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Happiness is: iron

Iron deficiency in childhood is common even in socially advantaged populations; it is even more common in the socially deprived.[1] A recent report from Bradford has again drawn attention to its frequency in preschool children from both the white endogenous population and families of Asian origin.[2] Anaemia (Hb <110 g/l) was found in 12% of white children and 28% of Asian children admitted to hospital between the ages of 6 months and 4 years. Low serum ferritin concentrations (<10 μg/l) were found in 23% of white and 45% of Asian children. Does iron deficiency on this scale matter? How should iron deficiency be detected and investigated, and what needs to be done about the problem?

The ill effects of chronic anaemia are well recognised, but the metabolic importance of iron extends far beyond the red cell, and recent attention has focused on the non-haematological effects of lack of iron.[3,4] Studies on animals have shown that, irrespective of anaemia, iron deficiency produced metabolic and functional defects in muscle[5] and impaired function of white cells.[6] Functional abnormalities of both lymphocytes and neutrophils have been shown in anaemic children.[7] A recent study in California found iron deficiency to be more common in 1 year old infants who had a history of recurrent mild infections.[8] Whether the infections preceded or followed the iron deficiency is not clear.

Most importantly, there is now substantial evidence that iron deficiency has an adverse effect on brain function. In rats iron deficiency leads to disturbed enzyme function in the brain affecting cerebral serotonin metabolism[9] and learning ability.[10] Pica in children has long been recognised as a concomitant of iron deficiency, and the eating of excessive quantities of ice (pagophagia) has been described in the United States.[4,11] Several studies have shown that iron deficiency in children, with or without anaemia, is associated with abnormalities of behaviour and mental performance which improve with treatment with iron.[12-15] Oski and Honig studied 24 iron deficient anaemic children aged 9 to 26 months.[12] Twelve were given intramuscular iron and 12 placebo, and tests of mental development and of behaviour were administered before the injection and five to eight days later. Improvements were found at the second testing in those who had been given iron but not in the placebo group. In particular, the treated children tended to become more responsive to their environment. In a similar study in Guatemala Lozoff and her colleagues showed that children with iron deficiency anaemia scored less well than other children in tests of mental development and that the iron deficient children were more tense and fearful but otherwise less responsive.[16] In their study no improvement in test scores was seen after one week of treatment with oral iron. More recently Oski and his colleagues showed an improvement in mental development test scores one week after intramuscular iron injection in babies aged 9 to 12 months who were iron deficient but not anaemic,[13] and Walter and his colleagues in Chile obtained similar results in 15 month old children using treatment with oral iron and retesting after 11 days.[14]

The most noticeable behavioural characteristic of the anaemic Chilean babies was that they were more unhappy than non-anaemic babies. Studies in Java and Egypt have shown deficits in mental performance in schoolchildren with iron deficiency which were reversible with treatment.[15] Since in the first of these studies the children were tested in academic subjects and improvement after treatment was rapid the deficit was presumably in either recall or performance rather than learning.

In clinical practice iron deficiency is usually detected by measuring the haemoglobin concentration and red cell morphological indices. The lower value for haemoglobin (mean minus 2 SD) in normal children of either sex is 110 g/l at 1 year of age slowly rising to 120 g/l at 11 years. Between 11 and 16 years the concentration remains constant in girls but rises further to 130 g/l in boys.[17] Lower limits for mean corpuscular volume are 70 fl at 1 year and about 77 fl at 16 years in both sexes.[17] In populations in which the β thalassaemia gene is common a function derived from the usual indices may help to distinguish between iron deficiency and thalassaemia trait.[18] After clinical assessment of diet, nutritional state, and possible blood loss a trial of treatment with oral iron is usually called for, and (provided that compliance with treatment can be assured) the response is a more sensitive indicator of iron deficiency than laboratory tests of iron status.[19]

Recurrent or unresponsive anaemia will need further assessment, in particular to exclude blood loss from, for

example, reflux oesophagitis with or without hiatus hernia, Meckel's diverticulum, or enteritis due to sensitivity to cows' milk. Recurrent iron deficiency must not be ascribed to poor diet alone without excluding other causes even in underprivileged children. Assessment of iron status may require measuring iron stores (serum ferritin) and also iron transport by means such as serum concentrations of iron and iron binding proteins (total iron binding capacity or transferrin) and their degree of saturation. The serum iron and transferrin saturation increase gradually throughout childhood, while serum transferrin is higher and ferritin lower in normal children than in adults, the change taking place in late childhood.[20]

What needs to be done? Firstly, the size of the problem should be assessed by community based surveys of children from various racial, cultural, and social backgrounds. Little such information seems to be available about children in Britain in recent years. A nutritional survey of children of Bangladeshi parents in London showed dietary deficiencies of vitamin D, energy, and iron.[21] Although the amount of iron present in human milk is small compared with that in fortified baby milks, its bioavailability is high, and breast feeding does not cause iron deficiency in the first six months of life.[22] The early introduction of fresh cows' milk into the infant diet may lead to iron deficiency, possibly because of loss of red cells from the intestines.[23] Whether a nationwide campaign of extra iron supplementation similar to the recent British "Stop Rickets Campaign" is desirable or feasible is a matter for debate, but in my opinion the information which would justify such action in Britain is not yet available, although an American programme of dietary aid to needy families does seem to have reduced the prevalence of iron deficiency.[24]

An alternative approach—more in keeping with present knowledge—would be to test infants aged 9 to 12 months especially in socially underprivileged areas and to give a course of iron treatment to those found to be anaemic. Giving iron in this way causes few problems[25] and is less expensive and more efficient than investigating all anaemic infants.[19] Doctors in hospital might also give more attention to detecting and treating mild iron deficiency in children, and all health professionals working with young children should give appropriate dietary advice at the time of weaning. Mild iron deficiency in children can no longer be ignored. In some children, it seems, happiness may indeed be iron.

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1 Oski FA. Iron deficiency—facts and fallacies. *Pediatr Clin North Am* 1985;**32**:493-7.
2 Ehrhardt P. Iron deficiency in young Bradford children from different ethnic groups. *Br Med J* 1986;**292**:90-3.
3 Jacobs A. The non-haematological effects of iron deficiency. *Clinical Science and Molecular Medicine* 1977;**53**:105-9.
4 Oski FA. The non-hematologic manifestations of iron deficiency. *Am J Dis Child* 1979;**133**: 315-22.
5 Finch CA, Miller LR, Inamdar AR, Person R, Seiler K, Mackler B. Iron deficiency in the rat: physiological and biochemical studies of muscle dysfunction. *J Clin Invest* 1976;**58**:447-53.
6 Mackler B, Person R, Ochs H, Finch CA. Iron deficiency in the rat: effects on neutrophil activation and metabolism. *Pediatr Res* 1984;**18**:549-51.
7 Srikantia SG, Prasad JS, Bhaskram C, Krishnamachari KAVR. Anaemia and immune response. *Lancet* 1976;i:1307-9.
8 Reeves JD, Yip R, Kiley VA, Dallman PR. Iron deficiency in infants: the influence of mild antecedent infection. *J Pediatr* 1984;**105**:874-9.
9 Mackler B, Person R, Miller LR, Inamdar AR, Finch CA. Iron deficiency in the rat: biochemical studies of brain metabolism. *Pediatr Res* 1978;**12**:217-20.
10 Massaro TF, Widmayer P. The effect of iron deficiency on cognitive performance in the rat. *Am J Clin Nutr* 1981;**34**:864-70.
11 Coltman CA. Pagophagia and iron lack. *JAMA* 1969;**207**:513-6.
12 Oski FA, Honig AS. The effects of therapy on the developmental scores of iron deficient infants. *J Pediatr* 1978;**92**:21-5.
13 Oski FA, Honig AS, Helu BM, Howanitz P. Effect of iron therapy on behavior and performance of non-anemic iron deficient infants. *Pediatrics* 1983;**71**:877-80.
14 Walter T, Kovalskys J, Steel A. Effect of mild iron deficiency on infant mental development scores. *J Pediatr* 1983;**102**:519-22.
15 Pollitt E, Soemantri AG, Yunis F, Scrimshaw NS. Cognitive effects of iron deficiency anaemia. *Lancet* 1985;i:158.
16 Lozoff B, Brittenham GM, Viteri FE, Wolf AW, Urratia JJ. The effects of short term oral iron therapy on developmental deficits in iron deficient anemic infants. *J Pediatr* 1982;**100**:351-7.
17 Dallmann PR, Siimes MA. Percentile curves for hemoglobin and red cell volume in infancy and childhood. *J Pediatr* 1979;**94**:26-31.
18 England JM, Fraser PM. Differentiation of iron deficiency from thalassaemia trait by routine blood count. *Lancet* 1973;i:449-52.
19 Dallman PR, Reeves JD, Driggers DA, Lo EYT. Diagnosis of iron deficiency: the limitations of laboratory tests in predicting response to iron treatment in 1 year old infants. *J Pediatr* 1981;**99**:376-81.
20 Milman N, Cohn J. Serum iron, serum transferrin and transferrin saturation in healthy children without iron deficiency. *Eur J Pediatr* 1984;**143**:96-8.
21 Harris RJ, Armstrong D, Ali R, Loynes A. Nutritional survey of Bangladeshi children aged under 5 years in the London Borough of Tower Hamlets. *Arch Dis Child* 1983;**58**:428-32.
22 Saarinen UM, Siimes MD, Dallman PR. Iron absorption in infants: high bioavailability of breast milk as indicated by extrinsic tag method of iron absorption and by the concentration of serum ferritin. *J Pediatr* 1977;**91**:36-9.
23 Sadowitz PD, Oski FA. Iron status and infant feeding practice in an urban ambulatory center. *Pediatrics* 1983;**72**:33-6.
24 Miller V, Swaney S, Deinard A. Impact of the WIC program on the iron status of infants. *Pediatrics* 1985;**75**:100-5.
25 Reeves JD, Yip R. Lack of adverse side-effects of oral ferrous sulphate therapy in 1-year-old infants. *Pediatrics* 1985;**75**:352-5.

Claudication

Population studies in countries as diverse as Finland and the United States have elicited symptoms of claudication in around 2·2% of men and 1·8% of women.[1,2] In the United States the Framingham study showed that the incidence increased sharply with age up to 75,[3] and a study in Basle reported a prevalence of 10% over the age of 65.[4] Claudication is the most frequent manifestation of arterial disease for which patients attend a vascular clinic, yet paradoxically it is the condition for which they receive the least practical help. Whether active intervention should be considered depends on the degree of disability, the social circumstances, and the level of arterial occlusion.

The most frequent site of occlusion is the femoral artery beyond the origin of the profunda femoris. For as long as the profunda, together with its inflow and outflow vessels, remains free of substantial obstruction the patient may merely have to moderate his or her walking pace or to pause for two or three minutes' rest at 300 metres. Limitations that are intolerable for a postman or a shepherd may scarcely be noticed by the average person in modern motorised society. Furthermore, patients with mild or moderate claudication due to occlusion of the femoral artery frequently have relatively stable symptoms for many years; and if they can modify their lifestyles and social habits they may experience spontaneous improvement as collaterals develop.

There are additional reasons why reconstructive surgery is seldom recommended for the patient with claudication. Many patients with claudication have a history of myocardial infarction and angina, which increases the risk of anaesthesia. A history of cerebral ischaemia is less common, but ausculta-