EFFECT OF A LOW COST FEED ON RECOVERY AND DEATH RATE IN MALNOURISHED CHILDREN

Nutritional Rehabilitation in Africa is frequently based on provided skimmed milk, enriched with sugar and salt mixture : in several units traditional foods are tried to support nutritional rehabilitation. In a Nutritional Unit in Northern Uganda we prepared a thick cereal based porridge, with added proteins and fats using cheap local ingredients (maize flours, dried fish or meat, peanut butter and oil) providing 8,3 J/g. In a cohort study we compared 96 severely malnourished children rehabilitated with the powdered milk with 100 children fed twice/daily with a locally prepared nutritional porridge in addition to UNICEF milk.
After the introduction of the porridge oedema-free average daily weight gain went from 21 grams/day (C.I. 12-29) before NUTRICAM to 35 g/day (C.I. 25-45) in 2002 up to 59 g/day (51-65) in 2003 after more than one year of nutritional supplement. Mortality dropped from 22% to 7.8%, nutritional failures decreased more than 50%.
The cost to provide the milk by UNICEF is about 32370 Euro/year for 100 children/day, while the cost of this Nutritional Porridge is about 2640 Euro/year (8% of the milk).
A persistent nutritional education program was at the same time directed to all the mothers of malnourished children.

INTRODUCTION

International Agencies stimulated the development of nutritional rehabilitation centres in many developing countries in the global attempt to reduce malnutrition-associated fatalities. International agencies provide powdered milk for the treatment of the early phase (F75) and maintenance phase (F100) of malnutrition. In addition to the milk supplementary feeding has been encouraged to cure malnutrition on the long run (1). Nevertheless the efficacy of cereal-and-legume-based supplementary feeding in large-scale programs has not been conclusively demonstrated (2-4): many nutritional rehabilitation units just distribute milk.

Ready-To-Use Food (RTUF), in the form of a fortified spread, has recently been showed to be effective for the cure of malnourished children (5), but again this imported and industrially prepared spread is expensive and does not meet with the cultural attitudes, which are at the base of infantile malnutrition. (6). Locally produced RTUF is as effective at 1/3rd the cost (7) but again a spread is not a culturally acceptable food for most local cultures.

At St Mary's Hospital, Lacor, Acioli region, north of Uganda, child malnutrition is the first cause of fatality, but it also underlies a significant proportion of the fatalities due to common infections (8). About 100 severely malnourished children are attended daily in the Nutritional Unit, admitted according to WHO criteria (9).
A nutritional rehabilitation intervention based on the modified (skimmed milk with added sugar, oil and electrolytes) cow's milk F75 (starter) and F100 (follow up) is supplied by UNICEF.
From the frequent observation of diarrhoea and growth failure following milk ingestion, we suspected that some malnourished children could not fully absorb the energy provided by the milk.

The fatality rate observed at Lacor in the malnourished group, above 20%, is not at all unusual in developing countries, but it is 3 to 4 times higher of that expected after nutritional rehabilitation in similar units in Africa (9).

The analysis of the individual weight growth curves (Figure 1), from cases admitted in the months of June and July 2002, before this intervention, did not show in most cases the expected catch up growth, after the nutritional rehabilitation based upon milk only. Finally a significant proportion (>10%) of mothers 'escaped', often because of discouraging results.
According to WHO recommendations, we proposed to introduce a supplementary feed, added to the milk, for the following reasons:

- Results of the nutritional rehabilitation with the milk only are discouraging
- The lactose and sugar of the milk might facilitate diarrhoea, malabsorption and fatality

- The milk is not available outside the hospital: many children do relapse, because they are poorly fed when the milk is interrupted out of the hospital
- Milk feeds are not available and not traditional to the Acioli children
- Mothers have to learn how to cook for their children if we aim to prevent relapse

POPULATION AND METHODS

CASES AND OUTCOME VARIABLES

Children were admitted to the Nutritional Unit according to the WHO criteria:
Age 6 months to 6 years, affected by severe malnutrition, with a weight 75% below that expected for height, or peripheral oedema scored 1 to 4 +. A third group shows both conditions (underweight and oedema).
Children were discharged as 'cured' when the threshold of 80% weight for length and no oedema was reached.
The study design was a cohort study: cohorts of children admitted before and after the intervention were studied. The sample size of each cohort was estimated according to : population prevalence of nutritional failures = 20% , we expected that the prevalence in the study group should be lower, the minimal difference to be evaluated was 20% before-after the intervention, the power of the study is set 95% , the first degree error = 0,05. 78 cases were required for each group, we decided to study one hundred, to account for missing data.
To evaluate the mean daily weight increments before and after the Nutricam intervention and to control for seasonal effects, we randomly sampled the files of 100 cases dismissed in the months of October, November and December in the years 2001 (before the intervention), 2002 (soon after the intervention), 2003 (more than one year after the intervention). For each group of children we computed the average length of stay in the unit and the average weight gain reached at discharge. To get the oedema-free weight gain we have computed for all cases with oedema > 1+, the increment between the lowest weight reached in the unit (nadir of the weight curve) and the weight at discharge. Means and 95% Confidence Intervals were computed. Differences between means were evaluated by the Student *t* test, after controlling for normality of distribution and homoscedasticity.
The main outcome variable was the oedema-free daily weight gain of children before and after the intervention. Additional outcome variables were obtained for the period January 2002 to December 2004 (3 years) by routine hospital statistics:

- % Of cases 'cured' /total admissions for each month
- % Of cases dead/ total admissions for each month
- % Of cases lost or escaped / total admissions for each month

Where 'cured' means dismissed after the 80% weight-for-length and no oedema was reached
'Lost or escape': children who where taken off the hospital by the family.

BASELINE NUTRITIONAL PROCEDURES

Admitted children were fed the F75 (75 Cal/100 ml, 314 J) starter milk for the early phase of nutritional rehabilitation in the amount of 100 ml/kg of body weight administered every 2-3 hours (except at night) followed by the F100 (100 Cal/100 ml, 418 J) formula 100 ml/kg body weight for the catch up phase. This formula contained a complete micronutrient mixture. Composition is on ref. 9, appendix 3. They were supplied according to the WHO recommendations: night feeds were not distributed due to security problems.

NEW NUTRITIONAL INTERVENTION

By locally available ingredients, a thick semi-solid porridge was prepared, with a cereal flour base as carbohydrates (in a week: corn 4 times, rice 2 times, millet 1 time), proteins (in a week: local dry fish 4 times, chicken 1 time, cow's meat 1 time, beans 1 time) and fats (every day: peanut butter and vegetable oil). The porridge was named NUTRICAM, in Acioli language 'nutritional feed'. 160 Calories (665 J) and 6,3 grams of proteins are provided by a serving of 150 grams of NUTRICAM, made by 20 grams of flour (65 Cal, 274 J), 10 grams fish or meat or dry legumes (20 Cal, 84 J), 5 grams of peanut butter (30 Cal, 122 J) and 5 grams of oil (45 Cal,185 J). On average100 child/day/servings of 150 grams are prepared each morning and 100 each afternoon. Each child was offered twice daily the NUTRICAM serving of 150 grams in addition to the scheduled amount of milk, which was not discontinued. Administration of feeds was under surveillance in a purposely-built feeding hut, but we could not measure exactly the amount of food ingested: the vast majority of children consumed the whole feed over the first or second hour after the distribution.
The monthly cost to prepare NUTRICAM for the whole unit (ingredients, fuel, salary of the cook) is 220 Euros.

RESULTS

The two daily servings of NUTRICAM were well accepted. No adverse reactions were observed. During the first 20 days of intervention oedematous children lost on average 32 grams/day till disappearance of oedema; underweight cases showed catch up of + 36 grams/day.

WEIGTH INCREMENTS

Fig. 2 shows the mean duration of stay at the unit and the mean daily oedema-free weight gain. Days in care did not changed over the years, while mean weight increments, over the full length of treatment, went from 496 grams in 2001 (C.I. 306-587), before NUTRICAM, to 798 grams in 2002 (C.I. 584-1011); in 2003, after more than one year, increments reached 1310 grams (C.I. 1129-1491) for the same duration in care (no significant difference among the years 2002 to 2003). Oedema-free average daily weight gain went from 21 grams/day (C.I. 12-29) before NUTRICAM to 35 g/day (C.I. 25-45) in 2002 up to 59 g/day (51-65) in 2003 after more than one year of nutritional supplement. Mean weight increments in 2003 were significantly higher than in 2002 ($p = 0.0001$ by the Student *t* test)

OUTCOME AND SURVIVAL

Fig. 3 shows the number and the trend of survival outcome as a percentage of cases admitted each month. The top regression line shows the % cases dismissed as 'cured' (above the 80% weight for length) moves from 36/66 (54,5%) in Jan 2002 to 97/104 (93,3%) in Aug 2004. The lower regression line shows the trends for % death and % escape summed up. Mortality and 'escape' rates are summed as 'overall failures' on the left scale: they move from 30/66 (45,5 %) in Jan 2002 to 7/104 (6,7%) in Aug 2004. Out of these we had a 14/66 (21,2%) fatality rate in Jan 2002 versus 3/104 (2,9%) in Aug 2004.

CONCLUSIONS

95,4% of African children has the genotype C/C-13910 of the lactase-phlorizin hydrolase gene defining adult-type hypolactasia (versus 14.5% of Finnish) (11). 91% of population of Sao Tome (West Africa) have lactose intolerance (12). Diarrhoea is one of the main causes of fatality in malnourished children: skimmed lactose rich milk with added sugar is not the best treatment for malnourished children with diarrhoea (13,14). International Agencies recommended the addition of supplementary feeding (9).

The NUTRICAM feed supplement is locally feasible at low cost (about 0,056 Euro/serving/child, including labour and fuel), very well accepted by the local dwellers, simple to prepare and very effective for the nutritional rehabilitation.
NUTRICAM does not contain lactose or other simple sugars (as sucrose), but it is made up by complex starches, animal as well as vegetable proteins, mono and poli unsatured fats. NUTRICAM is not intended to supply fully the daily energy requirements, but is well suited to be added to mother's milk and mixed with the other family foods. NUTRICAM is easily prepared at home with local ingredients. A twice daily session of nutritional education to mothers was given by an health educator: mothers were not discharged from the Nutritional Unit of Lacor if they had not participated to the preparation and cooking of NUTRICAM for at least 5 days.
Nutritional failures dropped more than 50% comparing the 7 months with milk only for nutritional rehabilitation with the period with NUTRICAM feed supplement added. We estimated from August 2002 to September 2004 454 children saved from nutritional failure , 216 less deaths and 238 less lost-to-treatment compared to the mean value from Jan to July 2002.
This intervention required no special project, no sponsors and a single man action at low cost (about 220 Euro/month for the entire action). Just the provision of powdered milk by international agencies costs more than ten times (2700 Euro/month, 32370 Euro/year for these same children).

This intervention has been took over by the local hospital management and exported to three districts in the region. About 3000 Euros were required to build the kitchen and purchase all the equipments locally in each new locations. This experience reinforces the nutritional recommendations by WHO and stimulates the extension of this experience in other nutritional units in the developing world.

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