European Journal of Clinical Nutrition (1993) **47**, 750–754

Conference

Treatment of severe child malnutrition in refugee camps*

On 4–5 May 1993 Médicins Sans Frontière, with Epicentre and the Institut National de la Santé et de la Recherche Médicale (INSERM Unit 290) hosted a meeting, in Paris, on the treatment of severe childhood malnutrition am ongst refugees. The meeting was convened because complicated treatment protocols for severe childhood malnutrition, which have been developed in metabolic wards of research units, need to be adapted for use in the conditions of refugee camps, such as those recently seen in Somalia, Angola and South Sudan. Here the 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. Simple protocols for treatment of severe malnutrition are required. They should be practical and, as far as possible, embody all the essential principles of the more complex regimes. Some issues discussed at this meeting are relevant to other settings.

Treatment of dehydration in severely malnourished children

The meeting expressed its concern regarding the use of WHO oral rehydration solution (ORS) for treating dehydration among severely malnourished children when close clinical supervision is not possible. The sodium content of the WHO ORS (90 mmol/l) is sufficiently high to induce heart failure in *severe* malnutrition, particularly the oedematous forms of malnutrition (Wharton, Howells & McCance, 1967). This sodium concentration was chosen to match the concentration of sodium occurring in severe watery diarrhoea including cholera (Hirschorn, 1980). However, the *concentration* of sodium in the stools of severely malnourished children is very much lower (Golden & Golden, 1985) and they already have a greatly increased total body sodium as part of their illness (Waterlow, 1992).

The potassium concentration of the WHO ORS (20 mmol/l) is too low to match the stool output in malnourished children who already, universally, have depleted body stores; the low total body potassium contributes significantly to their illness (Waterlow, 1992). Higher concentrations of potassium are needed to prevent hypokalaemia which is, itself, a further risk factor for heart failure.

Other minerals, which are deficient in severe malnutrition and probably contribute to both the malnutrition and the diarrhoea, are not present in WHO ORS. Thus, magnesium deficiency is common in malnourished children (Caddell & Goddard, 1967). Magnesium is essential for the retention of potassium and is usually lacking in refugees' rations (Michaelsen & Clausen, 1987). Zinc and copper deficiencies are common and may themselves contribute to the diarrhoea (Rodriguez *et al.*, 1985; Tomkins, 1991). Selenium deficiency is also common and likely to affect heart function (Golden, 1988).

Opinions regarding the optimal sodium concentration of ORS for severely malnourished children varied between 30 and 60 mmol/l. For practical purposes, however, the value of 45 mmol/l was chosen, since it can be obtained

* Participants: A. Briend (ORSTOM, INSERM U290, Epicentre, Paris), A. Moren, V. Brown (Epicentre, Paris), J.F. Desjeux, P. Pochart (INSERM U290, Paris), P. Biberson, B. Le Lin, V. Genaille, J. Rigal, F. Fermon (Medicins Sans Frontières, France), M. Bolaert (MSF, Belgique), K. Ritmeijer (MSF, Holland), Y. Grellety (Action Internationale Contre la Faim, Paris), O. Fontaine (WHO, Geneva), J.C. Waterlow (London School of Hygiene and Tropical Medicine), M.H.N. Golden (University of Aberdeen), A. Tomkins (Institute of Child Health, London), C.J.K. Henry (Brookes University, Oxford), J.P. Beau (ORSTOM, Dakar, Senegal), P. Goyens (Université Libre de Bruxelles), R. Albrecht, M.A. Pélissier (Conservatoire National des Arts et Métiers, Paris), J.C. Dillon (Institut National d'Agronomie, Paris–Grignon), D. Lemonnier (INSERM, Hôpital Bichat, Paris).

Table 1. Concentration of minerals for a mineral mix to add to diets and oral rehydration solutions used for treatment of severely malnourished children

Per litre of feed	
Potassium	30 mmol (1173 mg)
Magnesium	3 mmol (72.9 mg)
Zinc	300 μmol (19.5 mg)
Copper	45 μmol (2.9 mg)
Selenium	0.6 μmol (47 μg)
Iodine	0.6 μmol (76 μg)

easily, under field conditions, by diluting a WHO ORS packet into 2 litres of water instead of 1 litre. The participants agreed that the solution should have a mineral supplement added to give a final potassium concentration of 40 mmol/l, with magnesium, zinc, copper and selenium; these minerals can be added in the form of a second sachet (Tables 1, 2). 25 g/l of sucrose should also be added to the half-diluted WHO formula solution to prevent the risk of hypoglycaemia during rehydration and to make the solution isotonic. Thus, the meeting recommended that one WHO ORS sachet, two 'Mineral Mix' sachets and 50 g of sugar should be made up to 2 litres, for use in rehydrating severely malnourished children. It was stressed that WHO ORS is best suited to treat dehydration in the absence of severe malnutrition and in all cases with copious watery diarrhoea.

The participants emphasized the difficulty of assessing 'dehydration' in severely malnourished children, particularly those with oedema, and expressed the opinion that only those signs directly related to intra-vascular volume contraction should be used. Except in hypovolaemic shock, these children should only be rehydrated orally. ORS should be given slowly (120 ml/kg/d), without an initial large dose. Available clinically trained staff should monitor the respiratory rate to detect over-hydration.

The meeting highlighted our lack of knowledge of sodium metabolism in severely malnourished children who were also dehydrated. The meeting encouraged studies of children with diarrhoea in famine situations, including the measurement of stool electrolyte concentrations and the efficacy of the newly recommended formula. The meeting recognized that definitive studies, under the conditions pertaining in refugee camps, are, both practically and ethically, very difficult.

Milk formula for intensive feeding

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 & Golden, 1987). Nevertheless, for practical purposes of rehabilitation in refugee camps, the meeting agreed that a single formula should be recommended. Some participants, on the basis of clinical experience, felt that there was a risk in introducing feeds high in protein and energy at too early a stage, but there is no hard evidence of the extent of the risk. The meeting

Table 2. A mineral mix formula for use in diets for the treatment of severely malnourished children

Salt	*Mol. wt*	*Amount to add to 1000 ml of diet*	*Weight of salt to add to 1000 ml of diet*
Potassium chloride (KCl)	74.6	24 mmol	1789.2 mg
Tripotassium citrate (K_3 Citrate)[a]	324.4	2 mmol (6 mEq)	648.8 mg
Magnesium chloride ($MgCl_2{\cdot}6H_2O$)	203.3	3 mmol (6 mEq)	609.9 mg
Zinc acetate (Zn acetate$\cdot 2H_2O$)	219.5	300 μmol	65.8 mg
Copper sulphate ($CuSO_4{\cdot}7H_2O$)	249.7	45 μmol	11.2 mg
Sodium selenate ($NaSeO_4{\cdot}10H_2O$)[b]	369.1	0.6 μmol	0.221 mg
Potassium iodide (KI)[b]	166.0	0.6 μmol	0.100 mg

[a] The citrate salt of potassium is added in equivalent amounts to the magnesium chloride, because magnesium chloride causes acidosis in malnourished children (Golden, 1988).
[b] The selenium and iodine are less critical than the other elements. If there are no scales capable of weighing small amounts accurately and the technology to ensure that they are evenly dispersed throughout the mix then they should be omitted from the formula.

agreed that the standard formula of 80 g dried skimmed milk, 50 g sugar and 60 g oil per litre feed (Alleyne *et al.*, 1977) is a reasonable compromise in this respect and can be used for all phases of treatment. Its energy density (1 kcal/ml) is sufficient for rapid catch up growth. Weight gains of over 15 g/kg/d were reported from a nutritional rehabilitation unit in Senegal using a formula with a slightly lower energy density (Beau, 1992). The formula has to be fed to appetite. If the child does not take it well in the early stages of treatment, the feed may be diluted with a little water (about 3 formula: 1 water); the formula should be diluted in this way, if the child requires to be fed by naso-gastric tube. One should aim to give up to 120 ml/kg/d of the formula in the first few days of treatment and then very much more (200 ml/kg/d) once the child's appetite has returned.

Mineral and vitamin supplementation of milk formulae

The absolute requirement for supplementing the formula with potassium, magnesium, zinc, copper, selenium and iodine was stressed during the meeting. It was acknowledged that the optimum concentrations of these minerals will vary according to the underlying nutritional deficiencies which may give rise to geographical differences. Until further data are at hand the concentrations given in Table 1, derived from practice in Jamaica, were recommended. It was agreed that iron should not be added to this mineral supplement since there is evidence that additional iron, in the early stage of treatment of severe malnutrition, may increase mortality (Smith, Taiwo & Golden, 1989). Iron should be given during the rapid weight gain phase of treatment.

Sufficient vitamins to provide at least the Recommended Dietary Allowance for each vitamin should be added to the milk preparation. A vitamin mix should be added separately from the mineral supplements to avoid vitamin losses. The concentrations given in Table 3 were recommended.

The mineral and vitamin concentrations have been calculated to provide the quantities needed for rapid recovery of infants or children taking between 100 and 200 ml/kg/d of the feed.

Table 3. Concentration of vitamins for a vitamins mix to add to diets used in treatment of severely malnourished children

Per litre of feed	
Water soluble	
Thiamine	0.7 mg
Riboflavin	2.0 mg
Niacin	10 mg
Pyridoxine	0.7 mg
Cobalamin	1 μg
Folic acid	0.35 mg
Ascorbic acid	180 mg
Pantothenic acid	3 mg
Biotin	100 μg
Fat soluble	
Retinol	1.5 mg
Calciferol	30 μg
Tocopherol	22 mg
Vitamin K	40 μg

Need for multipurpose mineral sachets

In the absence of a pre-formulated diet for nutritional rehabilitation, addition of the various minerals to the milk formula, made up in the field, is only feasible if ready-made sachets (which can be diluted in standard quantities of milk) are available. It was recommended that this approach be tested under field conditions. The same mineral sachets would be used to add potassium, magnesium, zinc, copper and selenium to the diet within the therapeutic feeding units and also to the half-diluted WHO ORS. Field research is needed to determine which mineral salts are most stable and palatable when included in milk formulae or oral rehydration solutions. A typical formula for a mineral mix, derived from practice in Jamaica, which will give the recommended concentrations is given in Table 2. The quantities for 1 litre of feed can be scaled up if larger quantities of feed are being prepared; a concentrated stock solution can be made if sachets are not available.

The meeting emphasized that the mineral sachets and vitamin supplements should be limited to Therapeutic Feeding Units. They are not a substitute for the provision of adequate minerals and vitamins in the general food ration.

Use of yoghurt

The advantages of using yoghurt prepared from the milk formula were recognized. Yoghurt is bacteriologically safer than unfermented milk because it has a low pH and contains antibacterial products synthesized during fermentation. Yoghurt is better tolerated than unfermented milk by children with persistent diarrhoea (Boudraa *et al.*, 1990) who may have lactose intolerance. Yoghurt has been used with success in a pilot nutrition rehabilitation unit in Senegal for the past 10 years (Beau, 1992). The D-lactic acid that is produced during fermentation should not pose a metabolic problem except, perhaps, in infants below 3 months of age. Field studies are needed to measure D-lactic acid production during milk fermentation in tropical climates. Despite its undoubted advantages, yoghurt is infrequently used to treat severely malnourished children in refugee situations; thus, experience is limited. Observation of traditional techniques used in tropical countries to produce fermented milk should help us to develop the appropriate technology to produce safe yoghurt in refugee settings.

Treatment of infections among severely malnourished children

Nearly all malnourished children have infections and bacterial overgrowth of mucosal surfaces, which are difficult to diagnose clinically. Early treatment with antibiotics appropriately prescribed for defined clinical infections, has an important role in decreasing mortality and improving the nutritional response to feeding. However, in view of the scant inflammatory response which results in a lack of physical signs in the malnourished child, the lack of laboratory facilities and the level of training and workload of many of the front-line staff, some form of blind unselective antibiotic treatment is nearly always recommended in treatment regimes (Alleyne *et al.*, 1977; Jackson & Golden, 1987; Golden, 1988; Waterlow, 1992). This increases the cost and complexity of management and favours the emergence of antibiotic resistance. There is also the risk of toxicity with such drugs as gentamicin and metronidazole. The benefits of routine antibiotic treatment of malnourished children who have no clinical evidence of systemic infection (~30%) have not been demonstrated. The meeting agreed that a controlled trial could put future recommendations for this subgroup of children on a more secure footing.

Persistent diarrhoea, which frequently accompanies severe malnutrition, is difficult to treat; antibiotics do not consistently improve the condition, whereas intensive nutritional rehabilitation itself will frequently succeed.

Tuberculosis is common in severe malnutrition; frequently presenting as failure to grow while adequate nutrients are being supplied.

In certain countries, between 30% and 50% of malnourished children have HIV infection. This is bound to alter the epidemiology and outcome of severe malnutrition. The meeting agreed that children with HIV infection should be treated in the same way as those without HIV infection. If HIV testing is done at all (often a sensitive subject with the host country), it is best delayed until after nutritional rehabilitation.

André Briend,
INSERM U290,
107 rue du Faubourg Saint Denis,
75010 Paris, France

Michael H.N. Golden,
Department of Medicine and Therapeutics,
University of Aberdeen,
Foresterhill,
Aberdeen AB9 2ZD, U.K.

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Volume 47 • Number 10 • October 1993

European Journal of CLINICAL NUTRITION

Editor: J.S. Garrow