

Why is this tachypneic child so pale?

Patricia Parkin MD FRCPC, Stanley Zlotkin MD PhD FRCPC

A 19-month-old boy, born at term, presented to an emergency department with fever and upper respiratory symptoms. An initial physical assessment documented a weight, height and head circumference at the 50th percentile. The child was found to be tachypneic, pale and weak, and had not yet achieved independent walking. Intravenous fluids were started and laboratory tests were sent for assessment. His complete blood count revealed a white blood cell count of $11.8 \times 10^9/L$, a hemoglobin (Hb) level of 41 g/L, a mean corpuscular volume (MCV) of 46 fL and a platelet count of $647 \times 10^9/L$. Hypochromasia, microcytosis, moderate polychromasia, mild pencil cells and occasional fragments were found on the blood film. A chest x-ray showed mild lower airway inflammation, no pneumonia and normal heart size. Further investigations revealed the following: ferritin 4.5 µg/L, total protein 57 g/L and albumin 30 g/L. Hb electrophoresis and Hb H preparation were normal.

Of note, the boy was breastfed for six weeks and took iron-fortified formula up to 14 months of age. Between six and 12 months of age, his solid food intake was poor. At one year of age, he began to eat table foods, almost solely rice. His milk intake at the time of presentation was 1.2 L (40 oz) per day of homogenized milk by bottle. Management included the following dietary counselling: limit milk intake to 480 mL (16 oz) per day as per nutritional recommendations for age, increase solid food intake, eliminate the bottle and use a cup. Therapeutic doses of oral iron supplementation were prescribed for four months.

During a follow-up visit one month later, his parents reported that he had improved significantly, with more energy and increased activity. He was now walking unsupported and was temperamentally much less irritable. Three months after his initial presentation, he was growing appropriately, and repeat laboratory investigations were all normal: Hb 116 g/L, MCV 73 fL, total protein 60 g/L, albumin 35 g/L and ferritin 22 µg/L.

The final diagnosis was severe iron-deficiency anemia (IDA), secondary to possible chronic microscopic blood loss in the stool and inadequate dietary iron intake from cow's milk and rice.

LEARNING POINTS

- Epidemiological studies in Canada have shown the prevalence of IDA among eight- to 15-month-old

children to be between 4% and 8% (1,2). Less is known about the prevalence of IDA among infants between 12 and 36 months of age, and about the prevalence of severe IDA.

- The evidence is strong but not conclusive for an association between IDA and neurodevelopmental delay (3,4).
- Case reports and case-control studies suggest a possible association between severe IDA and stroke in young children (5).
- In adults, low serum ferritin has been found to be the most accurate test to predict IDA compared with histological examination of bone marrow aspirate (6).
- In young children,
 - IDA is defined as a Hb level of less than 110 g/L, a ferritin level of less than 10 µg/L to 12 µg/L, and an MCV of less than 70 fL to 73 fL (7). Other supportive laboratory tests include low iron, high transferrin receptor and high free-erythrocyte protoporphyrin.
 - severe IDA has not been well established, but should be considered with a Hb level of less than 80 g/L accompanied by a low ferritin level and MCV.
- Physical examination findings, including conjunctival, palmar and nailbed pallor, are only apparent with severe anemia and are not very accurate in identifying mild to moderate IDA (8).
- Several clinical factors have been found to be associated with IDA in children 12 to 36 months of age (9,10). The risk increases with obesity, race or ethnicity (Hispanic, Asian), prolonged bottle use (beyond 16 months of age) and excessive cow's milk consumption (greater than 480 mL [16 oz]) per day. Daycare attendance is protective for IDA.
- There are no controlled trials of secondary prevention for IDA through screening. Implementing screening may be difficult because of poor follow-up and changing patterns of IDA before and after one year of age. IDA is more frequently reported in children older than one year of age described as difficult eaters and/or below the 10th percentile (11,12). Focused screening of individuals with risk factors or new Canadians may be

The Hospital for Sick Children and the Research Institute, University of Toronto, Toronto, Ontario

Correspondence: Canadian Paediatric Surveillance Program, 2305 St Laurent Boulevard, Ottawa, Ontario K1G 4J8. Telephone 613-526-9397 ext 239, fax 613-526-3332, e-mail cpsp@cps.ca

Accepted for publication January 26, 2010

considered. Testing for IDA in the first year of life does not preclude the need for testing in the second or third year of life.

- Primary prevention should remain a priority through anticipatory guidance regarding nutrition and feeding practices.
- The Canadian Paediatric Surveillance Program study on severe IDA (13) was initiated in October 2009. The goal is to increase awareness by health professionals and better delineate the health implications of severe IDA in infants and young children.

REFERENCES

1. Zlotkin SH, Ste-Marie M, Kopelman H, et al. The prevalence of iron depletion and iron-deficiency anemia in a randomly selected group of infants from four Canadian cities. *Nutr Res* 1996;16:729-33.
2. Innis SM, Nelson CM, Wadsworth LD, et al. Incidence of iron-deficiency anemia and depleted iron stores among nine-month-old infants in Vancouver, Canada. *Can J Public Health* 1997;88:80-4.
3. Grantham-McGregor S, Ani C. A review of studies on the effect of iron deficiency on cognitive development in children. *J Nutr* 2001;131:649S-666S.
4. Martins S, Logan S, Gilbert RE. Iron therapy for improving psychomotor development and cognitive function in children under the age of three with iron deficiency anaemia. *Cochrane Database Syst Rev* 2001:CD0001444.
5. Maguire JL, deVeber G, Parkin PC. Association between iron-deficiency anemia and stroke in young children. *Pediatrics* 2007;120:1053-7.
6. Guyatt GH, Oxman AD, Ali M, Willan A, McIlroy W, Patterson C. Laboratory diagnosis of iron-deficiency anemia: An overview. *J Gen Intern Med* 1992;7:145-53. (Erratum in 1992;7:423).
7. Looker AC, Dallman PR, Carroll MD, Gunter EW, Johnson CL. Prevalence of iron deficiency in the United States. *JAMA* 1997;277:973-6.
8. Chalco JP, Huicho L, Alamo C, Carreazo NY, Bada CA. Accuracy of clinical pallor in the diagnosis of anaemia in children: A meta-analysis. *BMC Pediatr* 2005;5:46.
9. Brotanek JM, Gosz J, Weitzman M, Flores G. Iron deficiency in early childhood in the United States: Risk factors and racial/ethnic disparities. *Pediatrics* 2007;120:568-75.
10. Sutcliffe TL, Khambalia A, Westergard S, Jacobson S, Peer M, Parkin PC. Iron depletion is associated with bottle feeding in the second and third years of life. *Arch Pediatr Adolesc Med* 2006;160:1114-20.
11. Bogen DL, Krause JP, Serwint JR. Outcome of children identified as anemic by routine screening in an inner-city clinic. *Arch Pediatr Adolesc Med* 2001;155:366-71.
12. James JA, Laing GJ, Logan S. Changing patterns of iron deficiency anaemia in the second year of life. *BMJ* 1995;311:230.
13. Canadian Paediatric Surveillance Program. Severe iron-deficiency anemia in infants and young children. <www.cps.ca/english/surveillance/CPSP/Studies/IDA.pdf> (Accessed on February 4, 2010).

The Canadian Paediatric Surveillance Program (CPSP) is a joint project of the Canadian Paediatric Society and the Public Health Agency of Canada, which undertakes the surveillance of rare diseases and conditions in children and youth. For more information, visit our Web site at <www.cps.ca/cpsp>.