Anemia in James Bay Cree infants of northern Quebec

A report and recommendations written for the Cree Board of Health and Social Services of James Bay

by

Noreen Willows, PhD

and

Katherine Gray-Donald, PhD

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Background

One of the authors of the report, Noreen Willows, was a doctoral student at McGill University in the School of Dietetics and Human Nutrition when she conducted research about anemia in Cree communities in James Bay during the years 1997-2000. The reason she studied this health issue is that health care professionals in James Bay are concerned about anemia in Cree infants. In 1995, the Cree Board of Health and Social Services of James Bay (CBHSSJB) implemented a screening protocol for anemia in 9-mo-old infants. In 1997, an Iron Deficiency Anemia Working Team was established in the region to counteract the problem. One of the top priorities of the team was to study the magnitude of the problem. Members of the CBHSSJB approached the other author of this report, Dr. Katherine Gray-Donald at McGill University, with their concerns about anemia. Noreen Willows agreed in June 1997 to study the prevalence of anemia and associated risk factors in Cree infants for her doctoral research under the supervision of Dr. Gray-Donald. Graduate committee members were Dr. Johanne Morel and Dr. Elizabeth J. Robinson. Dr. Robert Harris, Lucie Leclerc and Rose Iserhoff, health care professionals for CBHSSJB, served as a steering committee for the research.

The study of anemia in James Bay Cree babies of northern Quebec was the first study in Canada to obtain a comprehensive data set of nutritional indicators from a large number of infants of First Nation ancestry (n = 314). Data on iron status, growth, diet, infection, blood lead levels, and vitamin A deficiency were obtained. Babies were screened for anemia and had blood tests when they came to well-baby clinics at 9-months of age. A nurse or CHR in each clinic administered a questionnaire to the guardian of each baby that asked about infant diet and health.

Acknowledgments

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Dr. Willows worked closely with health care professionals (physicians, nurses, nutritionist, community health representatives) in Cree communities, with her steering committee, members of her thesis committee, and with hospital lab

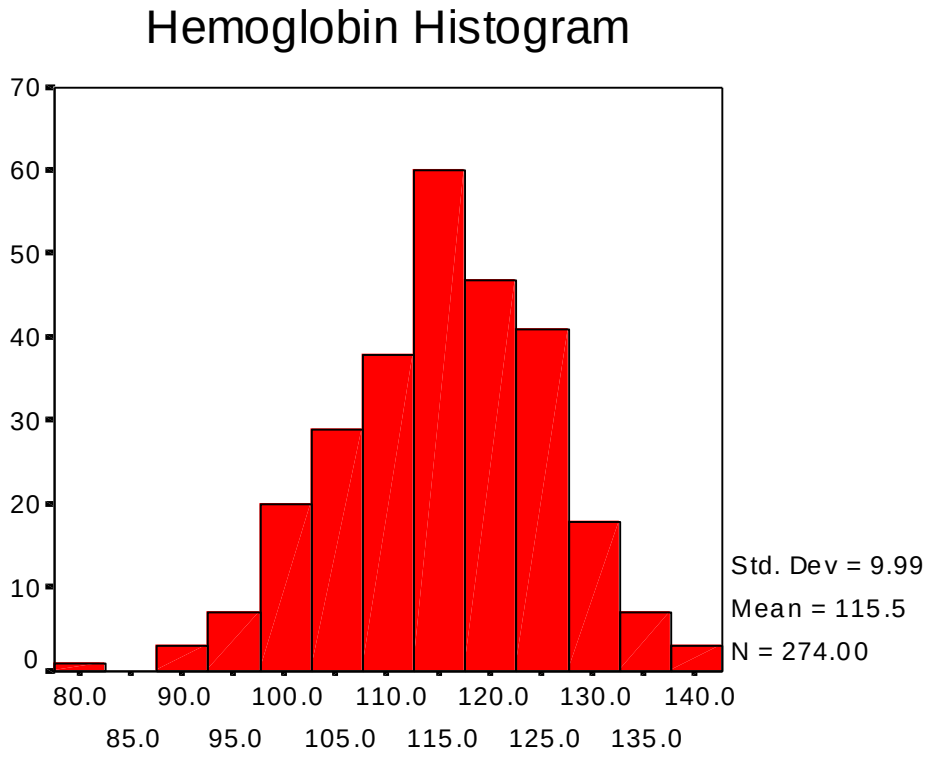
personal in Chibougamau, Chisasibi and Montreal. These cooperative efforts were important to ensure that infants were screened for anemia, blood was properly handled, and questionnaires were completed. All of these individuals are thanked deeply for their support. In particular, Dr. Willows is grateful to Drs. Johanne Morel, Elizabeth Robinson and Robert Harris of the CBHSSJB. Other individuals from the CBHSSJB were invaluable and included Lucie Leclerc, Mr. James Bobbish, Ms. Jill Torrie, and the Community Health Representatives: Rose Iserhoff, Joanne Matowahom, Mary Masty, Juliet Weapenicappo, Rita Mianscum-Trapper, Helen Iserhoff, Frances Diamond, Rosie Wapachee, and Alice Wapachee. Dr. Vijay Gray and Ms. Vi Kramer of Montreal Children's Hospital and Martine Soularde of Chibougamau hospital are thanked. None of this would have been possible without the support of Dr. Katherine Gray-Donald of McGill University.

Results of the Study

Anemia

(1) The prevalence of hemoglobin <110/gL was 25.9%.
(2) The prevalence of hemoglobin <105 g/L was 13.9%.
(3) The prevalence of hemoglobin <100 g/L was 5.1%.

The histogram figure below shows the hemoglobin distribution curve for infants who had blood measured for hemoglobin concentration. The mean hemoglobin concentration was 116 g/L and 95% of hemoglobin values were in the range of 96 – 136 g/L.



Hemoglobin is the iron-containing oxygen-carrying pigment of the red blood cells. Anemia in children is commonly defined as hemoglobin <110 g/L; however, mild anemia produces few clinical symptoms or signs. When the onset of anemia is gradual, mechanisms enable the body to compensate for a lower hemoglobin concentration. Serious health consequences of anemia are most likely at hemoglobin concentrations <100 g/L. These include shortness of breath and heart palpitations. Pallor of the skin and mucous membranes are signs of severe

anemia. The creases of the hand are lighter in colour than the surrounding skin when the hemoglobin level approaches 70 g/L. A systolic flow murmur can be heard when hemoglobin is <70 g/L (Baker and Bick 1993). Iron-deficiency anemia has been associated with psychomotor impairment in infants when hemoglobin concentration is <110 or 105 g/L (Idjradinata and Pollitt 1993; Lozoff et al. 1987; Lozoff, Jimenez, and Wolf 1991; Moffatt et al. 1994; Walter et al. 1989).

Iron status

- The prevalence of iron deficiency (serum ferritin < 10 μg/L) was 20.4%.
- The prevalence of iron-deficiency anemia (hemoglobin <110 g/L and serum ferritin <10 μg/L) was 6.9%.

Iron is found in heme-containing proteins including hemoglobin, myoglobin (the oxygen-carrying pigment in muscle) and the cytochromes, which function in electron transport in the mitrochondria. It is required by numerous cellular enzymes including enzymes in the citric acid cycle. When iron availability becomes a limiting factor for hemoglobin synthesis these other iron-containing tissue proteins and enzymes decrease (Beard, Dawson, and Pinero 1996). Iron is found throughout the brain and is necessary for the proper functioning of neurotransmitters (Beard, Connor, and Jones 1993a; Beard, Connor, and Jones 1993b).

Iron deficiency uncomplicated by anemia might not cause health problems. Iron deficiency sufficiently severe to cause anemia has been associated with psychomotor impairment causing delays in walking and talking and poor school performance (Idjradinata and Pollitt 1993; Lozoff et al. 1987; Lozoff, Jimenez, and Wolf 1991; Moffatt et al. 1994; Walter et al. 1989). For this reason, iron-deficiency anemia should be considered a serious health problem.

Vitamin A status

- No infant had vitamin A deficiency (serum retinol <0.35 μmol/L) although 2.7% (95% CI 0.40 – 5.0%) of infants had marginal vitamin A status (serum retinol ≥0.35 and <0.70 μmol/L).

    - These data suggest that subclinical vitamin A deficiency is a mild public health problem in Cree infants in James Bay. The World Health Organisation (WHO) states that subclinical vitamin A deficiency is of concern with a minimum 2.0% prevalence of serum retinol concentrations <0.70 μmol/L (WHO 1996). This is because serum retinol concentrations <0.70 μmol/L are associated with an increased risk of morbidity and mortality even in the absence of clinical evidence for disease associated with vitamin A deficiency.

- Infants with active infection had serum retinol concentrations that were lower than in infants who did not have active infection (1.11 vs. 1.33 µmol/L, p = 0.03).
    - A reasonable explanation for this observation is that acute infection causes vitamin A to be lost in the urine (Stephensen et al. 1994). This means that babies who experience chronic febrile illness are at risk for vitamin A deficiency.

Vitamin A is considered a nutrient at risk in aboriginal populations living in northern Canada (First Nations and Inuit) although cases of clinical vitamin A deficiency in children have not been reported (Godel et al. 1996; Moffatt 1995; Receveur, Boulay, and Kuhnlein 1997). Vitamin A has anti-infective properties and children with vitamin A deficiency are at risk for morbidity and mortality from infectious disease (Hussey and Klein 1990; Semba et al. 1993; Sommer, Katz, and Tarwotjo 1984). Vitamin A also is important for erythropoeisis and iron metabolism (Bloem et al. 1990; Garcia-Casal et al. 1998; Northrop-Clewes et al. 1996).

Lead toxicity

- The prevalence of elevated blood lead concentrations (>0.48 µmol/L) was 2.7% (95% CI 0.36 – 5.0). The blood lead concentrations of the 5 babies with elevated values were 0.49, 0.60, 0.70, 0.98 and 1.00 µmol/L. The three babies with the highest concentrations of blood lead continued to have elevated concentrations six to eight months later suggesting chronic environmental lead exposure.
- Babies with iron-deficiency anemia had a significantly higher mean blood lead concentration than did babies without iron-deficiency anemia (0.16 µmol/L vs 0.07 µmol/L, p = 0.001). This suggests that iron deficiency is a risk factor for lead absorption (Willows and Gray-Donald 2001a).
- In babies, no association between frequency of traditional food ingestion and blood lead levels were found (Willows and Gray-Donald 2001a). The analysis was based on the frequency with which babies ate traditional food, not the actual quantity of traditional food consumed.

Lead is a toxic metal that is absorbed through ingestion or inhalation. Iron deficiency increases the gastrointestinal absorption of lead. Children are at particular risk for lead poisoning because children are often iron deficient and they absorb up to 50 percent of the amount of lead ingested, whereas adults absorb only about 10 to 20 percent (Hu 1998). The concern with lead poisoning in children is related to the effects of lead on the brain. Children are vulnerable to the adverse neurotoxic effects of lead because their nervous systems are developmentally immature and cognition can be impaired even with low level lead exposure (Bellinger, Stiles, and Needleman 1992; Needleman and Gatsonis 1990). When a co-existing deficiency in iron exists, the neurotoxicity of lead may be increased (Ruff et al. 1996). The Center for Disease Control in Atlanta

considers blood lead levels ≥ 0.48 µmol/L (10 µg/dL) in children to be elevated, based on known adverse health effects at this threshold, including neurotoxic effects (Centers for Disease Control 1991). Recent studies show that in children blood lead concentrations <0.48 µmol/L are associated with cognitive deficits which point out that no safe level for lead may exist (Lanphear et al., 2000).

Aboriginal populations that hunt are at risk for elevated blood lead levels due to the consumption of game with lead tissue intoxication and/or ingestion of lead pellets lodged in game (Belinsky et al. 1996; Belinsky and Kuhnlein 2000; Carey 1977; Dewailly et al. 1998; Hanning et al. 1997; Reddy 1985; Scheuhammer and Norris 1995; Tsuji and Nieboer 1997; Scheuhammer and Norris 1995). Due to its weight, lead shot is retained in the appendix (Carey 1977; Reddy 1985; Tsuji and Nieboer 1997) and the ingestion of lead shot can cause lead poisoning (Greensher et al. 1974; Madsen et al. 1988). Among western James Bay Cree, adults have elevated dentine lead levels, evidence of a body lead burden (Tsuji et al. 1997). In the same population, cord and maternal blood lead are correlated with maternal consumption of traditional food (Hanning et al. 1997). The radioisotopes of lead found in Inuit cord blood matches that of lead found in the pellets used to shoot game, suggesting transplacental transmission of lead to the fetus (Dewailly et al. 1998). High blood lead concentrations are known in Cree adults living in at least one community in northern Quebec. Radiographs of the abdomen of Cree adults sometimes show radioopaque material, assumed to be lead shot (James Bobbish and Jill Torrie, personal communications).

Paradoxically, although potentially contributing to lead in the diet, many traditional foods are rich in iron (Belinsky et al., 1996; Belinsky and Kuhnlein, 2000) and might help prevent iron deficiency, thereby protecting against lead absorption in the gastrointestinal tract.

Compliance with oral iron therapy

Noreen Willows spoke to many physicians and nurses who work in the region that felt parents often did not give Fer-in-Sol to infants identified with anemia. This might explain the high prevalence of Jectofer usage (intramuscular injections of iron) in the region. Jectofer is used as a last resort for babies whose hemoglobin concentrations do not improve or worsen despite a prescription for Fer-in-Sol. (But see below. A failure of hemoglobin to respond to oral iron therapy could be the result of chronic or recurrent infection.)

The author spoke with CHRs and interviewed parents about anemia. The following factors were identified as causing parents to not give Fer-in-Sol: it stained the teeth, it made the baby cry, it made the baby constipated, it was not palatable, and the baby sometimes became sick (throwing up) from it. It also seemed that parents did not often understand the meaning of anemia and therefore were not motivated to give Fer-in-Sol.

Infection

The results of the anemia study indicate a high burden of infection in Cree infants.

- Parent's were asked if their baby had an infection in the previous two-weeks. More than one-half of infants (53.1%) were reported to have had an infection. The causes of infection, as reported by parents, were colds (43.7%), ear infections (20.2%), multiple infections (17.5%), fever or unspecified infection (15.2%), and diarrhea or skin infections (3.4%).
- Nurses were asked to not draw blood if the infant had an infection. Despite this precaution, white blood cells (leukocytes) were elevated in 8.9% of infants. C-reactive protein, a marker of active infection, was elevated in 11.8% of the infants who had a test result for this protein. Elevation in this positive acute-phase protein frequently precedes clinical symptoms of infection (Dinarello, 2000).

In general, infection prevalence is high among children of Canadian aboriginal ancestry (Harris et al. 1998).

Diet

- The prevalence of breastfeeding was 35% in babies who were 9-months old.
- The average amount of bottled milk consumed daily by infants who were strictly bottle-fed was 940 mL (33 oz), which is in excess of the recommended amount of 720 mL (24 oz) for infants 8 to 12 months old. Bottle-fed babies weighed substantially more than breastfed babies (Willows, Morel, and Gray-Donald 2000). This suggests that bottle-feeding might lead to overweight.
- Only 14.2% of infants were given red meat to eat daily and one-third of infants were not fed red meat at all.
- Traditional food was fed to 69% of babies.

Supplement use (as reported by guardians)

- 70% of babies were given Tri-Vi-Sol or Tri-Vi-Flor.
- 6.8% of babies had been prescribed Fer-in-Sol. (The questionnaire was administered before the screening for iron deficiency using hemoglobin concentration.)

Food insecurity

- Women were asked if they ever worried they did not have enough money to buy their children food and 20.9% of women answered "yes" to this question.
- Only 6.5% of women who breastfed their baby and did not give the baby any bottled milk answered "yes" to this question. In contrast, approximately 24.0% of women who bottle-fed their baby answered "yes" to this question.

- These results suggest that purchasing formula and milk, bottles, and bottle liners was an economic burden for many parents and that breastfeeding is the economic choice. Many babies who were bottle-fed drank 1-2 litres of milk or formula each day. In Whapmagstui, 2L of whole milk cost $4.60 to purchase in 1999. In one community, one woman was feeding her baby 3 cans of premade formula per day at a cost of $3.00 per can which would have amounted to $372.00 per month.

Etceteras

- 13.2% of infants had attended daycare
- 46.7% of infants had been to the bush
- 21.3% of women were teenagers when they gave birth to the baby in the study

Associations with iron deficiency and anemia

This study was cross-sectional so that statements about cause and effect cannot be made. The findings of the study are purely observational. The following associations were found in the Cree babies that were studied.

(1) Infants who were formula-fed had the lowest prevalence of iron deficiency and anemia (Willows and Gray-Donald 2001b; Willows, Morel, and Gray-Donald 2000).

The likely reason for this observation is that most infants in the study drank iron-fortified formula. In Canada, iron-fortified formula is fortified to the level of 7 to 12 mg iron/L, as ferrous sulfate, a readily absorbed iron salt (Canadian Pediatric Society 1998). At this level of fortification formula is efficient at providing dietary iron sufficient to maintain iron stores (Haschke et al. 1993; Irigoyen et al. 1991; Pizarro et al. 1991; Walter et al. 1993). Iron status is maintained in infants fed iron-fortified formula, irrespective of the level of iron consumed in solids food (Walter et al. 1993). Supplementary iron does not improve the hemoglobin concentration of infants who consume iron-fortified formula (Irigoyen et al. 1991). All women who choose to bottle-feed their baby should be encouraged to use an iron-fortified formula.

(2) Infants who consumed cow's milk had a high prevalence of anemia (Willows, Morel, and Gray-Donald 2000).

Many studies have found that infants fed cow's milk in the first year of life have poor iron status (Friel et al. 1997; Fuchs et al. 1993; Lehmann et al. 1992; Mills 1990; Mira et al. 1996; Pizarro et al. 1991; Saarinen and Siimes 1979). The addition of iron-fortified cereals to the diet of infants who consume cow's milk does not reliably prevent iron deficiency (Fuchs et al. 1993). Cow's milk is low in bioavailable iron (Saarinen and Siimes 1979) and fresh cow's milk consumed

during the first year of life results in gastrointestinal blood loss due to hypersensitivity to cow's milk protein (Ziegler 1989; Ziegler et al. 1999). Fecal blood loss in response to cow's milk is more common among infants who are breastfed early in life. The amount of iron lost during cow's milk feeding in formerly breastfed infants can be as high as 0.340 mg each day, substantial enough to negatively effect iron status. By 12 months of age, the hypersensitivity of the gut to cow's milk disappears (Ziegler et al. 1999). For these reasons, cow's milk should not be introduced prior to 9-months of age, and in formerly breastfed infants the introduction of cow's milk should be delayed until 1-year-old.

(3) Breastfed infants had a high prevalence of anemia and iron deficiency.

The association between breastfeeding and anemia in breastfed infants 6 months of age and older who are not fed iron rich solids has been reported in other populations (Calvo, Galindo, and Aspres 1992; Dewey et al. 1998). The anemia is not due to breastfeeding *per se*, rather breastfeeding in combination with a low iron diet. Human milk contains approximately 0.5 mg of iron per litre (Dallman, Yip, and Oski 1993). Although breast milk iron is highly bioavailable (Saarinen and Siimes 1979), an infant who drinks 750-1000 mL of breast milk per day will fall short of the RNI for infants 5-12-months-old unless consuming iron rich food. For this reason, it is recommended that breastfed infants receive iron-fortified cereals at 4 to 6 months of age (Canadian Pediatric Society 1998). Iron-rich foods such as red meat and iron-fortified cereal can help prevent iron-deficiency anemia in breastfed babies 6-months of age and older (Dallman 1996; Engelmann, Sandstrom, and Michaelsen 1998; Walter et al. 1993).

Although iron-fortified formula is an excellent vehicle for delivering iron, it is unclear how much would be required to prevent deficiency in a breastfed baby. Further, supplemental bottle-feeding may result in the termination of breastfeeding, and suggesting that women supplement breastfeeding with bottle-feeding may make women feel inadequate and lack confidence in breastfeeding.

The finding of an association between breastfeeding and iron deficiency should not be considered grounds to discourage women from breastfeeding their babies for the following reasons.

- Breastfeeding is recognized as the optimal method of feeding infants and with appropriate supplemental feeding is considered adequate to maintain the health of children for up to 2 years of age and beyond that age (Canadian Pediatric Society 1998). The Canadian Paediatric Society encourages exclusive breastfeeding for all infants in the first 4 months of life (Canadian Pediatric Society 1998).
- Breastfed infants may have enhanced global neurologic development compared with formula fed infants, and these cognitive developmental benefits of breastfeeding increase with its duration (Anderson, Johnstone, and Remley 1999).

- Breastfeeding seems to impose less of an economic strain on Cree families in James Bay based on the observation that 4 times as many women of infants in the study who bottle-fed their infants reported food insecurity.
- Cree infants from James Bay who are breastfed have more moderate body weight than do bottle-fed infants (Willows, Morel, and Gray-Donald 2000). Breastfeeding may protect against obesity in adolescence and adulthood (von Kries et al. 1999). This is an important consideration in James Bay where the prevalence of childhood obesity is high.
- Breastfeeding may reduce the risk of infections (Raisler, Alexander, and O'Campo 1999; Wilson et al. 1998).
- Breastfeeding is an important cultural practice among the Cree of James Bay. This tradition must be respected.

(4) Infants who were given the supplements Tri-Vi-Sol or Tri-Vi-Flor had higher hemoglobin concentrations than infants not given supplements (116 g/L vs. 113 g/L). The odds ratio for anemia for infants who were not given supplements as compared to infants who were given supplements was 3.0 (95% CI 1.3 – 6.8) when statistically adjusted for breast and formula feeding.

This finding suggests that supplements provided protection from anemia. Tri-Vi-Flor and Tri-Vi-Sol contain vitamins A and C; both can improve iron status. Vitamin C helps with the absorption of iron from food. Vitamin A supplements have been shown to improve iron status in infants and children (Bloem et al. 1989; Bloem et al. 1990; Mejia and Chew 1988; Semba et al. 1992). It has been speculated that vitamin A affects iron transport, metabolism and storage within the body; benefits erythropoiesis; decreases infections that modify iron status indicators; and, improves iron absorption (Bloem et al. 1990; Garcia-Casal et al. 1998; Northrop-Clewes et al. 1996).

(5) Infants who had an infection in the two-week period before blood was drawn had a higher prevalence of anemia (Willows and Gray-Donald 2001b). Thus, infections are one possible cause of anemia in Cree babies.

The prevailing opinion as to why hemoglobin concentration diminishes following infection is that the erythroid marrow becomes unresponsive to erythropoietin (Abshire 1996). In infants, erythrocytes are perhaps destroyed to remove antigen-antibody complexes on the red blood cell membrane, causing a transient hemolytic anemia (Seitz et al. 1993). In general, hemoglobin concentration spontaneously rises when infection passes, although it can remain depressed for up to three months (Abshire 1996; Abshire and Reeves 1983; Kaplan and Oski 1980; Seitz et al. 1993).

Mild anemia is not specific for iron deficiency. Confidence that anemia is due to iron deficiency is increased when anemia is coupled with low serum ferritin concentration or low erythrocyte mean cell volume or other abnormal red cell

indices. As anemia due to infection is usually mild, a hemoglobin concentration <100 g/L is relatively specific for dietary iron deficiency.

(6) Infants with acute infection (elevated C-reactive protein concentration) had lower transferrin saturation, lower serum iron concentration and elevated serum ferritin concentration (Willows and Gray-Donald 2001b).

The likely reason for this observation is that iron tests are altered by infection. Serum ferritin, which is an acute phase protein, increases in the presence of infection so that it no longer represents iron stores. In contrast, serum iron concentration and transferrin saturation become depressed (Abshire 1996; Jurado 1997; Olivares et al. 1989; Reeves et al. 1984). Thus, caution must be used when interpreting biochemical tests of iron deficiency in the presence of acute infection.

(7) Rapidly growing babies had the greatest odds for red blood cells that were small (microcytes) when the type of milk that was consumed was controlled for, suggesting that fast-growing infants were not getting enough iron.

This finding can be explained by the fact that the blood volume expands in parallel with growth, increasing requirements for iron (Owen 1989; Siimes 1981). High growth velocity in full-term infants in other populations has also been associated with poor iron status and anemia (Michaelsen, Milman, and Samuelson 1995; Morton, Nysenbaum, and Price 1988).

Recommendations based on study results

(1) Initiate primary prevention efforts to prevent iron deficiency in babies

- Primary prevention efforts should be emphasized given that it is difficult to treat iron deficiency if compliance to therapy is poor, and psychomotor impairment caused by iron deficiency may be irreversible despite iron therapy.
- Public health policies to improve iron nutrition in Cree babies are needed considering the potential for psychomotor impairment in babies with iron-deficiency anemia and the finding of higher blood lead levels in babies with iron-deficiency anemia.
- Ensure the availability of affordable iron-rich infant food and iron-fortified formula in local stores.
- Find a culturally appropriate and palatable food source of iron that can be promoted for infants and children.
- A systematic and widespread nutrition education program is required consisting of local nutrition educators. These nutrition educators should be integrated into well baby care or should be involved in home visits.
- Council all women with young infants about the importance of introducing high quality complementary foods beginning at 4-6 months of age.

- Discourage cow's milk until 1 year old, particularly in formerly breastfed infants.
- For women who choose to bottle-feed, encourage the use of iron-fortified formula.
- Breastfed infants need to be provided with iron-fortified foods such as infant cereals and meat or supplemented with oral iron at a dose of 1 mg/kg/day, not exceeding 15 mg/day, starting at 6 months of age (Dallman 1996).

(2) *After primary prevention efforts to prevent iron deficiency are established a repeated cross-sectional survey can be used to determine changes in risk factors and anemia prevalence over time.*

Successful efforts at reducing iron deficiency will result in a shift in the hemoglobin distribution curve of the population toward the right, and a higher mean hemoglobin concentration.

(3) *Therapeutic iron therapy should be initiated when the erythrocyte mean cell volume is <71 fL or hemoglobin is <105 g/L. Advice to increase the amount of iron in the infant's diet should be offered when hemoglobin is <110 g/L (see Table).*

(4) *Revise well-baby clinic forms so that they document in a clear manner:*
- the amount and type of formula consumed (regular or iron-fortified)
- the amount and type of cow's milk consumed (1%, 2%, 3.25%)
- the types of solid foods (iron-fortified cereals, meat, fruits, vegetables) fed to the baby and the frequency with which they are fed
- the type of supplements given to the baby (e.g., Tri-Vi-Sol, Fer-in-Sol, D-Vi-Sol) and the frequency with which they are given
- the babies hemoglobin concentration at 9-months of age (if screened)

(5) *Efforts to minimize contact between Cree babies and environmental lead sources are required. The source(s) of lead need to be identified.*

(6) *Studies to understand the sociocultural causes of anemia are required.* The questions that need to be answered are as follows:
- In a culture that has a strong tradition of hunting, why is the introduction of meat to children delayed and why do infants not eat red meat more often?
- Why do some parents choose to use cow's milk or formula that is not iron fortified?
- Why are sales of iron-fortified baby cereals slow?
- Do parents understand the meaning of anemia?
- How can health care professionals in the region improve their communications with parents and guardians about anemia?
- What are the factors that cause high infection prevalence among infants?

(7) *No public health measures need to be directed at vitamin A deficiency.* Although there is some subclinical vitamin A deficiency, this problem will likely resolve once issues of decreasing infection prevalence and increasing high quality foods in the diet are successful.

Screening for anemia at 9-months, and at follow-up, Dr. Johanne Morel, Pediatrician, and Noreen Willows, Ph.D.

9-month well-baby clinic

Draw blood for the complete blood cell count (CBC). Make sure the baby does not have a fever (38.2ºC), bad cold, otitis, or diarrhea when blood is drawn. Optimally, the blood draw should occur before the 12-month vaccination or the same day as the vaccination (hemoglobin may decline for up to 1 month following vaccination).

Hemoglobin < 105 g/L or MCV < 71 fl ⇓		Hemoglobin ≥ 105 -109 g/L ⇓
<u>If hemoglobin is >90.5 but <105 g/L</u> • Consult with physician about treatment • **Nutrition counseling** • Iron supplements for 3 months (if recommended by a physician) 5-6 mg elemental iron/kg body wt/day • Give in 2 doses with orange juice ⇓	<u>If hemoglobin is <90.5 g/L</u> • Consult with physician about treatment • **Nutrition counseling** • Iron supplements for 3 months (if recommended by a physician) 5-6 mg elemental iron/kg body wt/day • Give in 2 doses with orange juice • Check hemoglobin and reticulocytes in 1 month. If there is no improvement, counsel about the importance of iron drops and diet. If hemoglobin is <90.0 g/L discuss with a physician about administering iron shots. ⇓	• Nutrition counseling ⇓

12-month well-baby clinic (All anemic babies return to the clinic)

- Question about compliance (Was the baby given iron supplements and iron-rich food?)
- Check hemoglobin and serum ferritin for those babies who had hemoglobin <105 g/L at 9-months old

⇓

Hb < 90 g/L ⇓	Hb 90-104 g/L ⇓	Hb ≥105 g/L ⇓
• Nutrition counseling • Consult a physician about treatment • Follow-up CBC + ferritin in 3 months • (15-month baby clinic)	• Nutritional counseling • Iron supplements continue if recommended by physician. • Follow-up CBC + ferritin in 3 months • (15-month baby clinic)	• Nutritional advice • If ferritin is <10 µg/L give iron supplements for 3 more months if recommended by a physician. • No follow-up required unless anemia suspected.

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