

## Invited Review

# Treatment of Severe Malnutrition

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More than 50% of deaths in children aged 0 to 4 years is associated with malnutrition, and high priority is therefore given to its prevention and treatment. Regrettably, hospital treatment of severely malnourished children is often poor and outmoded and consequently fatality rates are high. Data from 67 studies worldwide show that the median fatality rate has not changed for the past 5 decades, and one in four severely malnourished children died during treatment in the 1990s (1). In any decade, however, there are some centers that do very well, with fewer than 5% dying, whereas others do badly, with approximately 50% dying. This disparity in outcome is not a result of differences in severity. It is a result of treatment practices. Where mortality is low, a set of basic principles is followed. Where mortality is high, the treatment is inappropriate. To improve treatment and reduce mortality, the World Health Organization (WHO) published a manual (2) and guidelines for the management of severe malnutrition in first-referral facilities (3). These activities form part of the WHO/United Nations International Children's Emergency Fund (UNICEF) initiative of Integrated Management of Childhood Illness.

This article highlights the serious problem of mismanagement of severe malnutrition and explains why many children die during treatment. It also describes how changing treatment practices saves lives. The focus is on management in hospitals in less developed countries, but the principles apply anywhere.

This invited review is accompanied by two editorials. Please see Manary M. Protein-energy malnutrition: there is still work to do. *J Pediatr Gastroenterol Nutr* 2001;32:519–20, and Briend A. Management of severe malnutrition: efficacious or effective? *J Pediatr Gastroenterol Nutr* 2001;32:521–2.

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## REDUCTIVE ADAPTATION

One reason why severely malnourished children die is that no allowance is made when prescribing treatment for the profound physiologic and metabolic changes that have taken place in the child. In severe malnutrition there has been a process of reductive adaptation to conserve energy, which affects every organ, system, and cell. This includes reduction in functional capacity of the heart, kidneys, liver, and gut, which means that there is little margin for error. This is particularly important in relation to intravenous fluids because any excess can easily kill the child.

Many prescribe a high-protein diet for children with kwashiorkor, but this can be fatal because the liver and metabolic machinery may not be able to process large amounts of protein straightaway and can be overwhelmed. Many prescribe diuretics to get rid of edema, but this too can prove to be fatal. Edema is mainly caused by an electrolyte imbalance, and diuretics make the imbalance worse by increasing potassium losses. At the start of treatment, wasted or edematous children should be given just enough energy ( $418.6 \text{ kJ} \cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ , or  $100 \text{ kcal} \cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ ) and protein ( $1 \text{ g} \cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ ) to meet their basic needs. This is sufficient to halt the catabolic processes but avoids stress to vital organs and systems.

## THE DIARRHEA-MALNUTRITION-DIARRHEA CYCLE

Most children admitted to the hospital with severe malnutrition have a history of diarrhea. One consequence of diarrheal illness is reduced food intake. This is usually the result of poor appetite but caregivers may also withhold food during the illness or only give teas or other fluids, adversely affecting nutritional status. Other consequences of diarrheal illness are reduced absorption of nutrients and increased endogenous losses, especially of protein, potassium, magnesium, and zinc. In addition, as for any illness, there is increased utilization of nutrients that are needed for an immune response. As a result, nutrient deficits usually accompany diarrheal illness, and these make malnourished children susceptible to more severe and longer lasting attacks. Children who are severely malnourished are likely to have accumulated substantial nutrient deficits by the time they arrive at the hospital because of recurrent or persistent episodes of diarrhea. It is therefore important to regard severe mal-

nutrition as a state of multideficiency and to provide extra potassium, magnesium, and micronutrients to correct deficiencies. In just a few days, the metabolic machinery will be in working order again, and then it will be safe to move ahead and promote rapid catch-up growth by feeding of high-energy, high-protein diets.

### CAUSES OF DEATH DURING TREATMENT

Severely malnourished children die in the hospital of four main causes: hypoglycemia, hypothermia, cardiac failure from overhydration and electrolyte imbalance, and infection (the infection often being missed completely or treatment being delayed). Centers with low mortality rates take steps to prevent these deaths. Centers with high mortality rates have practices that contribute to these deaths.

### INCREASED RISK OF HYPOGLYCEMIA

Severely malnourished children are at increased risk of hypoglycemia because their liver makes glucose less easily and their muscles have wasted so they have less glycogen in reserve. They often have multiple infections and the immune response requires glucose, so there are competing demands for a limited glucose supply.

Treatment practices contribute to hypoglycemia. Even if a mother sets off at sunrise and gets to the hospital early, she is usually kept waiting, and her malnourished child may not get to the ward until mid afternoon. Instead of being given priority in the queue, she may be asked to sit through a health education talk and wait another 2 to 3 hours to see the doctor. Then, she will probably be asked to take the child for radiography, even though this is not urgent, and then queue to register, and finally wait for an orderly to escort her to the ward. Such practices can lead to severely malnourished children being hypoglycemic by the time they arrive at the ward. The problem does not end there. The child may then have to wait until supper to be fed, and often there is no provision for children to be fed at night. They may go 12 hours or more without food. Also, adequate action is not taken for children who are anorexic.

To prevent death because of hypoglycemia, malnourished children need to be given priority in the queue and sent quickly to the ward. They need to be fed straightaway and then every 2 or 3 hours day and night, and anorexic children should be fed by nasogastric tube. Adult-oriented meals prepared by hospital kitchens are inappropriate for malnourished children. They need specially prepared diets.

### INCREASED RISK OF HYPOTHERMIA

Severely malnourished children also have an increased risk of hypothermia. Heat production is reduced because of their lower metabolic rate, and heat loss is increased because of the relatively larger body surface area per

kilogram and less insulation because of loss of fat. Infections increase the demand for glucose, and, if the glucose supply is limited, heat production will be affected. Frequent feeding helps prevent hypothermia.

Conditions in the wards may add to the risk because they may be draughty and cold. Children become chilled if left in wet clothes or if they are not dried carefully after bathing. Keeping malnourished children warm and dry, feeding frequently day and night, and treating infections straightaway help to prevent death as a result of hypoglycemia and hypothermia.

### INCREASED RISK OF CARDIAC FAILURE

The heart is smaller, thinner, and has a lower stroke volume if malnutrition is severe. The kidneys are also adversely affected and have difficulty excreting excess fluid and sodium. This means that the circulation becomes overloaded more easily than usual. In cells, the membranes become leaky because of oxidative damage. Also, to conserve energy, the number of Na-K pumps in the cell membrane is reduced and the remaining pumps work more slowly. This means that sodium accumulates inside cells and potassium leaks out, leading to electrolyte and fluid imbalances.

Treatment practices contribute to cardiac failure. Children are dying because they are given too much fluid. There are three main reasons. One is that dehydration is overestimated because the usual signs, such as slow skin pinch and dry mouth, are often present anyway in malnutrition even when there is no dehydration. Another reason is that fluids are given intravenously, increasing the risk of overload. Infusions are also left running for hours, which is very dangerous. Intravenous fluids should be given only to children in shock. The third reason is that children are not monitored carefully during rehydration, so no one realizes that a child is overloaded until it is too late.

Electrolyte imbalance contributes to cardiac failure, so sodium should be restricted and all malnourished children should be given extra potassium and magnesium. As mentioned previously, diuretics make potassium deficiency worse and should never be given to get rid of edema.

### MISSED INFECTION

Normal signs of infection are often absent in severely malnourished children. They may have no fever, no increased pulse or respiration, and no redness or swelling, and they may be too weak to breathe rapidly. Therefore, infections are easily missed or treatment is delayed. It should be presumed that all malnourished children have infections, even if there are no clinical signs, and they should be given broad-spectrum antibiotics without waiting for laboratory results.

Giving iron from the time of admission increases mortality. This is partly because malnourished children have less transferrin to bind the iron, and free iron promotes

the growth of some pathogens. Free iron also promotes oxidative damage to cell membranes. Therefore, provision of iron should be delayed for a few days.

Malnourished children are very vulnerable to cross-infection because their immune function is impaired; therefore, good ward hygiene is very important. Often children are crowded together, sharing cots, and there is no hand washing, either by doctors or nurses.

### IMPACT OF CHANGING TREATMENT PRACTICES

Substantial reductions in mortality rates have been achieved by modifying treatment to take account of the physiologic and metabolic changes that exist in severe malnutrition. Examples from three continents follow. At the International Centre for Diarrhoeal Disease Research in Bangladesh, no special treatment was given to severely malnourished children with diarrhea, and the fatality rate was 17%. When a standardized protocol, based on the WHO guidelines, was introduced, fatality rate decreased to 9% (4). The main changes were slower rehydration, avoidance of intravenous fluids if at all possible, giving antibiotics even when signs of infection were absent, immediate feeding, greater use of tube feeding for anorexic children, and giving potassium, magnesium, and micronutrients. Hypoglycemia developed in fewer children during their hospital stay (3% vs. 6%), and fewer children needed expensive administration of ceftriaxone (18% vs. 40%). Giving antibiotics immediately meant that fewer children had to be rescued using expensive drugs, and costs were lower.

In Hlabisa Hospital, KwaZulu Natal, South Africa, the mortality rate decreased from 30% to 20% when changes were first made, which included administration of antibiotics to all and provision of micronutrients. This modest reduction was disappointing, but when doctors and nurses discussed this and took steps to be more attentive and to monitor children more closely, the mortality rate decreased to 6% (5). At Holy Cross Hospital in Eastern Cape Province, South Africa, staff changed their treatment practices and now follow the WHO guidelines as much as possible given their resource constraints. Queuing times have been cut and malnourished children now reach the ward in a better state. Previously, intravenous drips permeated the ward, but hardly any are used now. Dietary management now begins with a stabilization phase, and potassium, magnesium, and vitamin supplements are given and iron is withheld initially. Fatality rates immediately decreased from 45% to 16%. In both hospitals human immunodeficiency virus (HIV) prevalence is estimated to be 30%.

Instituto de Prevenção à Desnutrição e à Excepcionalidade (IPREDE) is the main malnutrition center for the state of Ceara in northeast Brazil. Before implementing the WHO guidelines in 1995, staff found the work to be unrewarding because children continued to have diarrhea, poor appetites, and poor weight gain. After imple-

mentation of the guideline, these problems disappeared. Diarrhea and poor appetite were resolved by correcting potassium and micronutrient deficiencies and giving small feeding amounts of starter formula. The composition of the starter formula is 319 kJ (75 kcal) and 0.9 g protein/100 ml. In the catch-up phase, rates of weight gain were 5 times faster than before. Not only were the results good, but average food costs decreased from 2.5 Reals/(child · d) to 0.8 Reals, job satisfaction improved, and staff turnover decreased (6). The changes were not difficult to make. The whole process of problem assessment, training, and implementation took approximately 1 week. Helpful factors were that they had a qualified nutritionist and adequate staffing and facilities.

### ACHIEVING CHANGES TO TREATMENT

Knowledge, guidelines, and expertise about how to treat severely malnourished children have existed for at least 30 years. Emergency relief organizations successfully treat severe cases in the stark confines of a tent; therefore, hospitals should be able to perform equally well, if not better. If mismanagement is to be reversed, doctors and nurses must be taught the best practice during their training. Currently, most leave medical and nursing schools with little knowledge about correct treatment. In-service training is needed for those already qualified. The new manual and guidelines (2,3) and CD-ROM (7) explain what to do and why, but this information will need to reach staff in marginalized or remote areas. Hospital administrators need to be included in any training, so that they understand the need for special feeding, among other aspects, and can support the medical and nursing staff in implementing new procedures. The changes needed are not difficult, and many hospitals find them to be financially advantageous. Lives can easily be saved, and the dramatic and rapid transformations of severely malnourished children can be one of the great satisfactions of professional life.

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