2
Child	21.5±0.8	21.5±14.1

Table 4 Average number of days (mean ± sem) that the patients spent in each stage of recovery

Category	No wt	min wt 1	Min wt 2	max wt	last wt	Total
Infants	2.8	1.7±0.8	1.7±0.4	10.3±1.5	13.4±2.0	16.2± 1.7
Children	6.5	1.2±0.2	1.5±0.2	13.5±0.7	15.0±0.7	21.5±0.8
Juveniles	7.8	0.9±0.2	1.4±0.2	10.4±0.6	11.5±0.6	19.3± 0.7
Adolescents	6.4	0.8±0.3	1.3±0.4	12.5±1.5	14.1± 1.5	20.5±1.8
Adults		-	-	-	-	21.9±1.0

3.5Nutritional Status on admission

Table 5 shows the weight for height of the various categories of patient on admission, or at the first weight taken. As patients with oedema are expected to be of a higher weight than those without the data are presented by oedema category. Unfortunately, many of the patients have missing oedema data. Nevertheless, it appears as if the children who were recorded as having oedema were in fact of a lower mean weight than those without oedema and those without oedema status being recorded. It is also important to emphasise that many of the patients were gaining weight before the first weight we recorded – thus, the actual weight for height on admission was probably worse than that recorded in table 5.

Anthropometry

Table 5.WHZ for Patients on admission

Patient category	Oedema	No.	Missing Values	Mean	SE M	SD	Min	Max
Infant (n=69)	Oed	6	4	-1.80	0.27	0.66	-2.83	-1.22
	Non-oed	4	2	-2.30	0.30	0.59	-3.01	-1.22
	Not known	44	9	-1.85	0.14	0.90	-3.48	-0.01
Children (n=295)	Oed	55	11	-3.03	0.15	1.10	-5.56	-0.23
	Non-oed	46	3	-2.85	0.16	1.11	-5.80	-0.22
	Not known	132	48	-2.51	0.10	1.17	-4.96	+2.15
Juveniles (n=264)	Oed	34	12	-2.36	0.23	1.31	-4.81	+0.41
	Non-oed	42	1	-2.12	0.15	0.98	-4.18	+0.41
	Not known	139	36	-1.89	0.08	0.99	-4.39	+0.34
Adolescents (n=58)	Oed	6	4	-1.80	0.27	0.56	-2.83	-1.22
	Non-oed	4	2	-2.30	0.30	0.59	-3.01	-1.58
	Not known	25	17	-2.24	0.27	1.34	-4.70	+0.38
Adults**	Oed							
	Non-oed							

** Adults were not weighed

Table 6 shows the change in Z score during treatment. The data shows that the various categories of patient were more or less equally malnourished on admission except the children who were more malnourished. They gained between 0.7 and 1.2 Z-score units during treatment. Although the children gained more weight than the other groups they were still more wasted on discharge than infants, juveniles or adolescents.

Table 6. WHZ index at minimum weight, maximum weight and discharge weight during rehabilitation.

	WHZmin	WHZmax	WHZlst	Change during Treatment
Infants(n=69)	-2.14	-1.42	-1.47	+0.67
Children(n=295)	-2.87	-1.58	-1.62	+1.25
Juveniles(n=264)	-2.10	-1.23	-1.23	+0.87
Adolescents(58)	-2.23	-1.44	-1.47	+0.78

3.6Recovery Pattern

The mean rate of weight gain for the first seven days after minimum weight for infants, children, juveniles and adolescents were 14.3, 14.3, 11.1, and 11.4 g/kg body wt/day. This was slightly more than the rate of weight gain, when assessed over a two week period. By definition the highest rate of weight gain was between the minimum and maximum weights. Although this was very high for the infants, and higher for adolescents, it was not much higher than that obtained by linear regression for children or juveniles. The rates to discharge, which are the rates of weight gain normally quoted in studies of malnutrition, are given in the last column of table 5. The children gained weight at 15.6 g/kg/d. This figure is comparable with the rates obtained from centres where children are residential and are treated over a 24h period, including throughout the night, instead of over a 7 hour period during the day.

The corresponding rates of weight gain for other groups were 9.9 g/kg body wt/day for juveniles and 16.5 g/kg body wt/day for infants (table 7). It is not clear why the rate of weight gain of the juvenile should have been the lowest, lower even than the adolescents.

There is not much data on the rate of recovery of adolescents. It is noteworthy that this group gained weight at over 10g/kg/d (being fed over a 7 hour period) – this suggests that adolescents can normally recover at a rate comparable to those seen in children and certainly as well as juveniles.

Table 7 Rate of Weight Gain at one week, two weeks, maximum weight and discharge weight (Mean ± s.e.m)

	Mean Rate of Weight Gain (g/kg/d)			
Patient Category	Linear regress Day 0-7	Linear regress days 0 – 14	Min to Max	Min to Discharge
Infant	14.3 ± 1.8	14.1 ± 1.6	25.6±4.4	16.5±1.8
Child	14.3±1.3	11.7±1.0	15.6±1.1	15.6±1.1
Juvenile	11.1± 0.8	9.4± 0.5	12.1±0.7	9.9±0.6
Adolescent	11.4±1.1	9.5±1.1	14.5±2.2	11.5±1.8
Adult**	-	-	-	-

** Rate of weight gain not calculated because adults were not weighed.

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3.7Cumulative Weight Gain (0-21 days)

Table 8.Cumulative weight gain 0-21 days(g/kg/day)

	Cumulative Weight Gain (g/kg)							
Day	Infant		Adolescents		Juveniles		Child	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
1	41.2	6.9	14.0	2.4	15.1	1.2	23.6	2.1
2	59.7	9.9	25.3	3.8	29.5	2.3	40.3	3.4
3	73.6	10.0	37.4	4.9	42.1	3.4	55.8	4.7
4	82.4	11.5	44.9	5.1	52.9	4.4	65.4	5.3
5	91.7	11.8	57.5	5.8	65.1	5.8	78.2	6.2
6	103.5	14.5	63.5	6.6	73.7	6.2	88.9	7.4
7	107.2	13.6	73.8	7.9	81.0	6.4	100.0	8.8
8	137.4	18.6	75.2	8.6	94.3	7.6	112.2	10.5
9	162.7	25.8	84.9	10.9	107.0	9.2	123.3	11.6
10	176.5	27.2	87.0	12.8	111.2	10.0	133.8	12.4
11	185.0	26.7	93.9	15.2	111.0	6.9	137.7	13.3
12	170.9	26.3	101.8	16.1	116.2	8.0	139.1	13.7
13	199.8	27.9	110.8	16.7	121.6	8.7	148.9	15.8
14	206.2	27.6	115.5	16.6	131.7	9.9	160.3	16.3
15			126.5	16.8	142.8	10.7	171.8	17.6
16			138.6	20.3	147.8	10.4	184.0	20.8
17			148.7	19.6	149.5	11.0	196.3	20.5
18			162.9	20.5	151.4	11.5	206.5	21.9
19					159.8	13.1	219.9	22.3
20					170.8	16.0	230.8	22.9
21					180.8	17.3	243.8	23.8

Table 8 shows the number of g of weight, on average, gained for each kilo of body weight each day for the different categories of patients (this is 10 times the percent gain in weight). Thus for example, after 10 days infants had gained 17.7 % body weight, children 13.4 %, juveniles 11.1% and adolescents 8.7% despite the dietary intake period being restricted to about 7 hours per day**.**

The cumulative of weight gains one week on admission for infants, children, juveniles and adolescents were 107.2, 88.9, 73.7, and 63.5 g/kg. By the second week they had cumulative weight gains of 206.2, 160.3, 131.7 and 115.5 g/kg for infants, children, juveniles and adolescents respectively. Children and juveniles had cumulative weight gains of 243.8 and 180.8 g/kg respectively by the end of three weeks. In other words by the end of three weeks children and juveniles were gaining weights of 11.6, 8.6 g/kg/day respectively. The rates of weight gain for infants and adolescents at the end of three weeks were not calculate because of smaller numbers on admission (table 8).

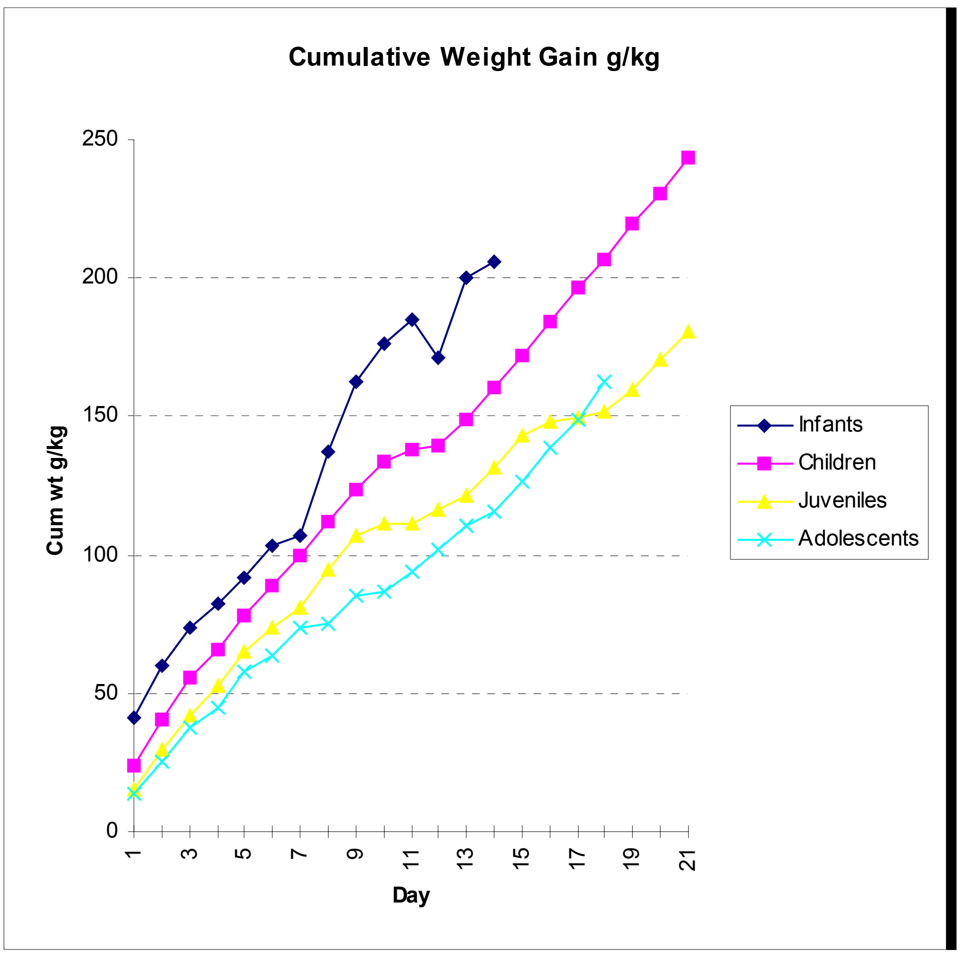

Fig 1 Cummulative weight gain of of patients(first 21 days)

The weight gain (g/ kg body weight) of infants was the highest in the first 21 days. By the 10th day,

the weight gain/kg body weight was 17.7, 13.4, 11.1, and 8.7 for infants, children, juveniles and adolescents respectively.(Fig 1)

3.8Clinical signs

Tables 9 to 20. Shows the clinical signs recorded for patients. There were no data for the patients who were first admitted to the centre. The data is thus derived mainly from patients admitted after 5 days of operation.

3.8.1Infection

Most of the patients in the first 4 days had no diarrhoea. 14.6% , 8.2%, 8.3%, 12.8% and 4.2% of infants, children, juveniles, adolescents and adults respectively had diarrhoea for one day in the first 4 days. Fewer patients had diarrhoea for more than one day in the first 4 days (table 9).

Similarly, table 10 shows the number of patients experiencing diarrhoea in the first 21 days of treatment was very small. In the first 21 days, majority of patients had no diarrhoea. 19.2%,12.0%,12.2%,17.0% and 7.8% of infants, children, juveniles, adolescents and adults respectively had diarrhoea for one day. 4.3%,1.3%,8.9%,4.3% and 3.0% of infants, children, juveniles, adolescents and adults respectively had diarrhoea from 2-4 days.

Except 2.4% of adults and 0.5 % of juveniles who had diarrhoea for 5 or more days, no other category of patients had diarrhoea for 5 or more days in the first 21 days(table 7).

Table 11 shows the number of patients that experienced vomiting in the first 4 days and table 12 over the first 21 days.

Over 90% of patients did not vomiting at all, in the first 4 days. However, the highest proportion of patients who vomited were infants (for one day only). Only 4.1%, 1.8% and 1.8% of children, juveniles and adults respectively vomited for one day in the first 4 days. No adolescent vomited in the first 4 days (table 11).

For the first 21 days, over 80% of patients of all categories of patients did not vomit. No adolescent was found to have vomited and 6.3, 7.7, 5.6 and 4.3 % of infants ,children, juveniles and adults had one day of vomiting. Vomiting from 2 to 4 days occurred among 6.3,4.7, 1.9 and 1.2 % of infants, children, juveniles and adults respectively

It is clear that very few of the patients had diarrhoea or vomiting and that refeeding diarrhoea does not seem to have been a problem. There was also no outbreak of major diarrheal disease.

Table 9. Proportion of patients with 0 to 4 episodes of Diarrhoea in the first 4 days

Category of patient	Missing Data	No	Frequency/Episodes of Diarrhoea in first 4 days			
			0	1	2	3 or 4
Infants	21	48	83.3 %	14.6 %	2.1 %	0.0 %
children	51	244	89.8 %	8.2 %	1.2 %	0.8 %
Juvenile	46	218	86.7 %	8.3 %	4.1 %	0.9 %
Adolescent	11	47	85.1 %	12.8 %	0.0 %	2.1 %
Adult	64	168	92.7 %	4.2 %	1.2 %	1.8 %

Table 10. Proportion of patients with 0 to 5 or more episodes of Diarrhoea in the first 21 days

Category of patient	Missing Data	No	Diarrhoea in first 21days			
			0 times	1 day	2 to 4 days	5 or more days
Infants	22	47	76.6 %	19.2 %	4.3 %	0.0 %
children	51	234	83.3 %	12.0 %	1.3 %	0.0 %
Juvenile	50	214	78.5 %	12.2 %	8.9 %	0.5 %
Adolescent	11	47	78.7 %	17.0 %	4.3 %	0.0 %
Adult	66	166	86.8 %	7.8 %	3.0 %	2.4 %

Table 11. Vomiting in the first 4 days.

Category of patient	Missing Data	No	Vomiting in first 4 days			
			0 day	1 day	2 days	3 or 4 days
Infants	20	49	91.8 %	8.2 %	0.0 %	0.0 %
children	52	243	95.1 %	4.1 %	0.8 %	0.0 %
Juvenile	47	217	97.2 %	1.8 %	0.5 %	0.5 %
Adolescent	12	46	100 %	0.0 %	0.0 %	0.0 %
Adult	66	166	98.2 %	1.8 %	0.0 %	0.0 %

Table 12.Vomiting in the first 21 days

Category of patient	Missing Data	No	of Vomiting in first 21days			
			0 day	1 day	2 to 4	>= 5
Infants	21	48	87.5 %	6.3 %	6.3 %	0.0 %
children	61	234	87.6 %	7.7 %	4.7 %	0.0 %
Juvenile	51	213	92.5 %	5.6 %	1.9 %	0.0 %
Adolescent	12	46	100 %	0.0 %	0.0 %	0.0 %
Adult	68	164	94.5 %	4.3 %	1.2 %	0.0 %

Table 13. Days with hypothermia during rehabilitation at Therapeutic feeding Centres

Category of patient	Missing Data	No	Days of Hypothermia			
			0 day	1day	2 days	3-5
Infants	13	56	80.4	12.5	7.1	0.0
children	36	259	70.3	13.5	13.9	2.3
Juvenile	40	224	74.6	11.6	12.5	1.3
Adolesce	7	51	76.5	11.8	9.8	2.0
Adult	22	210	66.7	20.5	10.7	2.1

Although the majority of patients during the course of recovery had no hypothermia, this is normally a serious clinical sign and with corrrect management no patient should have hypothermia. It is thus of concern that 18% of infants, 30% of children 25% of juveniles, 24% of adolescents and 33% of adults had at least one episode of hypothermia whilst in the center. It should be noted that all the temperatures taken were during the day, and night time temperatures could not be ascertained. Despite this between 20 and 35 % of the patients had at least one recorded episode of hypothermia. It is notable that none of the categories of patient escaped hypothermia. Indeed, the infants, who would be thought of as the most vulnerable had the lowest incidence and the adults who should have been most resistant in view of their low surface-area to volume ratio, had the highest proportion of patients with hypothermia. The reasons could be related to the dietary intakes, the exposed nature of the temporary accommodation and the relative lack of "body contact" by the adults with each other, unlike the infants who slept and were being held close to their mothers.

Table 14.Days with fever

Category of patient	Missing Data	No	Days of Fever			
			0 times	1(once)	2 to 4	=>5

Infants	13	56	94.6	5.4	0.0	0.0
children	36	259	86.1	11.2	2.7	0.0
Juvenile	41	223	93.3	6.7	0.0	0.0
Adolescent	8	50	90.0	8.0	2.0	0.0
Adult	36	196	99.5	0.5	0.0	0.0

Most of the patients on admission had no fever during the course of recovery. Only 5.4%,11.2%,6.7%,8.0% and 0.5% of infants, children, juveniles, adolescents and adults who had their fever status recorded, had fever for only a day. Only 2.7% of children and 2.0% of adolescents had fever for 2 to 4 days. No patient had fever for 5 or more days.

Table 15. Days with history of dehydration

Category of patient	Missing Data	No	Days of Dehydration			
			0 day	1 day	2 to 4 days	5 or more days
Infants	23	46	89.1	8.7	0.0	2.2
children	62	233	82.8	9.4	3.9	3.8

Juvenile	51	213	93.4	5.6	0.9	0.0
Adolescent	11	47	85.1	4.3	4.3	6.4
Adult	65	167	86.8	4.2	6.0	3.0

Dehydration was diagnosed clinically in 9, 9, 6, 4 and 4 % of Infants, children, juveniles, adolescents, and adults for only a day during the course of recovery. Dehydration for 2 to 4 days was recorded for 4% of children , 1% of juveniles 4% of adolescents and 6% of adults. Five or more days of dehydration occurred in 2.2% of infants, 3.8 % of children, 6.4 % of adolescents and 3% of adults(Table 15). The adults seem to have had more problem with dehydration than the children. It is possible that the staff were less familiar with the clinical signs of dehydration in adults than children, and confused the signs of severe wasting with those of dehydration in some cases.

Table 16. Days with Chest infection during rehabilitation

Category of patient	Missing Data	No	Days of Chest Infection			
			0 Days	1 Day	2 to 4 Days	=>5 Days
Infants	23	46	47.8	19.6	13.1	19.5
children	53	242	31.0	14.5	27.3	27.2
Juvenile	48	216	39.4	12.5	31.0	17.1
Adolescent	10	48	43.8	16.7	27.1	12.4
Adult	53	179	43.0	14.5	13.4	29.1

Over 50% of all categories of patients had chest infections for one or more days (table 16).

Table 17. Number of days anaemic during rehabilitation at TFC

Category	Missing Data	No	Days Anaemic			
			0 Days	1 Day	2 to 4 Days	5 or more Days
Infants	50	19	73.7	10.5	10.5	5.3
children	197	98	22.5	19.4	24.5	33.6
Juvenile	189	75	49.3	10.7	20.0	20.0
Adolescent	38	20	40.0	5.0	25.0	30.0
Adult	154	78	33.3	7.7	21.8	37.2

Most patients were clinically anaemic. This could be ascribed to a co-limitation of nutritional deficiency and malaria. Anaemia was common among patients during the course of rehabilitation. Over 5% of all categories of patients had anaemia for 5 or more days. The lowest proportion of anemia cases were among the infant and the highest was among children (table 17).

Table 18 Oedema status of patients

Category of patient	Missing Data	No	Grade of Oedema			
			0	1 +	2 ++	3+++
Infants	61	8	100 %	0.0 %	0.0 %	0.0 %
children	180	115	42.6 %	34.8 %	22.6 %	0.0 %
Juvenile	175	89	48.3 %	32.6 %	19.1 %	0.0 %
Adolescent	42	16	37.5 %	25.0 %	37.5 %	0.0 %

Adult	58	174	4.0 %	24.1 %	62.6 %	9.2 %

A large number of the patients did not have their oedema status recorded. Most of the patients, however, were oedematous (personal communication, Y Grellety and M Golden). Of those who had oedema recorded the highest incidence of oedema was among adults and 24.1% , 62.6% and 9.2% had 1+ , 2++, and 3+++ grades of oedema respectively. The infants had no oedema. Over 50% of all categories of patients except the infant had oedema during the course of recovery.(table 18)

Table 19. Length of time(days) for oedema to resolve.

Category of patient	Missing Data	No	Days Oedema resolved			
			0 Days	1 Day	2 to 4 Days	5 or more Days
Infants	66	3	100.0 %	0.0 %	0.0 %	0.0 %
children	207	88	44.3 %	2.3 %	14.8 %	38.6 %
Juvenile	199	65	43.1 %	1.5 %	32.3 %	76.9 %
Adolescent	46	12	41.7 %	16.7 %	8.3 %	33.3 %
Adult	108	124	1.6 %	9.7 %	18.6 %	70.1 %

Among the adult patients who had oedema, 70% of them had their oedema resolving in 5 or more days. Generally, it took 5 or more days for the oedema of patients for over 30% of patients in all categories for the oedema to resolve(table 19).

Table 20. Breastfeeding of infants(0-6mons) and Children (7-24mons).

Category of Patient			Breastfeeding	
	Missing data	No. Patient	YES (%)	NO(%)
Infants (0-6mon)	31	38	97.4	2.6
Children(7-24 mon)	0	122	34.4	65.6

For infants aged 0-6 months, 38 out 69 breastfeeding records were kept and 97.4 % were being breastfed(not exclusively)and only 2.6% were not being breastfed. 122 children were aged 7-24 months, 34.4% were still being breastfed (Table 20).

3.9 Mortality and case fatality

Table 21, shows the outcome of the infants, children and juveniles for whom anthropometric measurements were available. The expected number of deaths were calculated from the equations derived by Prudhon et al (1997). Based upon the weight, height, and oedema status of each patient a 'risk of death' was computed. These 'risks' were then summed to give the expected number of deaths shown in column 6 of table 21 with the 95% confidence intervals of this count assuming a Poisson distribution. The observed deaths were very much fever than the predicted number of deaths. Although the original equation was derived for children 6-60 months of age they have been applied to the infants and the juveniles as well. In each category of patients there was a highly significant difference between the observed and expected mortality rates.

The possibility arises that the mortality for patients for whom no anthropometric values were taken could be different from those for whom measurements were made. This could be either because they died during the first few days of opening the center or after admission before any record of weight, height and oedema could be made. Therefore average risk of death for the patients for whom measurements were available was assigned to each of the patients with missing data. This is likely to be a conservative estimate of their Prudhon index because the more severely malnourished patients were admitted at the beginning when records were not taken.

In table 22, the outcome of all the patients admitted to the centre whether or not they had anthropometric data recorded is shown together with conservative estimates of the total deaths expected for infants, children and juveniles. These data confirm that the mortality rate was much lower than expected and refute the hypothesis that those with unrecorded anthropometric data experienced a higher mortality than those for whom records were available.

The table also shows the outcome experienced by adolescents and adults. There is no index available to compute the expected mortality rate in these groups, and we did not think it appropriate to apply the equation derived for young children. Nevertheless, of the 58 adolescents admitted, none died and of the 232 adults only 6 died giving a case fatality rate of 2.5%. this is much lower than that experienced in other famines where large number of adults have been malnourished(Collins et al 1998).

Of the 918 patients treated only 16 died (case fatality rate 1.7%). Comparison of the mortality rates suggest that the most vulnerable section of this population was the less than 6 months old child (CFR 5.7%) followed by the adult population. Most of the adults did not like taking the therapeutic milk designed for children and protocols specific for treatment of adults and adolescents have not been developed and implemented in the way that they have for children.

Table 21. Outcome of Treatment,

Category	Aband	Trans f	Discharge	Observe d Deaths	Expected Deaths	95 % CI	Observed/ Expected	Case Fatality
Infants (n=60)	10	1	45	4	15.3	8.7 –24.6	26.7	6.7 %
Children (n=237)	37	0	198	2	11	5.8 – 19.0	18.2	0.8 %
Juveniles (n=219)	19	2	197	1	5.7	2.5 – 12.4	16.7	0.5 %
Total	66	3	506	7	32	23.1 – 45.8	21.8	1.1

Table 22. Outcome of treatment , expected deaths and case fatality rates at therapeutic feeding centres.

Category	Aband	Transf	Discharge	Observed Deaths	Expected Deaths	95 % CI	Observed/ Expected	Case Fatality
Infants (n=69)	16	1	48	4	17.6	11.1- 27.8	22.2	5.7
Children (n=295)	55	0	234	4	13.7	8.1- 22.9	28.6	1.3
Juveniles (n=264)	36	2	224	2	6.9	3.1-13.7	28.6	0.8
Adolescent(n= 58)	11	0	47	0	**	-	-	0.0
Adults (n=232)	45	1	180	6	**	-	-	2.5
Total(n=918)	163	4	735	16		28.1-52.7	10/39	1.7

** No index for adolescents and adults(Prudhon probability of death is for children)

4.0 DISCUSSION

The data from the relief of the siege of Tubmanburg, represents a unique opportunity to examine the effects treatment of acute starvation of a population. That the siege and famine were severe is demonstrated by the survey of Nabet done shortly after the relief. About 19 % of the population had died of starvation – 57% of the children and 12% of the adults. When the relief came over 30% the population that had not died were severely malnourished and required immediate medical help to prevent their deaths. The results of treatment of such a population with modern methods of rehabilitation have not been reported before. In other areas that have been besieged and then relieved, for example during the second world war, no data on mortality or rates of recovery have been recorded, and in some modern sieges, such as that if Sarejevo, there has not been massive death from starvation or widespread malnutrition.

Unlike other famines, however, there does not seem to have been an epidemic of the infective diseases that normally accompany mass starvation. Thus, typhus, typhoid and cholera were not seen during the siege or during the relief effort. A cholera epidemic did strike a nearby relief center, run by OXFAM, close to the front line of hostilities several months later. The reason for the lack of epidemic disease is unclear; presumably it is related to the isolated nature of the town of Tubmanburg , the very restricted population movement and the lack of initial cases to start an epidemic.

4.1 **Rate of weight gain.**

The rates of weight change during recovery were higher than found else where in the West African Sub-region using treatment protocols and rehabilitation foods from before the advent of the WHO 1999 treatment manual. Although, other centers run by ACF have been using these protocols since 1994, and nearly always achieve a rate of weight gain of over 10g/kg/d, usually about 15g/kg/d, when there is 24h residential care and "round the clock" feeding. What is most remarkable about the present data are that the treatment was restricted to about 7 hours per day. During this time sufficient food was taken by the patients to achieve rates of weight gain similar to those seen in the other ACF centers.

Thus, infants at the beginning of recovery were gaining 14.3 g/kg/day and this rose to an average of 16.5 g/kg/day at the time of discharge. There was also an increase rate of weight gain for children from 14.3 g/kg/day at the beginning of recovery to 15.6 g/kg/day at discharge.

These results can be compared with the rate of weight gain of children aged less 60 months in Kersey Nutrition Rehabilitation Centre (KNRC) located in Ogbomoso, in western Nigeria (Ibekwe & Ashworth, 1994). Here the rate of weight gain for marasmic and marasmic-kwashiorkor cases was 7.0 g/kg/day and 7.2 g/kg/day and 6.0 g/kg/d for kwashiorkor cases (p value <0.01). However, standards set by the KNRC are rated highly in Nigeria as being an exemplary center; it is a Baptist Medical Center and as such enjoys more medical facilities than any other Nutrition rehabilitation center in Nigeria (Ibekwe & Ashworth, 1994) – it is therefore expected that the other centers do not even achieve a rate of weight gain at this level, which is itself less than half that achieved in Tubmanburg.

Generally, the rate of weight gain for all categories of patients, from the beginning of recovery to discharge was within the range stated to be readily achievable with the correct management by WHO, 1999 of 10-15 g/kg/day. During recovery there was also no patients with ‘failure to thrive’; all the rates of weight gain, for all categories of patient, (table 3) were far above the cut-off point of failure to thrive during rehabilitation of 5 g/kg/day . This could be used as a measure of the successful case management at the Tubmanburg TFC’s

4.2 Rate of loss of oedema.

Because of the lack of recording during the initial phase of the emergency, it is difficult to know the rate of loss of oedema. Nevertheless, it seems that all categories of patients had lost oedema and by the second day after records were being taken – as the records started, on average, 5 days after admission, the maximum likely time for loss of oedema is 6 days.

The fast rate at which the oedema resolved could be explained by feeding to attain the energy levels spelt out in the protocol and the mineral and vitamin content of the diets helped to correct electrolyte imbalance. Golden, 1982, explained the relationship between energy intake and loss of oedema. The energy intake above which oedema resolved and below which oedema accumulates was 245-270 kJ/kg/day. In the treatment the use of the F100 diet and the frequency of feeding to attain the desired energy was strictly adhered to, within the constraints of the time for treatment. This upper limit of energy intake was exceeded, on average, by all categories of patient through supervised feeding. This could have accounted for the fast rate of loss of oedema.

4.3 Mean length of Stay

The mean length of stay at the centres ranged from 16.2 days (95% CI; 12.8-19.6) for infants to 21.5 days (95% CI;19.9-23.1). This also compared with an average length of stay of 35 days for children treated at the KNRC in Nigeria(Ibekwe & Ashworth, 1994) also indicate a faster recovery rate of patients. The most expensive component of treatment of patients is the costs of keeping the patient in residential care. If the diets used in Tubmanburg were applied generally, and the length of stay was thereby reduced from 35 days to 21 days, then the cost saving per patient would more than off-set any additional expenditure on the diets.

It is a major advantage to have the patients discharged as quickly as possible. Not only can limited facilities then be used to treat more patients, but also a) the patients are not exposed to the cross-infections of hospital for longer than necessary, and b) the mother does not have to be away from the rest of her family for an extended period. The admission on a child to hospital, with the mother, involves considerable social costs to the family.   There are thus very strong arguments from both economic and social points of view for giving a diet that promotes the most rapid rate of recovery possible.

4.4 Incidence/Treatment of infections.

Diarrhoeal diseases were not common among patients. The few cases that had diarrhoea could be refeeding diarrhoea of new arrivals at feeding centres and generally regarded as the response of a starving and atrophic intestine to the initial reintroduction of food. Why there was such a low prevalence of diarrhoea is unclear. It may be related to the fact that the surviving population that presented had true acute malnutrition, and that chronic malnutrition was not a common underlying feature of their illness. Because of the restricted time over which the food had to be given, each individual meal had to be larger than is normal in the treatment of malnutrition. For this reason refeeding diarrhoea was anticipated when the protocols were designed. The fact that it did not occur demonstrates that the size of each individual feed may not be as critical in causing refeeding diarrhoea as was previously thought.

Vomiting was also uncommon among patients because small volumes of volumes of isosmotic feed (F100) was given at an average of 4 times over 7 hours and bacterial over growth was treated with the use of broad-spectrum antibiotics. Golden and Ramdath,1987 have observed that this is normally the case when these procedures are followed

Hypothermia was present among the patients during recovery. Between 20-35% of patients had at least one recorded episode of hypothermia. This could have been due to the fact that patients were not fed in the night and the restricted periods of feeding and the open nature of the accommodation could account for this. Nevertheless, it does not seem to have been associated with excess mortality. In other studies hypothermia is frequently seen in the moribund patient who is about to die, and is a common accompaniment of septic shock, hypoglycaemia, and overwhelming or serious infection, and has serious prognostic implications. This does not seem to have been the case in Tubmanburg.

Fever rates during recovery was also low. Over 80% of patients in all categories had no fever during recovery despite the fact that they were in a malaria hyperendemic area.

Dehydration was also not a problem among patients. The few cases of dehydration was effectively treated with ReSoMal.

Chest infections was rather common over 50% had chest infections for one or more days.

The very high rates of weight gain could in part be explained by the low rates of infection and the effective manner infection was controlled among patients.
Roland et al, 1977 have illustrated quantitatively the role of infection in controlling the nutritional status of children in a Gambian village. There is a strong relationship between gastroenteritis(defined as diarrhoea illness) and growth faltering. Diarrhoea was found to be more strongly related to gain in length than weight. Vomiting which curtails the dietary intake of nutrients and the additional loss of nutrients from the gut that could occur through diarrhoea were not problem among the patients. Malaria is also significantly related to growth faltering and malaria was not a common problem. The treatment protocols were effectively applied and infection was controlled among the patients.

4.5 Mortality rate

Out of 918 patients treated only 16 died (CFR, 1.7%). The most vulnerable were the less than 6 month old infants (CFR, 5.7%) and the adults had a case fatality rate of 2.5%. Both these categories of patient are normally ignored in relief efforts and protocols. The infants because they are supposed to be fully breast fed and therefor “protected” from malnutrition and the adults because they are meant to be able to “fend for themselves”. And yet it was these groups that have the highest case fatality rates.

The mortality rate among all categories of patients was significantly lower than expected (tables 21 and 22). Collins et al, 1998, detected case fatality rates of 37% for oedematous malnutrition and 20% for marasmus or mild oedema when they compared two diets with different protein contents in a therapeutic feeding centre in Baidoa in

Somalia during the 1992 famine. Among oedematous patient the reduction in protein intake was associated with a three fold decrease in mortality ($p<0.05$) and accelerated resolution of oedema ($p< 0.05$) – this is in accord with the regimen used in Tubmanburg. In Bangladesh at a children's Nutrition Unit, Dhaka, Schofield and Ashworth, 1996 reported that case fatality dropped from 20% to 5% over a four year period. The reduction in mortality was ascribed to modification in case management, routine prescribing of broad -spectrum antibiotics, transfusion of packed cells for severe anaemia, withholding iron supplements in the first week of treatment, avoiding intravenous rehydration when ever possible, cautious refeeding, use of a low sodium diet and daily monitoring of signs of fluid over-load.

Results from Tubmanburg indicate that with improved case- management case fatality rates of less than 5% can be attained even in less crisis situations like in Tubmanburg. The dietary treatment protocols used in Tubmanburg had all these characteristics, and even without night feeding case fatality rates of 0.8-5.7 was attained among all categories of patients (table 22). Schofield and Ashworth, 1996; Brewster and Manary 1995, have all recommended appropriate treatment protocols as a way of reducing case fatality of severe malnutrition. Schofield and Ashworth, 1996 went further to recommend that these updated treatment regimes/ protocols should be prescriptive rather than descriptive, and these were exactly the characteristics of the treatment protocols approved by ACF, Paris and used in Tubmanburg. ReSoMal, an improved rehydration solution recommended by WHO,1999 was also used and this could have averted more death and contributed to the low case fatality.

CONCLUSION

The management of the crisis in Tubmanburg was clearly successful. Despite a small staff suddenly having to deal with a massive case load when the local staff were previously untrained, in an insecure situation, during restricted daylight hours, low rates of mortality and high rates of weight gain were achieved. It is not clear if this was mainly due to the particular nature of the patients in Tubmanburg. Nevertheless, without application of modern concepts of management, it is likely that the mortality rate would have been much higher, the rate of recovery lower and the stay in the center prolonged. What aspects of these very restricted and simplified treatment protocols contributed to the success must await further studies in other crises.

The present study also demonstrates what can be achieved, in terms of data collection, even under the most intense pressure and shortage of staff. It also demonstrates the value of such data collection and the need for detailed analysis and appraisal of the operation after the even. It is only through such "research" that we will continue to improve our responses to such tragic and harrowing realities of modern warfare.

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Original Protocol

NUTRITIONAL STATUS AND SURVIVAL IN THE SIEGE OF TURMANBURG-LIBERIA

INVESTIGATORS:

Kareem Daari (MSc Student-International Nutrition)

Supervisor: Professor Michael Golden (Dept. of Medicine and Therapeutics, University of Aberdeen)

Introduction

The major problems faced by people displaced by complex emergencies are insecurity and malnutrition. Here health workers were confronted with managing large numbers of severely malnourished people in highly insecure conditions.
Recommendations for the management of severe malnutrition are clearly spelt out (Golden, 1996; WHO,1999). The extent, to which these recommendations can be carried out, given the logistic, security and personnel constraints, as well as the initial state of the patients, determines the outcome of patients presenting to therapeutic feeding centres with severe malnutrition.

Background

In December 1989, civil war broke out in Liberia: involving 5 main factions: Charles Taylor's NPFL, Roosevelt John's ULIMO-J, Alhaji Kroma's ULIMO-K, Georges Boley's LPC and General Bowen's AFL.In August 1996, after several years of violent fighting, a cease-fire was signed between the warring factions in Abuja, Nigeria.

During the transitional period, soldiers (ECOMOG force), were sent by the Economic Community of West African States (ECOWAS) to monitor (actually enforce) the peace process and progressively take control of the entire territory pending return to civilian rule by May 1997.

In September 1996, a town, Tubmanburg (located 50 km North of Monrovia, the capital), Bomi county, which had been totally besieged for over 4 months by the fighting forces was relieved by Ecomog forces (Nabeth P et al, 1997). Initially, an assessment was conducted by a joint UN-NGO team in Tubmanburg. The assessment team found very large numbers of severely malnourished children, adolescents and adults – with an initial assessment of over 1000 severely malnourished people in urgent need of care. Three therapeutic feeding centres were immediately established, two by Action Contre la Faim and one by Medcines Sans Frontiere.

An epidemiological assessment by Dr Pierre Nabeth about 3 weeks after the start of the relief operation by ACF, between October 4 and October 10, 1996 of Tubmanburg (population size 22,338 mostly made of displaced refugees), according to Nabeth and Michelet, 1996, indicate that out of 4160 people who died in the previous 4 months, 1916 were under 5 years. The main cause of death was malnutrition. The severe malnutrition prevalence was 32.0 % and the proportion admitted in nutrition facilities was 42.1%. Professor Michael Golden visited Tubmanburg from the 12 – 18th October 1996, and found out that a reported outbreak of epidemic beriberi by Nabeth was rather epidemic oedema due to kwashiorkor

The security situation was particularly hazardous. The relief teams could only work in Tubmanburg from about 10 am until 4 p.m. .The residents of the TFCs could not therefore be fed at night. Given these circumstances, where very large numbers of patients had to be managed under conditions of extreme insecurity, it was observed that there were remarkably few deaths in comparison to patients treated in other parts of Africa, and the rate and extent of recovery were excellent. It is the objective of this project to examine the records of these patients in detail and to compare the outcome of the patients from Tubmanburg with those from other centres in Liberia and West Africa where much better facilities existed.

The clinical records of over 600 patients treated in ACF's therapeutic feeding centres after ECOMOG relieved the siege of Tubmanburg were transported back from Liberia to Aberdeen by the staff of ACF in Liberia and Paris.

Hypothesis: The mortality rate was significantly lower and the rates of recovery comparable to other centres, which were able to provide 24h care in a more secure environment.

Study Design:

A retrospective case study of patients who were treated at therapeutic feeding centres at Tubmanburg using clinical records.

Measurements

The main measures would include age, sex, date of admission and discharge, outcome (discharged, transferred, died, abandoned etc.), number days of diarrhoea on admission, number of days of vomiting, body temperature measurements (< =35.5-hypothermia,>= 39-fever), number of days of dehydration, number of days of rapid respiratory rate, number of days with pallor, days in phase one, days in phase two, care practices (IV fluids given, Use of NG tube, diets used e.g. F75, F100, porridge, breastfeeding etc.), oedema, MUAC on admission and discharge, daily weight until discharge and height (on admission and discharge).

Statistical Analysis

Statistical analysis would be done using RS1 and SPSS for windows to determine the rate of recovery and the clinical course of patients, and compared to the time frame for the management of a child with severe malnutrition and recommendations for management of severe malnutrition (WHO, 1999)

Data Handling and Storage:

Data were collected on Action Internationale Contre la Faim (AICF) treatment cards for therapeutic feeding centres by health personnel and stored later at the Department of Medicine and Therapeutics, University of Aberdeen by Professor Michael Golden.

Problems

Due to the very low staff-patient ratio and the exigencies of the emergency there are incomplete records and missing data, There is no possibility of correcting for these missing data.

Use of Results

Result of this research would be used to improve future management of severely malnourished people under similar circumstances.

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Appendix 1

Report4 of AKF Meeting
Comit6 Scienfif que Consultatif **de Nutrition**

A mineral/vitamin pre-mix to be added to cereal/pulse based diets for supplementary feeding programmes given to mild/moderately undernourished populations

	Unit	*Desirable Nutrient Density*	*Safe Upper Density Limit*	*Lower Threshold Density*	***Final** Mineral Pre-mix*
Minerals: all values are per 10Okcal					
K	mmol	**4.8**	7.2	1.85	**4.0**
	mg	**190**	280	74	**160**
Na	mmol	**2.6**	5.1	1.15	**2.6**
	mg	**60**	120	26	**60**
Mg	mmol	**1.2**	4.1	0.4	**0.8**
	mg	***30***	**100**	**10**	**20**
Ca	mmol	**2.1**	3.0	0.7	**2**
	mg	**84**	120	28	**80**
p	**mmol**	**2.2**	3.3	0.7	***1.5***
	mg	**70**	**100**	21	**45**
Fe	PM01	**18**	18	8.7	11
	mg	1	1.0	0.5	**0.6**
Zn	PM01	**14**	16	5.9	11
	mg	**0.9**	**1.0**	0.4	**0.7**
Cu	**PM01**	**L5**	5.3	0.44	**0.7**
	pg	**95**	340	28	***50***
Se	nmol	***45***	190	23	**60**
	pg	**3.6**	15	1.85	***5.0***
1	nmol	**70**	265	36	110
	pg	**9.0**	34	4.6	***15***
Mn	Pmol	***0.3***			**0**
Cr	nmol	**2.0**			**1**
MO	ranol	***5.0***			3
F	Pmol	<1			0.3
Vitamins and essential fatty acids: all values are per lOokcal					
Water-soluble vitamins					
Thiamine	pg	**70**	17.000	23	**70**
Riboflavine	"g	110	00	43	**200**
Pyridoxine	pg	**75**	1800	40	**90**
Niacin	"g	1000	17000	440	***1300***
Vitamin B 2	ng	100	7000	33	**200**
Folic acid	pg	25	180	5.4	**40**
Vitamin C	mg	4.5	35	0.78	**8.0**
Biotin	big	5	v. high	=0.2	10
Pantothenic acid	*mg*	0.6	v. high	=0.7	1.0
Fat-soluble vitamins					

Vitamin A	Pg	60	100	20	**80**
Vitamin D	pg	1.0	2.4	0	1.0
Vitamin E	mg	2.4	>100	=0.2	**4.0**
Vitamin K	99	3.6	high	?	**4.0**
Essential fatty acids					
n-6 (Iinoleic acid)	kcal	4.5	*15*	1.0	
n-3 (ot-linolenic acid)	kcal	0.5	5	0.2	
Total lipid	kcal	25-55	?	16	

*The essential fatty acids should be provided by the basic ingredients of the food. Where the cereal and pulse do not provide this amount then an appropriate vegetable should oil should be included in the recipe.
The Desirable Nutrient Density is for the supplementary food. The Safe Upper Density Limit and Lower Threshold Density are for the whole diet - this may be the supplement alone or a mixture of the supplement and unknown amounts of other foods of unknown composition: the mineralIvitamin pre-mix is the amount to be added to a cereal/pulse diet to achieve the Desirable Nutrient Density in the supplementary food taking the composition of the cereal and pulse into consideration.

appendix 2

THERAPEUTIC FEEDING CENTER / TUBMANBURG
ACTION CONTRE LA FAIM

CRITERIA OF ADMISSION

CHILDREN

< 5 YEARS OR < 11O cm	> 5 YEARS OR > 11O cm
Red bracelet	blue bracelet
MUAC < 11 cm AND/OR Weight/Height < 70% of the median AND/OR OEDEMA (2+) (3+)	Weight/Height < 70% of the median AND/OR OEDEMA (2+) (3+)

ADULTS Green bracelet
MARASMUS OR OEDEMA (2+) (3+)

LACTATING MOTHER
MOTHER WITH MALNOURISHED BABY LESS THAN 4 MONTHS

SFC CRITERIA Green bracelet

brother or sister of severe malnourished child with SFC criteria

THERAPEUTIC FEEDING CENTER / TUBMANBURG
ACTION CONTRE LA FAIM

CRITERIA OF DISCHARGE

1. CURED :

A / DISCHARGED TO THE SFC :

CHILDREN	
< 5 YEARS OR < 11O cm	> 5 YEARS OR > 11O cm
MUAC > 11 cm AND Weight/Height > 80% of the median (after 3 weights) AND NO OEDEMA for 15 DAYS	Weight/Height > 80% of the median (after 3 weights) AND NO OEDEMA for 15 DAYS

LACTATING MOTHER
MOTHER WITH BABY LESS THAN 4 MONTHS

B / DISCHARGED TO THE KITCHEN / HOPE :

ADULTS
NO OEDEMA for 15 DAYS

2. DEFAULTER :

A DEFAULTER IS AN ABSENT WHO HAS NOT ATTENDED THE TFC FOR 4 CONSECUTUVE DAYS. IF HE COMES BACK AFTER 5 DAYS, HE HAS TO BE READMITTED AS A NEW ADMISSION, WITH A NEW NUMBER.

3. EXPIRED :

YOU HAVE TO KNOW THE CAUSE OF THE DEATH.

4. TRANSFERED :

THESE WHO ARE TRANSFERRED TO MONROVIA.

Appendix 3

ACTION CONTRE LA FAIM / 9-27-1996

THERAPEUTIC FEEDING CENTER / TUBMANBURG

PHASE 1	
< 5 YEARS **red bracelet**	**> 5 YEARS** **blue bracelet**
THERAPEUTIC MILK = 200 ML	**THERAPEUTIC MILK = 400 ML**
8:30 AM - 10:30 AM **12:30 AM - 14:30 PM**	**8:30 AM - 10:30 AM** **12:30 AM - 14:30 PM**

PHASE 2	
< 5 YEARS **red bracelet**	**> 5 YEARS** **blue bracelet**
THERAPEUTIC MILK = 400 ML	**THERAPEUTIC MILK = 600 ML**
8:30 AM - 10:30 AM **12:30 AM - 14:30 PM**	**8:30 AM - 10:30 AM** **12:30 AM - 14:30 PM**
PORRIDGE TH450	**PORRIDGE TH450**
12:30 AM	**12:30 AM**

+ BP5 FOR THE NIGHT

ACTION CONTRE LA FAIM / 10-2-1996

THERAPEUTIC FEEDING CENTER / TUBMANBURG

ADULTS **green bracelet**

PHASE 1	PHASE 2
THERAPEUTIC MILK = 400 ML	THERAPEUTIC MILK = 400 ML
8:30 AM - 10:30 AM 12:30 AM - 14:30 PM	8:30 AM - 10:30 AM 12:30 AM - 14:30 PM
	PORRIDGE CSB 10:30 AM - 14:30 AM
	BP5 / NIGHT

ACTION CONTRE LA FAIM / 9-27-1996

THERAPEUTIC FEEDING CENTER / TUBMANBURG

LACTATING MOTHER	CARETAKER (+ green bracelet)
PORRIDGE CSB 10:30 AM - 14:30 AM	PORRIDGE CSB 10:30 AM - 14:30 AM
BP5 / NIGHT	

ACTION CONTRE LA FAIM / 9-27-1996

appendix 4

PROTOCOLS OF TREATMENT TO BE FOLLOWED IN THE TFC

THERAPEUTIC FEEDING CENTRES / TFC

AT the ADMISSION

If it is possible : at admission, the first thing is to give something to drink to the children when they are waiting for the examination by the nurse and the proper treatment :

- ReSoMal 5 ml/ kg / hour
for children without oedema.
or
- Water with sugar : 5 ml / kg / hour (100 ml for 5 gr. of sugar)
for children with oedema.

Why ?

The severely malnourished children very often have hypoglycaemia or are dehydrated.

But we have to be careful with children with oedema : the salt in the ReSoMal can
increase his oedema if he has not a history of diarrhoea !

1. By the registration team :

First, select the very sick children (severe dehydration, diarrhoea, vomiting,) in the waiting room and take care of them as a priority .

After : * take the weight, height, muac, oedema and calculate % W/H.
* compare it to the admission criteria for TFC :
- W/H < 70 % of the median,
- and/or < 6 months don't take the muac, ≥ 6 months < 11 cm,
- and/or oedema,
- Adults or children less than 4 months.
* admit them or refer them to the SFC: cards, register, identification bracelet....
* give some information to the mother about the organisation of the TFC.
* don't forget to ask the mother whether it is an old admission (a child who was healed and who lose weight after because of a bad follow-up after the discharge).

2. By the medical team :

First, the PA (or Medical Assistant) has :
* to make a complete medical exam of the children (see the clinical guideline),
* to ask the mother about the history of the child, specially about diarrhoea.
* to read the TFC chart,

After : * make the diagnosis,
* write the medical prescription if necessary,
* write the nutritional prescription : « **therapeutic milk »** = write the quantity of milk (by day and by meal) on the nutritional chart.

Remember that the 4 first actions to do at the admission for severe malnourished children are :

- Rehydration,
- Keep warm,
- Nutritional treatment,
- Medical treatment.

Of course, if it is an emergency, you have to refer them to Monrovia.
(Don't keep them more than 3 days before the transfer, if you think it isn't possible for you to care for them). Use the reference form.

3. Treatment:

3.1. If the children are very dehydrated
(diagnosed by the PA (or the Medical Assistant)

*** INTENSIVE CARE :**
follow the protocol of **« dehydration treatment »,** with the ReSoMal for severe malnourished (or ORS SM) and follow the evolution with the dehydration sheet (Intensive care sheet).

3.2. If the children are not dehydrated :

*** PREVENTIVE CARE :**
(No for the small baby like less than 3 Kg and/or less than 4 months).

- ReSoMal (for severe malnourished) : 5 ml/Kg/hour

For the children without oedema, until the first meal of « therapeutic milk »

DON'T GIVE TO THE CHILDREN WITH OEDEMA and WITHOUT HISTORY OF DIARRHOEA

- Water with sugar : 5 ml/Kg/hour.
(100 ml of water + 5 g of sugar)

This is to avoid hypoglycaemia.

For the children with oedema, until the first meal of « therapeutic milk »

When it is the time for the meal and if the children seem to be all right :
Start to give them « **therapeutic milk »** (see the protocol phase 1).

Appendix 5

THERAPEUTIC FEEDING CENTER / TUBMANBURG
ACTION CONTRE LA FAIM / 9-24-1996.

ADMISSION

SEVERE DEHYDRATION	MARASME	OEDEMA
ReSoMal (See the protocol)	ReSoMal	GLUCOSE

PHASE 1

BABIES	< 5 YEARS	> 5 YEARS	ADULTS
THERAPEUTIC MILK + GLUCOSE (See the protocol)	THERAPEUTIC MILK	THERAPEUTIC MILK	THERAPEUTIC MILK
3O ML / FEEDING 4 TIMES / DAY	200 ML / FEEDING 4 TIMES / DAY	400 ML / FEEDING 4 TIMES / DAY	400 ML / FEEDING 4 TIMES / DAY

PHASE 2

BABIES	< 5 YEARS	> 5 YEARS	ADULTS
THERAPEUTIC MILK + GLUCOSE (See the protocol)	THERAPEUTIC MILK	THERAPEUTIC MILK	THERAPEUTIC MILK
Improve the quantity to 60 ML / FEEDING (Try to give the THERAPEUTIC MILK)	400 ML / FEEDING 4 TIMES / DAY	600 ML / FEEDING 4 TIMES / DAY	400 ML / FEEDING 4 TIMES / DAY
	PORRIDGE = TH450 1 TIME / DAY	PORRIDGE = TH450 1 TIME / DAY	PORRIDGE = CSB 2 TIMES / DAY
	+ 1 BP5 FOR THE NIGHT		

LACTATING MOTHER
PORRIDGE = 2 TIMES / DAY + ORS (OMS) + BP5

CARE TAKERS (+) Green bracelet
PORRIDGE = 2 TIMES / DAY
+ 1 BP5 FOR THE NIGHT

LACTATING MOTHER
PORRIDGE = 2 TIMES / DAY + ORS (OMS) + BP5

CARE TAKERS (+) Green bracelet
PORRIDGE = 2 TIMES / DAY