Management of the severely malnourished child: perspective from developing countries

Maharaj K Bhan, Nita Bhandari, Rajiv Bahl

Careful assessment and appropriate treatment and rehabilitation using standard protocols that are easy to follow reduce morbidity and mortality

Department of Paediatrics, All India Institute of Medical Sciences, Ansari Nagar, New Delhi-110029, India
Maharaj K Bhan *professor*
Nita Bhandari *scientist*
Rajiv Bahl *scientist*
Correspondence to: M K Bhan community.research@cih.uib.no

BMJ 2003;326:146–51

In the 1990s, the number of underweight children in developing countries declined from 177 million to 149 million.[1] The incidence of severe malnutrition also declined but, despite this, severe malnutrition remains an important problem (fig 1).[2 3] In India, for example, 2.8% of children under 5 are severely wasted.[3] Malnutrition is a contributing factor in nearly 60% of deaths in children for which infectious disease is an underlying cause.[4] Malnutrition is also linked to an increased risk of death in children with diarrhoea and acute infections of the lower respiratory system and it may be linked to malaria—and possibly measles—too.[5]

Death rates caused by severe malnutrition have changed little over the past few decades in hospitals of developing countries (median 23.5% during the 1990s) because malnutrition was inappropriately managed.[6] Recent studies from Bangladesh and Brazil, however, have reported a substantial decline in case fatality after the adoption of new treatment protocols by hospitals.[7 8] This review describes the new treatment regimens that have been introduced and the evidence that justifies their use.[9]

Sources and selection criteria

We performed a Medline search for the past 10 years and a Cochrane database search; we also sourced publications of the World Health Organization that were related to malnutrition. The search string used was "malnutrition *or* protein energy malnutrition *not* obesity," and we identified 4818 references. We briefly reviewed references that were related to assessment,

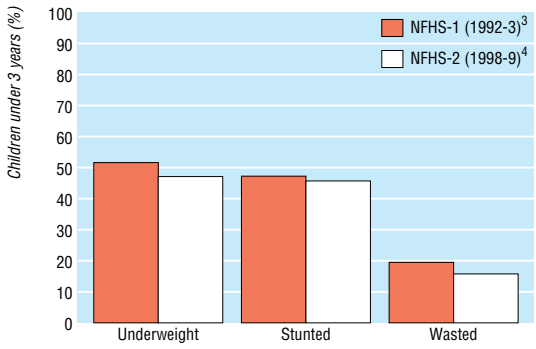


Fig 1 Percentage of undernourished children in India during the 1990s. NFHS=national family health survey

Summary points

- The high case fatality rates in children with severe malnutrition can be substantially reduced by adopting standardised treatment protocols
- Children with weight for height below 70% of the National Centre for Health Statistics median, bipedal oedema, or visible severe wasting should be hospitalised for initial stabilisation and preferably until full recovery
- In severely malnourished children with diarrhoea, intravenous fluids should be restricted to patients showing signs of shock; other severely malnourished children should be given an oral rehydration salts solution with a lower sodium concentration and a higher potassium concentration than the standard WHO rehydration salts solution
- Prevention and prompt treatment of hypoglycaemia and hypothermia reduce case fatality
- Severely malnourished children require supplements (up to twice the recommended daily allowance) of vitamins, potassium, magnesium, zinc, copper, selenium, and iodine. Iron should be given only after the child's appetite has returned
- During the initial week of treatment, only 330-420 kJ/kg energy and 1-1.5 g/kg protein should be given, to avoid metabolic stress
- During rehabilitation, intakes of energy and protein should be gradually increased to 630-920 kJ/kg/day and 4-5 g/kg/day, respectively, to achieve a weight gain of >10 g/kg/day until recovery

pathophysiology, and treatment of severe malnutrition in children to assess their relevance. We excluded references related to malnutrition in adults, secondary malnutrition, case series or case reports, and uncontrolled intervention trials. We reviewed the remaining 140 studies in detail.

Identification of children with severe malnutrition

An appropriate definition of severe malnutrition should enable the identification of children at high risk of death. In a study of 1202 children in a Kenyan hospital, bipedal oedema (indicating kwashiorkor) and two marasmus indicators—visible severe wasting and a weight for height z score of <-3 (more than three standard deviation units below the median of the international reference population) were associated with three to four times the risk of mortality.[10] WHO has recommended using these three criteria as the best way to identify children with severe malnutrition.[9]

A low cut off z score (<-4.4) for weight for age was not associated with an increased risk of mortality.[10] This may be because low weight for age is largely the result of low height in populations where stunting is prevalent and severe. Weight for height rather than weight for age is a better indicator of recent or ongoing weight loss or wasting.[11] Visible severe wasting may be used to identify severe malnutrition when height can not be measured[9]; it can be recognised by muscle wasting, especially in the gluteal region; loss of subcutaneous fat; and prominence of bony structures, particularly over the thorax.

In community based studies, mid-upper arm circumference was a good predictor of child mortality but the performance varied by age.[12] When a fixed cut off was used, wasting was overdiagnosed among younger children and underdiagnosed among older ones.[12]

Assessment of severely malnourished children

Clinical assessment of severely malnourished children is difficult, especially with respect to assessing how dehydrated they are. Dehydration is currently classified as "none," "some," and "severe."[9] In severely malnourished children, distinguishing between "some" dehydration and "severe" dehydration is difficult. Practically, dehydration is considered to be severe if the child shows signs of shock and lethargy or loss of consciousness; all other severely malnourished children with acute watery diarrhoea may be assumed to have "some" dehydration.[9 13]

Diagnosing severe infection is equally difficult because the usual signs—such as fever—are often absent. Severe infection is indicated if the child has hypothermia, hypoglycaemia, or lethargy, is unable to breastfeed, or looks sick. Recent intake of food and fluid and the degree of anorexia need to be assessed for planning feeding regimens. Blood glucose should be measured (by Dextrostix or biochemical analysis) routinely. If this is not possible, the children should be treated as if they have hypoglycaemia. If they have severe palmar pallor, haemoglobin or haematocrit estimation is indicated to assess the need for blood transfusion. A child with haemoglobin <4 g/dl or haemoglobin 4-6 g/dl with respiratory distress indicates the need for blood transfusion.[9]

Routine microscopic examination and culture of urine should be performed because urinary tract infections are common.[14] Chest radiograph and Mantoux test are indicated if the child has had contact with a person with tuberculosis, has poor growth despite good food intake, has a history of chronic cough (longer than 30 days), or has a chest infection that fails to respond to antibiotics. The results of the Mantoux test may be falsely negative in severe malnutrition. Samples of stomach fluids obtained by aspiration on three consecutive early mornings should be sent for microscopic examination. Stool examination for giardiasis is indicated if there is poor weight gain despite good food intake.

Management of severely malnourished children

Severely malnourished children should be managed in hospital during the acute and rehabilitation phases.[9] Shorter stays in hospital for initial stabilisation followed by domiciliary care may, however, be equally effective. In a study in Bangladesh, case fatality of severely malnourished children treated in hospital till they recovered and of children rehabilitated through day care or at home after a week of hospitalisation was similar ($<5\%$).[15] The latter approach was less costly, but the results were obtained in a carefully selected group and therefore may not represent the wider population. Home based regimens may result in only partial recovery.[16]

All severely malnourished children should ideally receive initial treatment in treatment centres and once they gain weight, they should be selected for early discharge according to carefully defined criteria.

General principles of treatment

Treatment involves stabilisation for the first seven days and rehabilitation over the following five weeks (fig 2).[9] Severe malnutrition leads to profound metabolic and physiological changes and reduces the functional capacity of the heart, liver, kidneys, and gastrointestinal

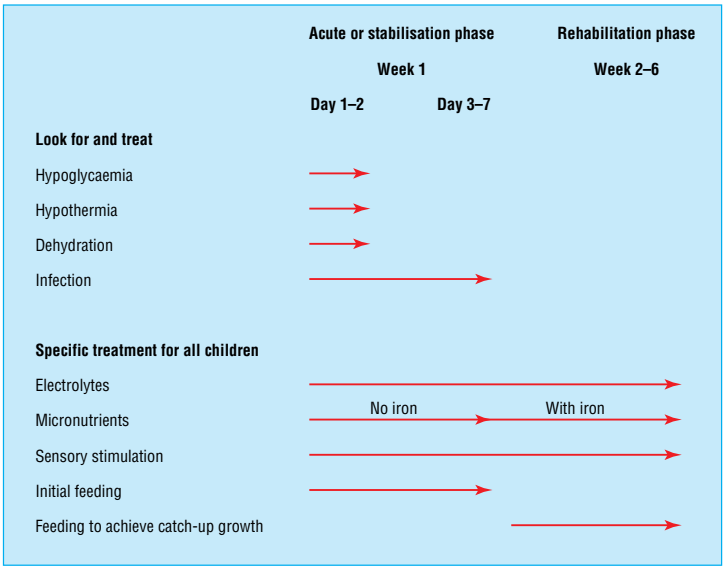


Fig 2 Time frame for individual components of management of a child with severe malnutrition

Box 1: Fluid treatment for a child with severe malnutrition and diarrhoea[9]

- If the child is showing signs of shock and is lethargic or unconscious, give any of the following solutions: intravenous Ringer's lactate with 5% glucose, half normal saline with 5% glucose, or half strength Darrow's solution with 5% glucose. If these solutions are not available, use Ringer's lactate
- Treatment regimen: 15 ml/kg intravenous fluid to be given over 1 hour. Repeat if the child improves. If the child fails to improve, consider septic shock
- If the child has no signs of shock and is passing several watery stools, assume some dehydration and use oral rehydration salts solution with reduced osmolarity and added potassium, or ReSoMal, for rehydration
- Treatment regimen: 5 ml/kg every 30 minutes for the first 2 hours; 5 ml/kg/hour for the next 4-10 hours

Table 1 Preparation of ReSoMal, one type of rehydration solution for severely malnourished children[9]

Ingredients	Amount
Water	2 litre
WHO oral rehydration salts solution*	One 1 litre packet
Sucrose	50 g
Electrolyte-mineral solution†	40 ml

*3.5 g sodium chloride, 2.9 g trisodium citrate dihydrate, 1.5 g potassium chloride, 20 g glucose.
†See table 3 for the recipe. If the solution cannot be prepared, use 45 ml of KCl solution (100 g KCl in 1 litre of water) instead.

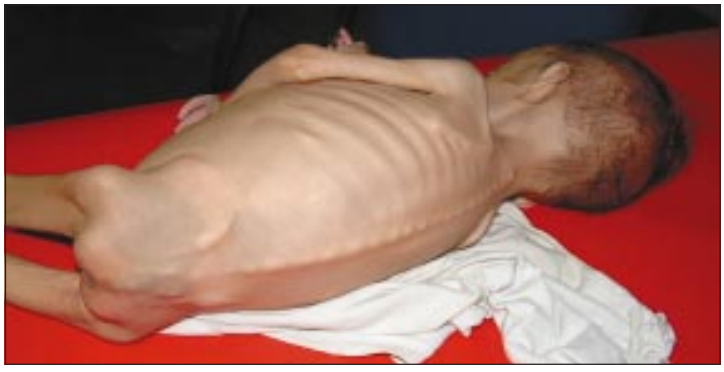
tract.[13] Too much food, particularly protein, in the initial phase aggravates the metabolic imbalance. As appetite returns, intakes of energy and protein are increased so that the shortfall in the growth of the patient can be made up.

Stabilisation or acute phase

Correction of shock and dehydration

Intravenous fluids should be restricted to patients with signs of shock; all other children with dehydration should be treated with oral rehydration salts solution.[9 13] An oral rehydration salts solution with reduced osmolarity—75 mmol/l sodium, 20 mmol/l potassium, and 75 mmol/l glucose—is now recommended universally to treat dehydration because it reduces stool output, the duration of diarrhoea, and the need for unscheduled intravenous fluids when compared with the WHO oral rehydration salts solution.[17] Some experts believe that the sodium concentration of oral rehydration salts solution for severely malnourished children should be even lower (45-60 mmol/l) because high intakes of sodium may cause heart failure, especially in children with oedema.[18]

A special oral rehydration salts solution for severely malnourished children, ReSoMal, used initially in refugee camps, has been endorsed by the WHO. It contains 45 mmol/l sodium, 40 mmol/l potassium, and magnesium, zinc, copper, and sucrose to prevent hypoglycaemia and make the solution isotonic. This formulation has not yet been evaluated in randomised controlled trials (table 1).[9] Oral rehydration salts solution with reduced osmolarity and extra potassium should soon be universally available (box 1).



A severely malnourished child

Other life threatening complications

Two other common complications, hypoglycaemia and hypothermia, which often occur together, are signs of possible serious infection and are associated with a high case fatality.[19] Body temperature has been shown to decrease during hypoglycaemia.[20] Rectal temperature less than 35.5°C or axillary temperature less than 35°C indicates hypothermia.[9] Treatment includes prompt initiation of two hourly feeding (day and night); keeping the child well clothed, with the head covered, in a warm environment; and antibiotics for infection, which is likely to be present.

Testing for hypoglycaemia (glucose <54 mg/dl) should be done routinely using Dextrostix. If the test results are positive, 50 ml of 10% glucose or sucrose solution should be given orally or by nasogastric tube followed by feeding as soon as possible.[9] If the child is unconscious, 5 ml/kg of 10% glucose should be given intravenously or by nasogastric tube. Blood sugar should be checked after 30 minutes and, if low, more 10% glucose solution should be given. If the rectal temperature falls below 35.5°C, or if there is deterioration in the level of consciousness, measurement with Dextrostix should be repeated and treatment provided accordingly.

Treatment of infections

No randomised controlled trials comparing empirical antibiotic treatment with selective antibiotic treatment have been undertaken. Although severely malnourished children may not have obvious signs of infection such as fever and tachypnoea, the prevalence of bacteraemia, urinary tract infections, and pneumonia is high.[21] This high prevalence justifies empirical antibiotic treatment. WHO recommends using such treatment for the first seven days. Intravenous antibiotics are recommended if hypothermia or hypoglycaemia is present or if the child is lethargic or appears very ill.[9] The guidelines proposed by Stegen et al for initiating antituberculosis treatment may be used.[22]

Electrolyte imbalance

Most severely malnourished children have deficiencies in potassium and magnesium, which may take two weeks or more to correct. Low concentrations of intracellular potassium promote sodium and water retention, reduce myocardial contractility, and affect transport of ions across cell membranes.[23] Magnesium deficiency leads to impaired retention of potassium.[24]

Evidence for the efficacy of potassium and magnesium supplementation from controlled clinical trials is

limited. In a double blind controlled trial in children with oedematous severe malnutrition, a total potassium intake of 7.7 mmol/kg/day compared with 4.7 mmol/kg/day during the first week did not significantly reduce mortality during hospitalisation, but fewer children died after day 5 of hospitalisation.[23] Trials of magnesium supplementation have been small and the results were inconclusive.[25 26] WHO recommends that extra potassium and magnesium be added to feeds during their preparation (3-4 mmol/kg/day and 0.4-0.6 mmol/kg, respectively).

Micronutrient deficiencies

Severely malnourished children are often deficient in vitamin A, zinc, iron, folic acid, copper, and selenium. Deficiencies in zinc and vitamin A impair the function of the immune system and have direct effects on the structure and function of mucosa.[27] Copper deficiency is characterised by neutropenia, bone abnormalities, and microcytic anaemia that fails to respond to iron.[28] Cardiac function is impaired in selenium deficiency.[29]

Zinc supplementation reduces the incidence of diarrhoea and pneumonia and improves growth.[30] Vitamin A supplementation has been shown to reduce mortality and morbidity due to diarrhoea and measles.[31] Iron supplementation improves cognition and growth but is not recommended in the acute phase because it may worsen existing infection.[32 33] Trials of copper supplementation in severely malnourished children show inconsistent results.[34 35] Selenium supplementation has not been assessed in controlled trials.

Table 2 Composition of electrolyte-mineral solution* for severely malnourished children[9]

Ingredient	Mass(g)	mmol per 20 ml
Potassium chloride (KCl)	224	24
Tripotassium citrate	81	2
Magnesium chloride ($MgCl_2.6H_20$)	76	3
Zinc acetate (Zn accetate.$2H_20$)	8.2	0.3
Copper sulphate ($CuSO_4.5H_20$)	1.4	0.045

*To be added to diet or oral rehydration salts solution.
Use water to make up to 2.5 l. If available, also add selenium (0.028 g of sodium selenate, $NaSe_4.10H_20$) and iodine (0.012 g of potassium iodide, KI) per 2.5 l. Add 20 ml of the solution to a litre of diet or oral rehydration salts solution.

Giving micronutrients to patients is often difficult because suitable formulations are not available. One approach is to prepare an electrolyte-mineral solution (table 2).[9] To mask the taste, the solution can be added to food. An alternative approach is to give multivitamin supplements: folic acid (5 mg on day 1, then 1 mg/day); zinc as acetate, sulphate, or gluconate (2 mg elemental zinc/kg/day); copper (0.3 mg elemental copper/kg/day); and—once the infant begins to gain weight—ferrous sulphate (3 mg elemental iron/kg/day).[9] Daily intake of individual micronutrients should be up to twice the recommended daily allowance. Additionally, vitamin A can be given orally (age <6 months, 50 000 IU; age 6-12 months, 100 000 IU; older children, 200 000 IU) on day 1.[9]

Dietary treatment during acute phase

Feeding should be started as soon as possible. Diets used for initial feeding should have low osmolarity and low lactose and should provide 330-420 kJ/kg energy and 1-1.5 g/kg protein per day.[7 9] The recipe and composition of a milk based starter formula (F-75a) is shown in table 3. A milk and cereal based formula (F-75b) has the advantage of lower osmolarity, which may be particularly beneficial for children with diarrhoea; however, it needs to be cooked, which may not always be practical.

Table 3 Recipes and composition of starter formulas and catch-up formula[9]

	Starter formula(F-75a*)	Starter formula with cereal(F-75b†)	Catch up formulaF-100‡
Dried skimmed milk (g)	25	25	80
Sugar (g)	100	70	50
Cereal flour (g)	-	35	-
Vegetable oil (g)	27	27	60
Electrolyte-mineral solution (ml)	20	20	20
Water: use to make up final solution to (ml)	1000	1000	1000
Contents per 100 ml			
Energy (kJ)	314	314	418
Protein (g)	0.9	1.1	2.9
Lactose (g)	1.3	1.3	4.2
Potassium (mmol)	4.0	4.2	6.3
Sodium (mmol)	0.6	0.6	1.9
Magnesium (mmol)	0.43	0.46	0.73
Zinc (mg)	2.0	2.0	2.3
Copper (mg)	0.25	0.25	0.25
% energy from protein	5	6	12
% energy from fat	32	32	53
Osmolality (mOsm/l)	413	334	419

*A comparable initial diet can be made from 35 g whole dried milk, 100 g sugar, 20 g oil, 20 ml electrolyte-mineral solution (table 3), and water to make a final volume of 1000 ml. If using fresh cow's milk, take 300 ml milk, 100 g sugar, 20 ml oil, 20 ml electrolyte-mineral solution and water to make 1000 ml.
†Cook for 4 minutes. This may be helpful for children with dysentery or persistent diarrhoea.
‡A comparable catch-up formula can be made from 110 g whole dried milk, 50 g sugar, 30 g oil, 20 ml electrolyte-mineral solution, and water to make up to 1000 ml. If using fresh cow's milk, take 880 ml milk, 75 g sugar, 20 ml oil, 20 ml electrolyte-mineral solution, and water to make up to 1000 ml.

The child should be fed every two hours—or, if this is not possible, every three hours—day and night. Breastfeeding should be continued. A recommended feeding schedule is shown in table 4. If the child's intake does not reach 330 kJ/kg/day despite frequent feeds, coaxing, and reoffering, the remaining feed should be given by nasogastric tube.

Rehabilitation phase

The return of the patient's appetite heralds the rehabilitation phase and usually occurs a week after treatment is started. The goal of treatment then is to achieve a weight gain greater than 10 g/kg/day until the patient has fully recovered (box 2). Frequent feeds, unlimited in amount, help to achieve daily energy and protein intakes of 630-920 kJ/kg/day and 4-5 g/kg/day, respectively. Increases in energy and protein intake should be gradual to avoid cardiac failure. A

Table 4 Recommended feeding schedule[9]

Days	Frequency	Volume/kg/feed (ml)	Volume/kg/day (ml)
1-2	2 hourly	11	130
3-5	3 hourly	16	130
≥6	4 hourly	22	130

Box 2: Monitoring progress during treatment

- If weight gain is good (>10 g/kg/day), continue with the same treatment
- If weight gain is moderate (5-10 g/kg/day), check whether intake targets are being met or if infection has been overlooked
- If weight gain is poor (<5 g/kg/day), make a full assessment and look particularly for inadequate feeding, untreated infection, tuberculosis, and psychological problems
- A child is considered to have recovered on reaching a weight for height that is 90% of the National Centre for Health Statistics median

Box 3: Criteria for discharge before full recovery[9]

- Age 12 months or older
- Antibiotic treatment completed
- Good appetite
- Good weight gain
- No oedema
- Potassium, magnesium, mineral supplements, and vitamin supplements taken for two weeks
- Mother or caretaker is not employed outside the home, has received specific training on appropriate feeding, has the financial resources to feed the child, and is motivated to follow the advice given

milk based catch-up formula (F-100) that provides 420 kJ/100 ml and 2.9 g protein/100 ml is appropriate (table 3). Modified porridges or other complementary foods can be used as long as they have energy and protein content similar to that provided by F-100. Porridges prepared with locally available cereals in milk or other complementary foods that have been modified to provide energy and protein concentrations comparable to the F-100 catch-up formula are also acceptable. Breastfeeding should be continued but the diet should be given first. If weight gain is less than 10 g/kg/day, infection or inadequate intake of energy and protein are likely to be contributing factors.

Recovery from malnutrition is possible in children with HIV or AIDS, but it can take longer and treatment failures are more common.[9 36 37] Love and care, a cheerful stimulating environment, structured play therapy, progressively increasing physical activity, and mother's involvement in care of the child are important components of therapy.[9 38]

WHO recommends that a child be discharged from hospital when the weight for height reaches 90% of the National Centre for Health Statistics median, but it is unclear whether use of a lower cut off point—for example, 80%—is linked to poor outcome.[9] Discharging patients before they have fully recovered should be considered only if the criteria in box 3 are met.

If a child is discharged before full recovery, he or she should be fed at home (see box 4).

Box 4: Feeding children at home after discharge before full recovery

- Feed at least five times a day
- Modify the usual home foods to contain approximately 420 kJ and 2-3 g/kg proteins per 100 g food
- Give high energy snacks between meals
- Encourage the child to eat
- Give food in a separate bowl
- Give electrolyte and mineral supplements
- Allow breastfeeding as often as the child wants to

Box 5: Important research questions that need to be addressed

- Clinical efficacy of magnesium, high dose potassium, copper, and selenium, including impact on case fatality rates
- Clinical evaluation of different oral rehydration salts formulations and fluid regimens for managing dehydration
- Comparison of empirical antibiotic treatment with selective antibiotic treatment during the initial phase
- Comparison of community based rehabilitation with hospital based rehabilitation

Educational resources

World Health Organization, Division of Child Health and Development. Integrated Management of Childhood Illness. Geneva: WHO, 1997. (Document ref WHO/CHD/97.3E) www.who.int/child-adolescent-health/publications/IMCI/in_service.htm (accessed 18 Dec 2002).

World Health Organization, Department Child and Adolescent Health and Development. Management of the child with a serious infection or severe malnutrition. Guidelines for care at the first referral level in developing countries. Geneva: WHO, 2000. www.who.int/child-adolescent-health/publications/referral_care/referencepdf/01prelims.pdf (accessed 20 Nov 2002).

Conclusions

The high case fatality rates among severely malnourished children have been reduced by using standardised and easily implementable protocols, and improved decision making, monitoring and supervision. Admittedly, not all the recommendations are based on firm evidence and more research is needed (box 5), but the approach described in this article has been shown to work. Whether resources should be focused on promoting optimal growth or on rehabilitation of the severely malnourished children is not an issue, as the two approaches are complementary. Effective rehabilitation of the severely malnourished child, an area that has long been neglected, must now find a key place in strategies to reduce child morbidity and mortality.

Contributors: NB did the search after all three authors had developed the search strategy. All three authors reviewed the papers independently. MKB wrote the first draft, which was revised and restructured by NB and RB. The final draft was reviewed and approved together by all three authors.

Funding: None.

Competing interests: None declared.

1 United Nations Children's Fund. *The state of the world's children 2002*. New York: Unicef, 2002.
2 International Institute for Population Sciences. *National family health survey (MCH and family planning), 1992-1993*. Mumbai, India: International Institute of Population Sciences, 1995.

3 International Institute for Population Sciences and ORC Macro. *National family health survey (NFHS-2), 1998-99.* Mumbai, India: International Institute of Population Sciences, 2000.
4 World Health Organization. *Global forum for health research. Child health research: a foundation for improving child health.* Geneva: WHO, 2002. www.who.int/child-adolescent-health/New_Publications/CHILD_HEALTH/GC/HealthyChild.pdf (accessed 20 Nov 2002).
5 Rice AL, Sacco L, Hyder A, Black RE. Malnutrition as an underlying cause of childhood deaths associated with infectious diseases in developing countries. *Bull World Health Organ* 2000;78:1207-21.
6 Schofield C, Ashworth A. Why have mortality rates for severe malnutrition remained so high. *Bull World Health Organ* 1996;74:223-9.
7 Ahmed T, Ali M, Ullah MM, Choudhary IA, Haque ME, Salam MA, et al. Mortality in severely malnourished children with diarrhoea and use of a standardised management protocol. *Lancet* 1999;353:1919-22.
8 Cavalcante AAM, Pinheiro LMP, Monte C, Guimaraes ARP, Ashworth A. Treatment of malnutrition in Brazil: simple solutions to common problems. *Trop Doctor* 1998;28:95-7.
9 World Health Organization. *Management of the child with a serious infection or severe malnutrition. Guidelines for care at the first-referral level in developing countries.* Geneva: WHO, 2000. www.who.int/child-adolescent-health/publications/referral_care/homepage.htm (accessed 20 Nov 2002).
10 Bern C, Zucker JR, Perkins BA, Otieno J, Oloo AJ, Yip R. Assessment of potential indicators for protein energy malnutrition in the algorithm for integrated management of childhood illness. *Bull World Health Organ* 1997;75:87-96.
11 Trowbridge FL. Clinical and biochemical characteristics associated with anthropometric nutritional categories. *Am J Clin Nutr* 1979;32:758-66.
12 de Onis M, Habicht J. Anthropometric reference data for international use: recommendations from a World Health Organization expert committee. *Am J Clin Nutr* 1996;64:650-8.
13 Briend A, Golden MHN. Treatment of severe child malnutrition in refugee camps. *Eur J Clin Nutr* 1993;47:750-4.
14 International Working Group on Persistent Diarrhoea. Evaluation of an algorithm for the treatment of persistent diarrhoea: a multicentre study. *Bull World Health Organ* 1996;74:479-89.
15 Khanum S, Ashworth A, Huttly SRA. Controlled trial of three approaches to the treatment of severe malnutrition. *Lancet* 1994;344:1728-32.
16 Schofield WN. Treatment of severe malnutrition [letter]. *Lancet* 1995;345:1303.
17 Fontaine, O. Effect of zinc supplementation on clinical course of acute diarrhoea. Report of a meeting, New Delhi, 7-8 May 2001. *J Health Popul Nutr* 2001;19:339-46.
18 Wharton BA, Howells GR, McCance RA. Cardiac failure in kwashiorkor. *Lancet* 1967;ii:384-7.
19 Bennish ML, Azad AK, Rahman O, Phillips RE. Hypoglycaemia during diarrhoea in childhood. Prevalence, pathophysiology, and outcome. *N Engl J Med* 1990;322:1357-63.
20 Fruchwald-Schultes B, Kern W, Dantz D, Born J, Fehm HL, Peters A. Preserved hypothermic response to hypoglycaemia after antecedent hypoglycaemia. *Metabolism* 2000;49:794-8.
21 Berkowitz FE. Infections in children with severe protein-energy malnutrition. *Pediatr Infect Dis J* 1992;11:750-9.
22 Stegen G, Jones K, Kaplan P. Criteria for guidance in the diagnosis of tuberculosis. *Pediatrics* 1969;43:260-3.
23 Manary MJ, Brewster DR. Potassium supplementation in kwashiorkor. *J Pediatr Gastroenterol Nutr* 1997;24:194-201.
24 Michaelsen KF, Clausen T. Inadequate supplies of potassium and magnesium in relief food: implications and countermeasures. *Lancet* 1987;1:1421-3.
25 Caddell JL. Studies in protein-calorie malnutrition: a double-blind clinical trial to assess magnesium therapy. *N Engl J Med* 1967;276:535-40.
26 Rosen EU, Campbell PG, Moosa GM. Hypomagnesemia and magnesium therapy in protein-calorie malnutrition. *J Pediatr* 1970;77:709-14.
27 Bhan MK, Bhandari N. The role of zinc and vitamin A in persistent diarrhoea among infants and young children. *J Pediatr Gastroenterol Nutr* 1998;26:446-53.
28 Cordano A, Baertl JM, Graham GG. Copper deficiency in infancy. *Pediatrics* 1964;34:324-36.
29 Golden MH. Marasmus and kwashiorkor. In: Dickerson JWT, Lee MA, eds. *Nutrition in the clinical management of disease.* 2nd ed. London: Edward Arnold, 1988:88-109.
30 Zinc Investigators' Collaborative Group. Prevention of diarrhoea and pneumonia by supplementation in children in developing countries: pooled analysis of randomised controlled trials. *J Pediatr* 1999;155:689-97.
31 Beaton GH, Martorell R, Aronson KJ, Edmonston B, Mccabe G, Ross AC, et al. Effectiveness of vitamin A supplementation in the control of young child morbidity and mortality in developing countries. Geneva: ACC/SCN, 1993. United Nations administrative committee on coordination/subcommittee on nutrition state of the art series. Nutrition policy discussion paper no 13.
32 Aukett M, Parks Y, Scott P, Wharton B. Treatment with iron increases weight gain and psychomotor development. *Arch Dis Child* 1986;61:849-57.
33 Stoltzfus R, Dreyfuss ML. Guidelines for the use of iron supplements to prevent and treat iron deficiency anaemia. International Nutritional Anaemia Consultative Group (INACG). Washington, DC: International Life Sciences Institute, 1998.
34 Castillo-Duran C, Fisberg M, Valenzuela A, Egana JI, Uauy R. Controlled trial of copper supplementation during the recovery from marasmus. *Am J Clin Nutr* 1983;37:898-903.
35 Castillo-Duran C, Uauy R. Copper deficiency impairs growth of infants recovering from malnutrition. *Am J Clin Nutr* 1988;47:710-4.
36 Kessler L, Daley H, Malenga G, Graham S. The impact of the human immunodeficiency virus type 1 on the management of severe malnutrition in Malawi. *Ann Trop Pediatr* 2000;20:50-6.
37 Brewster DR, Manary MJ, Graham SM. Case management of kwashiorkor: an intervention project at seven nutrition rehabilitation centres in Malawi. *Eur J Clin Nutr* 1997;51:139-47.
38 Elizabeth KE, Sathy N. The role of developmental stimulation in nutritional rehabilitation. *Indian Pediatr* 1997;34:681-95.

Lesson of the week

Unsuspected haemophilia in children with a single swollen joint

Beatrice Nolan, Vicky Vidler, Ajay Vora, Michael Makris

A clotting screen should always be performed in a child with a swollen joint, even if there is a history of minor trauma, to exclude underlying bleeding disorders. A prompt diagnosis of haemophilia will allow early arrest of bleeding by appropriate treatment, which will in turn minimise complications and reduce total exposure to blood products.

A clotting screen to exclude haemophilia is an essential investigation in a child with a single swollen joint

Correspondence to:
M Makris
m.makris@sheffield.ac.uk

continued over

BMJ 2003;326:151–2

Case reports

Case 1

A 1 year old boy, an only child, presented to an accident and emergency department with a painful, swollen right elbow following minor trauma. Examination and a radiograph showed no evidence of bone injury and he was sent home.

Three days later, he was brought back because of increasing pain and swelling. Joint aspiration yielded haemorrhagic fluid. Osteomyelitis was suspected and he was started empirically on antibiotic treatment. Approximately four weeks later, as the effusion had not resolved, the joint was explored, yielding dark blood, and a biopsy specimen was taken from a localised area of synovitis. Postoperatively the wound bled persistently. A coagulation screen showed normal prothrombin time but prolonged activated partial thromboplastin time (96 s; normal range 24-35 s) which was corrected by the addition of normal plasma, suggesting an underlying factor deficiency; at this stage he was referred to us at the regional comprehensive carer haemophilia centre. On further questioning it was found that his maternal great grandfather had bled abnormally after minor surgical procedures. His factor VIII concentration was 0.02 IU/ml (normal range 0.5-1.5 IU/ml). He was given factor VIII concentrate daily for 10 days and then three times a week for a further