Discussion

Acrodermatitis enteropathica presents in early infancy with alopecia, diarrhoea, and a pustular, bullous, or eczematous eruption. The face, extremities, and areas around the orifices are most severely affected. Additional features include nail dystrophy, dental caries, and retardation of growth and sexual development. It is thought to be inherited as an autosomal recessive. The course is intermittent but progressive and if untreated is usually fatal within three years.³

Treatment with di-iodohydroxyquinoline, first described in 1953,⁴ was the mainstay until 1973, when zinc deficiency was proposed as the basis of the disorder and success was described with zinc sulphate. This suggestion was supported by similarities between the disorder and zinc deficiency in animals.⁵ Zinc sulphate is of minimal toxicity as compared with di-iodohydroxyquinoline, and this, allied to its dramatic effectiveness, makes it the treatment of choice.

The serum zinc estimation were performed by the National Occupational Hygiene Service, Manchester.

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Cell-mediated Immunity in Iron- and Vitamin-deficient Children

Children with protein-calorie malnutrition have an altered immunological status.¹ Vitamin and mineral deficiencies may also lower resistance to infection in animals. Little is known, however, about how these deficiencies affect the immunocompetence of man. We have studied the cell-mediated immunity (C.M.I.) of nine children with iron-deficiency anaemia, nine with signs of vitamin A deficiency, and eight with vitamin B complex deficiency; 11 normal children were also investigated after the consent of their parents had been obtained.

Patients, Methods, and Results

The children were aged 2-10 years. Those with vitamin A deficiency showed conjunctival xerosis and Bitot spots, while those with vitamin B complex deficiency had angular stomatitis and glossitis. All weighed above 80% of the Indian standard.

Iron-deficiency anaemia was confirmed by routine methods, and serum vitamin A was determined spectrophotometrically. Serum albumin levels were measured in the vitamin A deficient children to exclude protein-calorie malnutrition. Children with iron-deficiency anaemia were given iron, and the studies repeated four to five weeks later, when haemoglobin had increased. The following procedures were used to assess C.M.I. (1) A T-lymphocyte count was performed using a rosette formation technique², 200 consecutive cells were counted and the percentage of rosette-forming cells determined. (2) cells Peripheral blood lymphocyte culture was set up using phytohaemagglutinin (PHA) and ³H-thymidine incorporation measured.¹ The results were expressed as T/C ratio = (C.P.M. in test culture/C.P.M. in control culture). (3) Delayed skin hypersensitivity was studied using PHA.¹

In the children with iron-deficiency anaemia the haemoglobin levels were 4-7 g/dl, and values for serum iron and total iron-binding capacity were

7-18 μmol/l (40-100 μg/100 ml) and 122-147 μmol/l (680-820 μg/100 ml) respectively. There were also significantly fewer T-lymphocytes ($P < 0.001$) than normal, and thymidine incorporation was depressed ($P = 0.05$ (table)). Four weeks after iron treatment the T cells were significantly increased but thymidine incorporation was unchanged. The skin reaction was negative in five of the nine children initially; in one it became positive after treatment.

All nine children with signs of vitamin A deficiency showed low levels of serum vitamin A (200-700 IU/l). They also had fewer T-lymphocytes ($P < 0.01$) but showed no change in thymidine incorporation when compared with the normal group. Skin reactions were negative in five of the children. In children with vitamin B complex deficiency both the proportion of T-lymphocytes and their response to PHA were similar to normal. Skin reactions were positive in all cases. Total lymphocyte counts were over $2.5 \times 10^9/l$ and serum albumin levels over 35 g/l in all the children studied.

Mean T-lymphocyte Counts and ³H-thymidine Incorporation in Deficient and Normal Children (Ranges are given in Parentheses)

Group	No. of Children	Percentage of T-lymphocytes	³ H-thymidine Incorporation (C.P.M. T/C)
Normal	11	65.7 (51.5-72.5)	27.3 (2.03-86.07)
Iron-deficiency anaemia before treatment	9	41.6† (37.0-47.0)	4.49* (1.4-13.1)
Iron-deficiency anaemia 4 weeks after treatment	6	52.08 (41.0-73.0)	4.96 (1.4-8.5)
Vitamin A deficiency	9	47.0† (40.0-61.5)	13.06 (0.9-74.70)
Vitamin B complex deficiency	8	55.5 (49.0-62.0)	35.2 (5.4-55.6)

P values between deficient and normal children: * <0.05; † <0.01; ‡ <0.001.

Discussion

Iron deficiency is associated with defective host defence mechanisms. The bactericidal potential of leucocytes is reduced in anaemic children. Our results indicate a depressed C.M.I. in iron-deficiency anaemia, confirming observations in adults.³ Protein-calorie malnutrition was excluded. The mechanism by which the immune response is altered is uncertain. Iron is important in mitosis. Possibly the impaired C.M.I. in anaemic children is due to altered DNA synthesis, which has been shown in bone marrow cells in iron-deficiency anaemia.⁴ After iron therapy, the T cells promptly increased but thymidine incorporation was unchanged. Lymphocyte function probably takes longer to return to normal.

Several studies have shown that vitamin deficiency may lower resistance to infection in experimental animals, but no such studies have been carried out in man. In our series, though T-lymphocytes were decreased, cell function was unchanged in vitamin A deficiency. The role of vitamin A in the immune response is not clear but it may act as an adjuvant and promote lymphocyte proliferation.⁵ In vitamin B complex deficiency none of the values studied were altered. Thus vitamin deficiencies may not have an appreciable effect on the immunological status of children.

Our findings are important since children of poor communities suffer from multiple deficiencies. Apart from protein-calorie malnutrition, iron deficiency may affect immunological competence and thus contribute to the increased susceptibility of malnourished children in infections.

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