

Meeting the iron needs of infants and young children: an update

Nutrition Committee, Canadian Paediatric Society

Iron deficiency remains a nutritional problem among infants and young children in Canada. Although there are no recent national data the prevalence of iron deficiency and iron deficiency anemia among infants at low risk was 3.5% for those 6 months of age and 10.5% for those 18 months of age.¹ Among infants aged 10 to 14 months of low-income families in Montreal 24.3% had iron deficiency anemia.² At high risk for iron deficiency are preterm infants and infants from a low socioeconomic background. The Canadian Task Force on the Periodic Health Examination recommends that high-risk infants be screened for iron deficiency at 9 months of age.³ Other risk factors include low birth weight,⁴ perinatal bleeding, a low hemoglobin concentration at birth, chronic hypoxia, frequent infections, early intake of cow's milk or solid food, or both, frequent and excessive tea intake, low vitamin C or meat intake, breast-feeding for more than 6 months without supplemental iron, intake of

infant formula not fortified with iron for more than 4 months without other foods,⁵ and ethnic practices.⁶

Nonhematologic consequences of iron deficiency include poor weight gain, anorexia, blood in stools, malabsorption, irritability, decreased attention span, exercise intolerance and decreased physical activity.⁷ A recent study on iron deficiency anemia and psychomotor development⁸ concluded that when iron deficiency progresses to anemia, performance on developmental tests is adversely affected for up to at least 3 months despite correction of the anemia with iron therapy. Among infants with severe or chronic iron deficiency some of these abnormalities may persist indefinitely despite adequate iron therapy.⁹ The relation between iron deficiency and behavioural development has been the subject of a recent international conference.¹⁰

Infant feeding patterns have undergone some notable changes since the mid-1970s. More mothers breast-feed and do so for at least 6 months, and

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fewer introduce solid foods before 4 months or unmodified cow's milk before 6 months.^{11,12} However, these changes have not occurred in all parts of Canada,¹ and whether they will continue is unknown.

Iron requirements

Newborn term infants have approximately 75 mg/kg of body iron, 75% of which is in the form of hemoglobin. On average, infants almost triple their blood volume during the first year of life and will require the absorption of 0.4 to 0.6 mg daily of iron during that time to maintain adequate stores.¹³

Premature infants have a lower level of body iron at birth, approximately 64 mg in infants weighing 1 kg. The loss of blood drawn for laboratory tests and the rapid rate of postnatal growth lead to a higher requirement for dietary iron than in term infants — 2.0 to 2.5 mg/kg daily to prevent late anemia.¹⁴

Assuming that 10% of the iron in a mixed diet is absorbed the recommended iron intake is approximately 7 mg/d for term infants aged 5 to 12 months, 6 mg/d for toddlers aged 1 to 3 years and 8 mg/d for children aged 4 to 12 years.¹⁵

Dietary sources of iron

Other factors affecting iron sufficiency are the amount and the bioavailability of dietary iron. The form of the iron influences its absorption: absorption is good from ferrous sulfate (the iron source generally used in infant formulas) and elemental iron of small particle size (e.g., the electrolytic iron used in infant cereals). In general, iron absorption from foods of animal origin surpasses that from foods of plant origin. Vitamin C, meat, fish and poultry facilitate iron absorption.¹⁶

One litre of human milk contains only 0.3 to 0.5 mg of iron. About 50% of the iron is absorbed, in contrast to a much smaller proportion from other foods. Term infants who are breast-fed exclusively for the first 6 months may not be at risk for iron depletion or for the development of iron deficiency.¹³ However, if solid foods are given they may compromise the bioavailability of iron from human milk.^{17,18} Although some term infants who are exclusively breast-fed may remain iron-sufficient until 9 months of age¹⁹ a source of dietary iron is recommended starting at 6 months (or earlier if solid foods are introduced into the diet) to reduce the risk of iron deficiency.

Infant formulas based on cow's milk contain 1.0 to 1.5 mg of iron per litre; soy-based formula and iron-fortified formula based on cow's milk contain 12 to 13 mg of iron per litre. The iron source of

fortified formulas is ferrous sulfate, which is significantly more available than the iron used in infant cereals.^{20,21} The availability of iron from soy-based formulas appears to be lower than that from milk-based products.²² The optimal amount of iron in formula based on cow's milk remains to be determined. Formulas in North America contain higher amounts of iron than those suggested in the United Kingdom (1.0 mg/100 kcal) and France (1.5 mg/100 kcal).

The decreased incidence of iron deficiency anemia in the United States since 1969 has been attributed to the increased and longer use of iron-fortified formulas, an increase in breast-feeding and the use of iron-fortified infant cereals.^{23,24} Contrary to popular belief significant behavioural or gastrointestinal problems do not develop in most infants fed iron-fortified formulas.^{25,26} Theoretically, the iron from neonatal reserves in term babies is sufficient to cover their needs during the first 3 months of life. However, in order to avoid possible confusion with formula changes during the first few months, iron-fortified formulas should be used from birth.

Cow's milk is not recommended for infants younger than 9 to 12 months of age. Although it contains approximately the same amount of iron as human milk (0.5 mg/L) the iron is poorly absorbed. Even when given iron-fortified cereals and other foods some infants fed cow's milk from 6 months of age have significantly lower mean serum ferritin levels and corpuscular volume and a greater incidence of hemoglobin concentration below 6.8 mmol/L at 12 months of age than infants fed iron-supplemented formula.²⁷ In addition, cow's milk compromises the absorption of dietary and medicinal iron.

Occult blood loss from the gastrointestinal tract has been demonstrated in infants younger than 4 months of age fed exclusively with unmodified cow's milk.²⁸ A more recent study of the effects of cow's milk on infants from 168 to 252 days old showed significant gastrointestinal blood loss in the experimental group, as measured by a sensitive quantitative method;²⁹ however, this group's iron nutritional status was not significantly different from that of the control (formula-fed) group.

Iron-fortified cereals are an important source of iron: they contain approximately 30 to 50 mg per 100 g of cereal, of which 4% on average will normally be absorbed.³⁰ Although the bioavailability of iron in infant cereals has been challenged³¹ several studies have demonstrated that it is 50% to 70% of the bioavailability of ferrous sulfate, a generally accepted standard.^{20,32-34} Furthermore, clinical studies have shown that iron-fortified infant cereals and formulas can maintain adequate iron status in healthy term infants.³⁵⁻³⁷

Recommendations

Term infants who are exclusively breast-fed do not need supplemental iron until they are 6 months of age. If solid foods are introduced earlier they should contain an adequate amount of iron. After 6 months of age breast-fed infants should receive extra iron in the form of iron-fortified infant cereals and other iron-rich foods. These infants should be offered an iron-fortified infant formula after they have been weaned from breast milk.

Term infants who are not breast-fed should be given an iron-fortified infant formula from birth. Studies are still under way to determine the optimal iron content of these formulas, and further studies are encouraged. Until the results are known the use of currently available iron-fortified formulas seems appropriate. After 4 to 6 months of age iron-fortified infant cereals provide a good additional source of iron.

For premature infants an iron supplement should be started by at least 8 weeks of age and continued until the first birthday. Iron-fortified formula for bottle-fed infants or commercial iron drops for breast-fed infants are the recommended source of supplemental iron.

Cow's milk should not be introduced until an adequate amount of solid food containing iron and vitamin C is included in the diet, preferably at 9 to 12 months of age.

For children over 1 year of age the recommended daily nutrient intake of iron should be given. Iron-containing foods such as meats, some vegetables, legumes, fruits and iron-fortified infant or toddler cereals provide iron in sufficient amounts. Supplemental iron is not required unless the diet is lacking in these foods.

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Conferences

continued from page 1423

Nov. 14-17, 1991: Québec Association of Urologists
16th Annual Meeting

Hilton Hotel, Quebec

Jacqueline Deschênes, Québec Association of Urologists, 2
Complexe Desjardins, East Tower, Rm. 3000, Montreal,
PQ H5B 1G8; (514) 844-9523

Nov. 22, 1991: Annual Practitioners Day

Mount Sinai Hospital, Toronto

Sybil Gilinsky, Education Department, Baycrest Centre for
Geriatric Care, 3560 Bathurst St., North York, ON
M6A 2E1; (416) 789-5131, ext. 2365, fax (416) 785-2378

Nov. 27-29, 1991: National Conference on Mental Health
Ottawa

Laura Thompson, conference coordinator, (416) 631-8088;
or Canadian Mental Health Association, 2160 Yonge
St., 3rd floor, Toronto, ON M4S 2Z3, (416) 484-7750,
fax (416) 485-8228

Dec. 8-11, 1991: International Conference on the Care
of the Elderly

Hong Kong

International and Regional Affairs Department, Hong
Kong Council of Social Service, 11/F, Duke of Windsor
Social Service Building, 15 Hennessy Rd., Wanchai,
Hong Kong; (852) 864-2992, fax (852) 865-4916

Feb. 11-14, 1992: 2nd International Conference on Recent
Advances in Crisis Intervention and Community Mental
Health (organized by the International Institute of Crisis
Intervention and Community Psychiatry in association
with International Crisis Therapists)

Krishna Oberoi Hotel, Hyderabad, India

International Conference Secretariat, 63 Nabcroft Lane,
Crosland Moor, Huddersfield HD4 5DU, England;
telephone 011-44-0484-658054, fax 011-44-0484-
654777

Mar. 10-12, 1992: The Lyon Conference — The Computer
as a Partner: Person-Machine Interactions

Lyon, France

Solange Dubeauclard, 1030 N Glenhurst, Birmingham, MI
48009; (313) 647-7833

May 9-12, 1992: Council of Biology Editors 36th Annual
Meeting

Westin William Penn Hotel, Pittsburgh

Council of Biology Editors, 1200-230 N Michigan Ave.,
Chicago, IL 60601; (312) 372-9800, fax (312) 372-7723

May 25-29, 1992: 12th International Congress of Hospital
Engineering (in concurrence with the Hospital-Health
Care International Exhibition)

Congress Hall, Bologna, Italy

Organizing Secretariat, SENAF, Via Michelino 69, 40127
Bologna, Italy; telephone 011-39-51-503318, fax 011-
39-51-505282

July 21-25, 1992: 6th International Conference on
Human-Animal Interactions (hosted by the Human-
Animal Bond Association of Canada and cosponsored
by the International Association of Human Animal
Interaction Organizations)

Palais des Congrès, Montreal

Abstract deadline is Sept. 1, 1991.

Human-Animal Bond Association of Canada, PO Box
313, Stn. B, Ottawa, ON K1P 6C4; (613) 747-0262,
fax (613) 745-1846

Sept. 6-10, 1992: Medinfo '92 — 7th World Congress on
Medical Informatics

Palexpo Congress Center, Geneva

Abstract deadline is Nov. 15, 1991.

Official language: English

Medinfo '92, Administrative Office, Symporg SA, 108,
route de Frontenex, CH-1208 Geneva, Switzerland;
telephone 011-41-22-786-37-44, fax 011-41-22-786-
40-80

Sept. 22-25, 1992: 1st International Symposium on Brain
Death

International Conference Center, Havana, Cuba

Official languages: English and Spanish

1^{er} Simposio Internacional sobre, Muerte Encefálica,
Palacio de las Convenciones, Apartado 16046, La
Habana, Cuba

May 8-11, 1993: Council of Biology Editors 37th Annual
Meeting

Sheraton Harbor Island Hotel, San Diego

Council of Biology Editors, 1200-230 N Michigan Ave.,
Chicago, IL 60601; (312) 372-9800, fax (312) 372-7723