Nutrition for Healthy Term Infants

Statement of the
Joint Working Group:
Canadian Paediatric Society
Dietitians of Canada
Health Canada

Canadian Paediatric Society | Société canadienne de pédiatrie
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Health Canada

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Executive Summary

The Canadian Paediatric Society Nutrition Committee, Dietitians of Canada and Health Canada collaborated on the preparation of this statement on nutrition for healthy term infants from birth to 24 months of age. This statement is intended for the use of health care professionals. It provides information that is basic to communicating consistent messages about infant nutrition to parents and caregivers across Canada. It is not designed, however, to be an all-encompassing practical guide to infant feeding. The recommendations in this statement are based on available scientific evidence. However, many studies on infant nutrition are not based on randomized trials because they are neither possible nor ethical in many circumstances. In the absence of solid science, accepted practice and its rationale is presented. Throughout the document, we have attempted to clearly distinguish those recommendations based on science versus those based on common practice. A summary of the principles and recommendations found in the document is presented below.

Summary of Principles and Recommendations

Breastfeeding

Breastfeeding is the optimal method of feeding infants. Breastfeeding may continue for up to 2 years of age and beyond.

Recommendation:

1. Encourage exclusive breastfeeding for at least the first 4 months of life.

Active public health, hospital, community and workplace support of breastfeeding will increase initiation rates and duration of breastfeeding.

Recommendations:

2. Provide antenatal and postnatal counselling about the principles and practice of breastfeeding.
3. Encourage frequent feeds during the early postnatal period.
4. Provide more community-based programs supporting breastfeeding families as the length of hospital stays decreases.
5. Encourage support in the community and workplace for flexible work schedules, part-time nursing and the use of expressed breast milk.

Breastfeeding is rarely contraindicated. Neither smoking nor environmental contaminants are necessarily contraindications to breastfeeding. Moderate, infrequent alcohol ingestion, the use of most prescription and over-the-counter drugs and many maternal infections do not preclude breastfeeding.

Recommendations:

6. Encourage women who smoke to stop or reduce smoking; however, even if smoking is continued, breastfeeding is still the best choice.
7. Limit intake of alcohol.
8. Whenever drugs are prescribed or infection detected, assess each case on an individual basis.
9. When the mother is known to be HIV antibody positive, alternatives to breastfeeding are indicated.

Vitamin D deficiency is a health concern in Canada. Infant formulas and milks are fortified with vitamin D. Breastfed infants should also receive extra vitamin D in the form of a supplement.

Recommendation:

10. Provide a vitamin D supplement to all breastfed infants starting at birth and until the diet provides a source of vitamin D.

Alternate Milks

If an infant is not breastfed, or is partially breastfed, commercial formulas are the most acceptable alternative to breast milk until 9 to 12 months of age.

Recommendations:

11. Use cow's milk-based, iron-fortified formulas until 9 to 12 months of age.
12. Iron-fortified follow-up formulas are a preferred alternative to cow's milk from 6 months until 9 to 12 months of age.
13. Use soy-based formulas only for those infants who cannot take dairy-based products for health, cultural or religious reasons, such as a vegan lifestyle, or galactosemia.
14. Specialty formulas are indicated only for infants with detected or suspected pathology.

The use of nutritionally incomplete alternate milks as the sole source of nutrition for infants is inappropriate. Pasteurized whole cow's milk, however, is an important component of a mixed infant diet after 9 months of age. For infants unable to take cow's milk products, continue commercial soy formula until 2 years of age.

Recommendations:

15. Pasteurized whole cow's milk may be introduced at 9 to 12 months of age and continued throughout the second year of life.
16. Partly skimmed milk (1% and 2%) is not routinely recommended in the first 2 years.
17. Skim milk is inappropriate in the first 2 years.
18. Soy (except soy formula), rice or other vegetarian beverages, whether or not they are fortified, are inappropriate alternatives to breast milk, formula or pasteurized whole cow's milk in the first 2 years.

Other Fluids in Infant Feeding

Tap water, well water meeting established standards of safety and commercially bottled water, except mineral or carbonated water, are generally suitable for infants. Limit the use of "fruit juice" to avoid interfering with the intake of nutrient-containing foods and fluids. Herbal teas and other beverages are of no known benefit to an infant and may be harmful.

Recommendations:

19. Bring all water for feeding infants under 4 months of age to a rolling boil for at least 2 minutes to ensure that it is pathogen free.
20. Limit fruit juice to avoid interfering with the intake of breast milk or infant formula.
21. Do not use herbal teas or other beverages.

Transition to Solid Foods

Infants between 4 and 6 months of age are physiologically and developmentally ready for new foods, textures and modes of feeding. By 1 year of age, the ingestion of a variety of foods from the different food groups of Canada's Food Guide to Healthy Eating *is desirable.*

Recommendations:

22. Introduce complementary foods at 4 to 6 months to meet the infant's increasing nutritional requirements and developmental needs.
23. To prevent iron deficiency, iron-containing foods such as iron-fortified cereals are recommended as the first foods.

Safety Issues Around Feeding

Foods provided to infants must be free of pathogens, appropriate in size and texture, nutritionally sound and fed safely.

Recommendations:

24. To prevent infant botulism, do not use honey in the feeding of infants under 1 year of age.
25. To prevent salmonella poisoning, cook all eggs well and do not use products containing raw eggs.
26. Hard, small and round, smooth and sticky solid foods are not recommended because they may cause choking and aspiration.
27. Ensure that infants and toddlers are always supervised during feeding.
28. Avoid feeding an infant using a "propped" bottle.

Nutrition in the Second Year

Healthy eating is important in the second year to: (a) provide the energy and nutrients needed to grow and develop; (b) develop a sense of taste and an acceptance and enjoyment of different foods; and (c) instill attitudes and practices which may form the basis for lifelong health-promoting eating patterns.

Recommendation:

29. Small, frequent, nutritious and energy-dense feedings of a variety of foods from the different food groups are important to meet the nutrient and energy needs during the second year.

Other Issues in Infant Nutrition

(i) Food allergies

Whenever possible, allergies to food should be prevented.

Recommendation:

30. Encourage exclusive breastfeeding for at least 4 months to decrease the risk of allergy in infants with a positive family history.

Treatment of proven food allergies involves avoidance of foods known to cause symptoms.

Recommendation:

31. When food choices are restricted, ensure that dietary intake continues to meet nutrient and energy needs.

(ii) Colic

Dietary manipulations have had limited success in the treatment of colic.

Recommendation:

32. Ensure that any dietary modification or pharmalogical interventions are safe.

(iii) Constipation

In infancy, true constipation is infrequent.

Recommendation:

33. Parents need to be educated about the wide variation in normal bowel function in infants and toddlers to avoid overtreatment of normal variants.

(iv) Dietary fat

Dietary fat is an important source of energy and the only source of essential fatty acids.

Recommendation:

34. Dietary fat restriction during the first 2 years is not recommended because it may compromise the intake of energy and essential fatty acids and adversely affect growth and development.

(v) Dental caries

Prevalence of dental caries is lower where infants and children have access to fluoridated water and where long-term exposure of teeth to nutrient-containing liquids is avoided. Excessive fluoride intake can cause dental fluorosis.

Recommendations:

35. Fluoride supplementation is not recommended for infants less than 6 months of age.

36. For infants between the ages of 6 months to 2 years who are living in areas where the household water supply contains less than 0.3 ppm (μg/L) fluoride, daily supplementation with 0.25 mg fluoride is recommended. Where the principal drinking water source contains ≥ 0.3 ppm (μg/L) fluoride, supplementation is not recommended.

37. Avoid excessive intake of fluoride.

38. Avoid the use of a bottle during sleep time or as a pacifier. Avoid nocturnal and long-term use of baby bottles containing liquids other than water.

39. Do not dip pacifiers or nipples in sugar or honey.

(vi) Gastroenteritis

Manage mild to moderate dehydration associated with gastroenteritis with oral rehydration therapy (ORT). Prevent malnutrition.

Recommendations:

40. Manage mild to moderate dehydration with an oral electrolyte solution and early refeeding.

41. For infants who are breastfed, continue breastfeeding while supplementing fluid intake with an oral electrolyte solution.

(vii) Diabetes

The exact role of early infant nutrition as a possible etiologic factor for infants genetically at risk for diabetes has not been proven.

Recommendation:

42. There is no justification at this time to recommend changes to infant feeding practices for the purpose of preventing diabetes.

(viii) Iron deficiency anemia

Iron deficiency is preventable through appropriate feeding choices.

Recommendations:

43. Continue exclusive breastfeeding for at least 4 months.
44. Introduce complementary foods containing iron at 4 to 6 months of age.
45. Choose iron-containing formulas for infants who are not breastfed or for infants receiving formula as well as breast milk.
46. Delay the introduction of whole cow's milk until 9 to 12 months of age.
47. Continue to offer iron-fortified foods beyond 1 year of age to provide sufficient iron.
48. Where informed parents choose not to adhere to these recommendations, screen for anemia at 6 to 8 months of age and provide medicinal iron drops if necessary.

(ix) Vegetarian diets

Nutritional needs can be met by most well-planned vegetarian diets. For vegetarian diets that are limited in variety and nutritional quality, professional advice regarding supplements is appropriate.

Recommendations:

49. For vegan infants who are not breastfed, promote commercial soy-based infant formula during the first 2 years of life.
50. After dietary assessment, recommend nutrient supplements for vegan diets which are found to be nutritionally incomplete.

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Introduction

The Canadian Paediatric Society Nutrition Committee, Dietitians of Canada and Health Canada collaborated on the preparation of this statement on nutrition for healthy term infants from birth to 24 months of age. The last national guidelines on infant feeding, entitled *Feeding Babies: A Counseling Guide on Practical Solutions to Common Infant Feeding Questions* (commonly referred to as Feeding Babies), were prepared by Health and Welfare Canada and the Canadian Paediatric Society in 1986 (HWC/CPS, 1986). Those guidelines built upon the infant feeding statement published by the Canadian Paediatric Society Nutrition Committee in 1979 (CPS, 1979).

This statement is intended for the use of health professionals. It provides information that is basic to communicating consistent messages about infant nutrition to parents and caregivers across Canada. It is not designed, however, to be an all-encompassing practical guide to infant feeding. It is expected that this statement will be used as a basis for the development of practical feeding guidelines by provinces and territories and other organizations.

The statement presents a summary of the nutrition principles and recommendations for healthy term infants from birth to 24 months of age. Four major topics related to nutrition in the first year of life are discussed: breastfeeding, alternate milks, other fluids in infant feeding, and transition to solid foods. Safety issues around feeding are presented next, followed by nutrition in the second year of life. The last section covers other issues in infant nutrition and includes food allergies, colic, constipation, dietary fat, dental caries, gastroenteritis, diabetes, iron deficiency anemia and vegetarian diets.

Wherever possible, the recommendations in this statement are based on available scientific evidence. However, many studies on infant nutrition are not based on randomized trials because they are neither possible nor ethical in many circumstances (e.g. it is not possible to randomize potentially breastfed infants into a non-breastfed control group). Similarly, it is often not possible to randomize infants into feeding practices that are rational from a nutritional perspective, but culturally unacceptable. In the absence of solid science, accepted practice and its rationale is presented. Throughout the document, we have attempted to clearly distinguish those recommendations based on science versus those based on common practice. As new clinical studies and meta-analyses are published in this area, recommendations may be altered accordingly.

Breastfeeding

Breastfeeding is the optimal method of feeding infants. Breastfeeding may continue for up to 2 years of age and beyond.

Recommendation:

1. Encourage exclusive breastfeeding for at least the first 4 months of life.

Active public health, hospital, community and workplace support of breastfeeding will increase initiation rates and duration of breastfeeding.

Recommendations:

2. Provide antenatal and postnatal counselling about the principles and practice of breastfeeding.
3. Encourage frequent feeds during the early postnatal period.
4. Provide more community-based programs supporting breastfeeding families as the length of hospital stays decreases.
5. Provide support in the community and workplace for flexible work schedules, part-time nursing and the use of expressed breast milk.

Breastfeeding is rarely contraindicated. Neither smoking nor environmental contaminants are necessarily contraindications to breastfeeding. Moderate, infrequent alcohol ingestion, the use of most prescription and over-the-counter drugs and many maternal infections do not preclude breastfeeding.

Recommendations:

6. Encourage women who smoke to stop or reduce smoking; however, even if smoking is continued, breastfeeding is still the best choice.
7. Limit intake of alcohol.
8. Whenever drugs are prescribed or infection detected, assess each case on an individual basis.
9. When the mother is known to be HIV antibody positive, alternatives to breastfeeding are indicated.

Vitamin D deficiency is a health concern in Canada. Infant formulas and milks are fortified with vitamin D. Breastfed infants should also receive extra vitamin D in the form of a supplement.

Recommendation:

10. Provide a vitamin D supplement to all breastfed infants starting at birth and until the diet provides a source of vitamin D.

Benefits of breastfeeding to infants in Canada

Breastfeeding is recommended for all infants, with very few exceptions. Exceptions include infants with galactosemia, or infants of mothers who are HIV antibody positive or have untreated, active tuberculosis.

(i) Reduced incidence of infection. Recent studies have provided evidence that, in developed countries, breastfeeding protects against gastrointestinal and respiratory infections and decreases the risk of otitis media (Beaudry *et al.*, 1995; Duncan *et al.*, 1993; Howie *et al.*, 1990; Boucher *et al.*, 1986). Newborn infants breastfed for 13 weeks or more had significantly fewer gastrointestinal and respiratory illnesses during the first year of life when compared to formula-fed infants (Howie *et al.*, 1990). In comparison to formula-fed infants, infants exclusively breastfed for a minimum of 16 weeks had fewer episodes of single and recurrent otitis

media during the first year of life (Duncan *et al.*, 1993). Breastfed infants supplemented with formula or food before 4 months were more likely to develop otitis media (Duncan *et al.*, 1993). A recent meta-analysis of the risk factors for acute otitis media showed that the risk decreased with breastfeeding for at least 3 months (Uhari *et al.*, 1996). Thus, exclusive breastfeeding seems to have a protective effect.

(ii) Prevention of SIDS. Although a number of studies have suggested an association between breastfeeding and protection against sudden infant death syndrome (SIDS), none has controlled for infant sleeping position and household smoke exposure, two important risk factors; thus, a causative protective relationship remains unproved (Ford *et al.*, 1993; Bernshaw, 1991; Kraus *et al.*, 1989). Nevertheless, breastfeeding may give some protection against SIDS.

(iii) Prevention of allergies. Atopic disease in infants is frequently reported. Its incidence has been estimated at 10%, but is likely closer to 2% (Falth-Magnusson *et al.*, 1987; Van Asperen *et al.*, 1983, 1984). The wide range of reported incidence is due to variable diagnostic criteria and techniques, and the high incidence of self-diagnosis. Poor study designs have contributed to the controversy regarding the protective effect of breastfeeding against atopic disease (Kramer, 1988). Breastfeeding compared to formula feeding does not appear to decrease the incidence of atopy in infants with no genetic predisposition to atopy (Lucas *et al.*, 1990). For infants at increased risk because of a positive family history (one or both parents, or a sibling with atopy), exclusive breastfeeding for at least 4 months does appear to have a protective effect (Chandra, 1997; Saarinen and Kajosaari, 1995; Burr *et al.*, 1993; Lucas *et al.*, 1990).

For infants with a family history of atopy, maternal avoidance of specific foods (e.g. milk and dairy products, eggs, peanuts) during pregnancy and lactation has not been proven to be more effective in reducing the incidence and severity of atopy throughout the first year of life than exclusive breastfeeding without maternal food restriction (Falth-Magnusson, 1994; Zeiger *et al.*, 1989). Risk of reduction in third trimester maternal weight gain and lower infant birth weight in the women avoiding potentially allergenic food during pregnancy illustrate the need for close nutritional monitoring. Until the efficacy of a restricted diet during pregnancy and lactation is known, routine restriction of diets of mothers of infants at risk for allergy is not recommended.

A small number of exclusively breastfed infants may develop allergic responses due to the passive transfer of food antigens from the mother's diet through breast milk. Two protein food antigens, bovine IgG (Clyne and Kulczycki, 1991) and ß-lactoglobulin (Jakobsson *et al.*, 1985) have been detected in breast milk. If exclusively breastfed infants present with clinical signs of atopy, a trial elimination-challenge of suspect foods in the mother's diet is recommended to determine whether or not the infant's reaction is to foods eaten by the mother. Common offending food antigens are protein-rich foods such as cow's milk, fish, eggs, soy and peanuts. If maternal diet modification is deemed necessary, counselling from a dietitian or nutritionist may be beneficial.

(iv) Enhanced cognitive development. Although the mechanism is unknown, there is documentation from cohort studies that the mean value for cognitive development in populations of children who are breastfed is slightly higher compared to bottle-fed infants from similar environments (Rogan and Gladen, 1993; Lucas *et al.*, 1992; Morrow-Tlucak *et al.*, 1988; Taylor and Wadsworth, 1984). Interpretation of these results is complicated by the concurrent association between breastfeeding and socio-environmental factors.

Maintenance of acceptable growth

Recent North American cohort studies have demonstrated that the growth rate of infants from similar socioeconomic and ethnic backgrounds who have been breastfed for more than 3 months is slower than that of formula-fed infants (or infants breastfed for less than 3 months) (Dewey *et al.*, 1992, 1993). Behavioural development, activity level and morbidity were not different between breastfed and formula-fed groups, suggesting that there was no health-related significance of the slower growth rate (Dewey *et al.*, 1993). When this slower growth pattern of otherwise healthy and thriving breastfed infants is misinterpreted as "growth faltering," it can lead to unnecessary concern about the adequacy of breastfeeding, and interfere with the promotion of breastfeeding for the first 4 to 6 months of life (Grummer-Strawn, 1993; Sheard, 1993a). There is no evidence that breastfed infants are at increased risk because of slower growth. Comparing the growth of breastfed infants to reference data can lead to unnecessary monitoring and investigation, as well as parental concern.

Development of reference growth charts for exclusively breastfed infants has recently started, but further reference data are needed (WHO, 1994). Meanwhile, regardless of which growth charts are used, growth is considered normal when weight and length track along similar percentiles or growth channels. Only when length and weight percentiles are disproportional, or when length and/or weight cross percentiles downwards by a significant amount, is intervention appropriate.

Factors influencing initiation and duration of breastfeeding

Duration of breastfeeding has decreased since 1960. Recent Canadian statistics show that while almost 75% of mothers begin breastfeeding in hospital, only 60% and 30% are still exclusively breastfeeding at 3 and 6 months, respectively (Health Canada, 1996). By 9 months, only 18% of mothers still breastfed in a Vancouver cohort (Williams *et al.*, 1996). Breastfeeding trends vary across the provinces; rates are higher in the west and drop off from Quebec to the east (Health Canada, 1996). Breastfeeding initiation and maintenance rates increase with increasing education and income levels, suggesting that there are many social factors that influence the method of infant feeding (Health Canada, 1996).

Since 1978, the World Health Organization (WHO) and Health Canada have made the promotion of breastfeeding a primary goal. The WHO currently recommends that breastfeeding exclusively to the age of about 6 months, then continuing breastfeeding and complementary foods for up to 2 years of age or beyond, is the optimal method for feeding infants and young children (WHA, 1994; WHO/UNICEF, 1990).

All health care professionals have a vital role and responsibility to promote and support breastfeeding, both antenatally and postnatally. The following measures are paramount to improving both the initiation and duration of breastfeeding: (a) supportive practices and written breastfeeding policies at health care institutions (ideally, these written policies should be based on the WHO/UNICEF 10 Steps) (WHO/UNICEF, 1989) and the WHO International Code of Marketing of Breast-milk Substitutes (WHO, 1981); (b) education and support for parents by health professionals and educators; and (c) more community-based programs as the length of hospital stays decreases. As well, supportive environments for breastfeeding in the community and workplace are important measures aimed at improving the duration of breastfeeding (Levitt *et al.*, 1996; Zlotkin, 1995; Wang, 1994). In Canada, less than 5% of hospitals have a policy for breastfeeding which complies with the WHO and UNICEF "10 Steps to Successful Breastfeeding" (Levitt *et al.*, 1996).

There are social, environmental and health factors that influence the practice of breast-feeding. A successful breastfeeding experience after discharge is related to support geared to the mother's unique needs, complete combined mother–infant care, frequent feeds in the early postpartum period, banning of formula samples in the peripartum period, and avoidance of artificial teats and pacifiers (Yamauchi *et al.*, 1992; Elander *et al.*, 1984; Salariya *et al.*, 1978; Illingsworth *et al.*, 1952). The benefits of initial postpartum feeds of water have not been documented.

(i) Maternal lifestyle. In today's society, many women are pursuing their education or are in the work force. It is not uncommon for a new mother to return to school or employment soon after birth or a maternity leave of 3 to 6 months. Some mothers discontinue or never attempt nursing their babies under these circumstances, believing that they will be unable to maintain a milk supply, or that breastfeeding will take too much of their time or cause discomfort when they are away from the baby. After lactation is well established, an occasional bottle of breast milk substitute should not necessarily have a detrimental effect on the continuation of nursing (Riordan and Auerbach, 1993). Many mothers have successfully maintained breastfeeding after returning to work or school with support in the workplace and appropriate child care arrange-ments (CICH, 1996). Factors which may increase the duration of breastfeeding include the use of breast pumps to express milk, flexible work schedules and part-time nursing (Hills-Bonczyk *et al.*, 1993).

(ii) Shortened postpartum length of stay. Shorter postpartum hospital stays (12-48 hours) need not negatively impact on breastfeeding success. When health care professionals in the community and hospital provide consistent, clear, breastfeeding information and support for mothers throughout pregnancy, childbirth, and the postpartum and the breastfeeding period, the breastfeeding experience can be positive and successful for both mother and baby.

The effect of distributing discharge packs on the duration of breastfeeding is uncertain. While no study has demonstrated a positive effect of discharge packs on the initiation or duration of breastfeeding, in high-risk populations the provision of formula-containing discharge packs

may (Dungy *et al.*, 1992; Frank *et al.*, 1987), or may not (Neifert *et al.*, 1988; Bergevin *et al.*, 1983), decrease the duration of breastfeeding.

Criteria for discharge from hospital should include at least two successful nursings managed independently by mother and baby (CPS, 1996; AAP, 1995). It is recommended that parents demonstrate a clear understanding of how they will feed their baby, and should receive written information on the signs of successful breastfeeding, their infant's birth and discharge weights, and a list of breastfeeding resources in the community. In addition, it is recommended that mother and baby be evaluated by a health care professional within 48 hours of discharge to assess the infant's feeding and hydration, and to evaluate for jaundice and other abnormalities (CPS, SOGC, 1996).

(iii) "Top-up" feeds. Glucose water and infant formula are often provided between feeds or to "top up" breastfeeds in the first days of life. The rationale, while unproved, is that such practices minimize weight loss and/or the development of early hyperbilirubinemia (Inch and Garforth, 1989; Gray-Donald *et al.*, 1985; Nicoll *et al.*, 1982). This practice may adversely affect both the demand for and supply of milk. The decline in the infant's hunger may also undermine the mother's confidence in being able to provide adequate milk for her infant and, thus, indirectly diminish the chance of breastfeeding success (CICH, 1996; CPS, 1994a; Howard *et al.*, 1994; Inch and Garforth, 1989). Since the benefits associated with this practice are unproved, women who are trying to establish their milk supply are advised to avoid feeding supplementary or complementary bottles of breast milk substitutes or water, or using pacifiers, for the initial 2 to 4 weeks of an infant's life (Riordan and Auerbach, 1993).

(iv) Smoking. Mothers who smoke have lower breastfeeding initiation and duration rates than non-smokers. Nicotine metabolites have been found in the urine of breastfeeding infants whose mothers smoke, and in both breastfed and bottle-fed infants, where passive smoking occurs. Heavy smoking (more than 10 cigarettes per day) has been associated with decreased milk production, decreased milk ejection, infant irritability and poor weight gain (Lawrence, 1994).

Breastfeeding mothers should be encouraged to stop or reduce smoking. However, even if smoking continues, breastfeeding is still the best choice. The harmful effects of smoking on the baby can be reduced by smoking after breastfeeding rather than before. Mothers who smoke (whether bottle- or breastfeeding) and other smokers in the household should be encouraged to smoke outside or, at least, in a different room than the baby, to reduce the effects of environmental tobacco smoke (CICH, 1996).

Potential contraindications to breastfeeding

(i) Drugs. Most prescription and over-the-counter drugs are minimally excreted through breast milk and are pharmacokinetically benign to the infant. Illegal drugs of abuse are contraindicated during breastfeeding (CICH, 1996). Breastfeeding is not advised for infants of mothers who are receiving long-term chemotherapy. Breastfeeding should be temporarily stopped (anywhere from 1 day to 2 weeks depending on the type of isotope used) when radioactive compounds for diagnostic or

therapeutic reasons are required (Fulton and Moore, 1990). Some of the drugs that may be contraindicated during breastfeeding include bromocriptine, cyclophosphamide, cyclosporine, doxorubicin, ergotamine, lithium, methotrexate and phencyclidine (AAP Committee on Drugs, 1994). Local drug information lines are useful in keeping up to date with information on drug usage and breastfeeding (CICH, 1996).

Herbal remedies may contain pharmacologically active substances. It is recommended that they be used with caution by breastfeeding mothers (Newall *et al.*, 1996).

(ii) Alcohol. Mennella and Beauchamp (1991) demonstrated that significantly less breast milk was consumed by infants of mothers drinking alcohol during a 3-hour period compared to when non-alcoholic beverages were consumed. The habitual ingestion of more than a moderate amount of alcohol (> 0.5 g/kg/day, equivalent to about 2 drinks) is contraindicated during breastfeeding. The Mother Risk Program (The Hospital for Sick Children, Toronto) suggests that if several alcoholic drinks have been ingested, nursing should be postponed at least 1 hour for each drink (personal communication). It takes an adult woman (55 kg) about 1.25 hours to metabolize 10 g of alcohol. Since the average drink contains 10 g of alcohol, a recommendation to wait 1 hour after a drink is reasonable.

(iii) Environmental contaminants. There is no current justification to warrant restriction in breastfeeding due to environmental contaminants (Rogan, 1996). Reports have continued to document accumulation of polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) in breast milk (Abraham *et al.*, 1996). Accumulation of lipid soluble environmental contaminants in breastfed infants due to relatively high daily exposure via breast milk (about 50 times higher per kg body weight than in adults) has caused concern about possible adverse health effects (Beck *et al.*, 1994). Although there is documentation of adverse neurodevelopmental outcomes and impaired intrauterine growth associated with prenatal exposure to polychlorinated biphenyls (PCBs), at present, exposure to PCBs, PCCDs or PCDFs in breast milk has not been associated with adverse outcomes (James *et al.*, 1993; Tilson *et al.*, 1990; Koopman-Esseboom *et al.*, 1996).

(iv) Maternal infections. The role of breastfeeding in the horizontal transmission of HIV has been uncertain because of the difficulty in differentiating congenital from early postnatal infection. Transmission of HIV through breast milk was initially recognized in situations where the mother acquired the infection shortly after birth (Goldfarb, 1993). The chances of the virus being spread to the infant depended on the mother's degree of infection. A woman who is viraemic during the acute phase of the primary infection is more likely to shed viruses into her milk than if she were HIV antibody positive with an established infection (Dunn *et al.*, 1992). The estimated risk of transmission through breast milk by a woman of high viral burden is 29% (95% C.I.: 16%-42%); by a woman who is already HIV antibody positive during the pregnancy, 14% (95% C.I.: 7%-22%) (Newell and Peckham, 1994).

When the mother is known to be HIV antibody positive, alternatives to breastfeeding are indicated. This recommendation is consistent with that of the Canadian Institute of Child Health (CICH, 1996), as well as the American Academy of Pediatrics and the American College

of Obstetricians and Gynecologists (AAP and ACOG, 1992). If the infant is HIV antibody positive at birth, breastfeeding would be indicated; however, currently, there are no diagnostic tools to determine HIV infection status of the newborn with an acceptable level of confidence (Goldfarb, 1993).

Tuberculosis is rarely transmitted by breast milk, but can be transmitted by exposure to sputum from an infected mother or other caretaker. Mothers with active tuberculosis should breastfeed their infants only after they are receiving adequate therapy and are considered to be non-infectious (AAP and ACOG, 1992).

Cytomegalovirus and rubella have been found in milk of infected mothers. The presence of these viruses in human milk is not considered a contraindication to breastfeeding since in the term infant they cause asymptomatic infections (Goldfarb, 1993). If present in the mother, hepatitis B is most likely to be transmitted during delivery, although it has been isolated from breast milk. For the nursing mother who acquires hepatitis while nursing, an important preventative measure for the infant is prompt immunization with the hepatitis B vaccine. Breastfeeding can then be encouraged. Although herpes simplex virus is unlikely to be shed into breast milk, breastfeeding would be contra-indicated in women who have active herpetic lesions on or near the nipple (Sullivan-Bolyai *et al.*, 1988).

Vitamin/Mineral supplementation of breastfed infants

The quality of the breastfeeding mother's diet is important for her health and energy, but has a variable effect on milk production and on milk composition (Riordan and Auerbach, 1993). Minerals and fat-soluble vitamin (A,D,E,K) levels in breast milk are minimally influenced by recent maternal diet as these can be drawn from storage in the body. Water-soluble vitamins (eg. ascorbic acid, nicotinic acid, thiamin, riboflavin, pyridoxine, B_{12}) are readily influenced by the maternal diet (Riordan and Auerbach, 1993; Atkinson, 1992). However, if the mother is well nourished, there is no need for supplementation. Only if a mother eats a very restricted diet (e.g. vegan) should supplemental nutrients be recommended to ensure adequate nutrient intake for her and adequate delivery of vitamins to the breastfed infant. With the exception of vitamin D, vitamin and mineral supplementation of breastfed term infants in the first 6 months is not recommended.

(i) Vitamin D. Three factors influence the vitamin D status of an infant: vitamin D status at birth, vitamin D intake and exposure to sunlight.

Poor maternal vitamin D status during pregnancy affects the vitamin D status of an infant at birth (Specker, 1994). A baby born to a vitamin D deficient mother will have limited stores of vitamin D and will be at higher risk of vitamin D deficiency. Women who do not consume milk or margarine (which are routinely fortified with vitamin D in Canada), and who have little exposure to sunlight, and do not take vitamin supplements are at increased risk for vitamin D deficiency.

In addition to those infants born to vitamin D deficient mothers, infants at greatest risk of vitamin D deficiency are those who are exclusively breastfed, those who are not exposed to sunlight or who are dark skinned. Breast milk is not a dependable source of vitamin D and poor maternal vitamin D status during lactation further limits the vitamin D content of breast milk (Lebrun *et al.* 1993). The use of protective clothing and/or sunscreens when exposed to the sun prevents the penetration of ultraviolet light through the skin, blocking vitamin D synthesis (Matsuoka *et al.*, 1987).

It is not possible to identify all infants at risk of vitamin D deficiency. Moreover, vitamin D deficiency has both acute and long-term serious sequelae that are totally preventable and there is low risk associated with vitamin D supplementation at recommended levels. Therefore, vitamin D supplements (10 µg/d or 400 IU/d) are recommended for all breastfed full-term infants. Supplementation should continue until the diet provides a source of vitamin D. For infants living in northern communities, 20 µg/d (800 IU/d) of vitamin D is recommended (CPS Indian and Inuit Health Committee, 1988).

Few studies have examined the effect of diet and sun exposure on vitamin D status of older infants and toddlers. Nevertheless, the negligible incidence of vitamin D deficiency rickets in this age group implies that vitamin D status is adequate from a combination of dietary intake and sunlight exposure. The precise amount of sun exposure time that is sufficient is not known, but based on a recommendation made for the elderly (Holick, 1994), 5 to 30 minutes per day on average, depending on the sensitivity of the infant's skin, is likely to be adequate (Specker *et al.*, 1985). However, it should be noted that the period of time when sunlight exposure does not stimulate formation of vitamin D in the skin varies with latitude. In Edmonton (52º N), for example, sunlight is devoid of vitamin D-stimulating UV rays from mid-October to the end of March; in Boston (42.2º N), this ineffective period extends from November through February (Webb *et al.*, 1988).

Alternate Milks

If an infant is not breastfed, or is partially breastfed, commercial formulas are the most acceptable alternative to breast milk until 9 to 12 months of age.

Recommendations:

11. Use cow's milk-based, iron-fortified formulas until 9 to 12 months of age.
12. Iron-fortified follow-up formulas are a preferred alternative to cow's milk from 6 months until 9 to 12 months of age.
13. Use soy-based formulas only for those infants who cannot take dairy-based products for health, cultural or religious reasons, such as a vegan lifestyle, or galactosemia.
14. Specialty formulas are indicated only for infants with detected or suspected pathology.

The use of nutritionally incomplete alternate milks as the sole source of nutrition for infants is inappropriate. Pasteurized whole cow's milk, however, is an important component of a mixed infant diet after 9 months of age. For infants unable to take cow's milk products, continue commercial soy formula until 2 years of age.

Recommendations:

15. Pasteurized whole cow's milk may be introduced at 9 to 12 months of age and continued throughout the second year of life.
16. Partly skimmed milk (1% and 2%) is not routinely recommended in the first 2 years.
17. Skim milk is inappropriate in the first 2 years.
18. Soy (except soy formula), rice or other vegetarian beverages, whether or not they are fortified, are inappropriate alternatives to breast milk, formula or pasteurized whole cow's milk in the first 2 years.

Infant formulas

If an infant is not exclusively or is partially breastfed, then commercial formulas are the most acceptable alternative to breast milk.

The composition, processing, packaging and labelling of all infant formulas are regulated under the *Canadian Food and Drug Regulations* (Department of National Health and Welfare, 1981). The nutrient content of iron-fortified infant formulas is designed to meet the nutritional needs of healthy term infants until 9 to 12 months of age.

(i) Cow's milk protein-based formulas. Cow's milk protein-based formulas are the standard product for healthy term infants with no family history of allergy. These formulas may be low iron (similar levels of iron as found in breast milk but significantly less available than the iron in breast milk) or iron-fortified. Iron-fortified formula based on cow's milk, rather than low-iron formula, should be used until an infant is 9 to 12 months of age and is consuming a variety of foods. At this time, formula can be replaced with pasteurized whole milk.

(ii) Soy protein-based formulas. Up to 20% of infants in Canada use soy-based formulas, presumably because of a perceived or real allergy to cow's milk protein. All soy formulas sold in Canada are iron-fortified.

Despite the wide use of soy protein-based formulas in Canada, indications for their use are limited. Appropriate uses include infants fed vegan diets and infants with galactosemia.

The use of soy protein-based formulas in the dietary management of infants with proven cow's milk allergy, or in the prevention of atopy, is

controversial (Johnstone and Roghmann, 1993; Businco *et al.*, 1992). For some infants, there is cross-reactivity between cow's milk protein-based and soy protein formulas (Businco *et al.*, 1992). Evidence demonstrating a reduced prevalence of atopic diseases in high-risk infants fed soy protein-based formulas in the first 6 months of life is not convincing (Businco *et al.*, 1992). It has been estimated that 30% to 40% of infants at risk for atopic disease will be sensitized to soy protein, especially in cases where the small bowel is damaged (Chandra *et al.*, 1989; Eastham *et al.*, 1982). For infants at high risk of cow's milk protein allergy, the formula of first choice would be a whey- or casein-hydrolysate. Whey-hydrolysate formulas may be better tolerated because of their taste. Infants with documented allergy should receive formula with an extensively hydrolysed source of protein; currently these are casein-hydrolysate formulas. Soy protein-based formulas are inappropriate for either of these indications (Chandra *et al.*, 1989; Zeiger *et al.*, 1989).

Specialized infant formulas

Specialized infant formulas available at the retail level are intended for the small number of infants who cannot tolerate formulas based on intact cow's milk protein or soy protein. Most often, these infants have confirmed food allergies, carbohydrate intolerance or malabsorption syndromes. Occasionally, because of a high risk of allergy based on family history, an infant may receive a specialized formula.

Most specialized commercial formulas are iron-fortified. The choice of formula should be individualized and based on the pathology detected or suspected. There are a number of specialized infant formulas, including ones for the preterm infant and ones for the dietary management of very specific medical conditions, that are not available at the retail level. These products will not be discussed here.

(i) Lactose-free, cow's milk protein-based formulas. These formulas are suitable for infants with lactose intolerance. Because they may contain residual galactose, they are contraindicated for infants with galactosemia.

Lactose-free cow's milk protein-based formulas contain the same ingredients as other infant formulas based on cow's milk, except that glucose polymers from corn syrup solids are substituted for lactose. They may be useful during periods of secondary disaccharidase deficiency due to acute enteritis or chronic conditions affecting the integrity of the small intestine such as diarrhea, enteropathies and Crohn's disease.

Primary lactose intolerance due to congenital lactase deficiency is extremely rare.

(ii) Protein hydrolysate formulas. Two types of protein hydrolysate formulas are available in Canada: those that are less extensively hydrolyzed (currently whey-based) and intended for feeding infants at risk for atopy, and those that are extensively hydrolyzed (currently casein-based) and intended for feeding infants who have confirmed allergy to cow's milk or soy proteins. Although in some trials, the extensively hydrolysed casein-hydrolysate formulas have been found to be significantly less allergenic than the less hydrolysed whey-hydrolysate ones, which in turn are less allergenic than ordinary cow's milk formulas, there still have been reports of reactions to whey- and casein-hydrolysates in highly allergic

infants. Although the most extensively hydrolyzed protein formulas (i.e. currently the casein hydrolysate formulas) should be used for infants with allergy, caution even with their use is indicated (Saylor and Bahna, 1991; Businco *et al.*, 1989).

"Follow-up" formulas

Like other infant formulas, follow-up formulas are regulated under the *Canadian Food and Drug Regulations*. Follow-up formulas are an alternative to cow's milk in the second 6 months of life when infants are already eating solid foods. Compared to cow's milk, follow-up formulas provide more appropriate quantities and forms of nutrients, including essential fatty acids, and of energy during this transition period. For example, compared to whole cow's milk, infants fed iron-fortified follow-up formula achieved better iron status (Fuchs *et al.*, 1993). Also compared to cow's milk, follow-up formulas provide a lower renal solute load and contain fats that are better absorbed (Fuchs *et al.*, 1992). The clinical significance of the latter has not been determined.

Although follow-up formulas have advantages compared to cow's milk, no superiority to starter formulas has been established.

Homemade evaporated milk formulas

Homemade formula made with canned evaporated milk, whether cow's or goat's, is not recommended as an alternative to breast milk or commercial infant formula because it is nutritionally incomplete. Formula based on evaporated milk has a low iron content, is low in essential fatty acids, and delivers a high "renal solute load" (see Pasteurized Cow's Milk). Evaporated milk formulas are used in a number of areas in Canada because of cost, convenience and tradition. If evaporated milk formula needs to be used, the recipes below[1] should be followed to ensure proper dilution and appropriate amounts of energy, protein and carbohydrate. Only evaporated whole milk should be used.

If evaporated milk formula is fed, alternate sources of iron should be provided. Monitoring iron status at around 6 to 8 months of age is recommended. Although undocumented, because of risk of deficiency of essential fatty acids, after 4 months of age a source of essential fatty acids (vegetable oil) should be introduced.

All evaporated whole cow's milk sold in Canada is fortified with vitamins C and D. If evaporated goat's milk is used, only products fortified with vitamins C, D, and folic acid should be chosen.

[1] **For infants up to 6 months of age:** A 1 to 2 dilution of evaporated whole milk to water plus added sugar to yield 67 kilocalories per 100 mL. The 1 to 2 dilution is required to bring the protein and sodium content down to appropriate levels for the infant up to 6 months of age. Sugar is added to adjust the carbohydrate and energy content.

Example: 30 mL evaporated whole milk and 60 mL water and 1 teaspoon sugar.

For infants after 6 months of age: A 1 to 1 dilution of evaporated whole milk to water to yield 67 kilocalories per 100 mL. No sugar is added.

Other alternate milks

(i) Pasteurized cow's milk. Due to risks of infection, non-pasteurized milk (cow's or goat's) is contraindicated. The quality and quantity of nutrients in cow's milk differ greatly from those of human milk and cow's milk does not contain many of the various growth and immunological factors found in human milk. With regard to nutrient content, cow's milk contains greater amounts of protein and minerals (calcium, phosphorus, sodium, chloride and potassium) and smaller amounts of essential fatty acids (linoleic and alpha-linolenic acid), zinc, vitamin C and niacin than human milk. The higher renal solute load of cow's milk results in a urine osmolality approximately two times higher than that observed in breastfed infants (Fuchs *et al.*, 1992). Usually, there are no adverse clinical sequellae associated with the increased renal solute load; however, in an infant with increased water losses (e.g. diarrhea) and decreased intake (e.g. from vomiting), cow's milk may not supply enough free water (Fomon, 1993).

The use of pasteurized cow's milk is associated with occult blood loss in stool, especially in infants in the first 6 months of life. Recent studies suggest that after 6 months of age, occult blood loss in stool is unlikely to occur (Fuchs *et al.*, 1993). Cow's milk has a low iron content and the iron is poorly absorbed. To lower the risk of iron deficiency anemia, cow's milk is not recommended before 9 to 12 months of age.

Skim milk is an inappropriate milk choice during the first two years (Fomon, 1997). It provides no essential fatty acids and has a very low energy density. To meet energy needs, an infant would have to drink very large volumes of this milk. With high intakes, protein and solute intake would be significantly higher than the infant needs. Partially skimmed milk (1% or 2% fat) is also low in essential fatty acids and energy. To meet energy and essential fatty acid needs, the infant would have to eat a wide variety and adequate quantity of other foods. Approximately 15% of Canadian infants are on 2% milk around 1 year of age. Although there is no clear indication of negative consequences, there is no medical or nutritional indication to recommend the routine use of partially skimmed milk, other than convenience. There is, however, a theoretical risk of growth faltering and essential fatty acid deficiency when partially skimmed milk provides a significant component of the infants' daily intake. Therefore, while whole cow's milk (3.25% butterfat) continues to be recommended for the second year of life, 2% milk may be an acceptable alternative provided that the child is eating a variety of foods and growing at an acceptable rate.

(ii) Goat's milk. For the same reasons as cow's milk, pasteurized goat's milk is not an appropriate milk choice for infants before 9 to 12 months of age (Taitz and Armitage, 1984). Unlike cow's milk, goat's milk may or may not be fortified with vitamin D (fortification will be indicated on the label). Because of cross-reactivity, infants who are allergic to cow's milk protein are also likely to have an allergic reaction to goat's milk (Fomon, 1993; Jeness *et al.*, 1967; Saperstein, 1960). After 9 months of age, full-fat goat's milk may be used as an alternative to cow's milk (Razafindrakoto *et al.*, 1994). If partly skimmed or skimmed goat's milk is ever used, a product with added vitamin A as well as vitamin D should be chosen.

(iii) Soy, rice and other vegetarian beverages. Soy, rice and other vegetarian beverages, whether or not they are "fortified," are not appropriate alternatives to breast milk or infant formula or to pasteurized whole milk in the first two years. "Fortified" vegetarian beverages will be fortified with vitamins A, D and B_{12}, riboflavin, calcium and zinc, and may contain other vitamins and minerals. However, there are no minimum requirements for total fat or protein. Rice and vegetarian beverages other than soy contain virtually no protein and if used as a whole or major source of nutrition, may result in marasmus and failure-to-thrive (Muir and Kalnins, 1987).

Unresolved issues in the composition of infant formulas

(i) Fatty acids. Commercial formulas in Canada contain adequate amounts of the essential fatty acids, linoleic and alpha-linolenic acid. The presence of two other fatty acids, arachidonic acid (AA) and docosahexaenoic acid (DHA), in the brains and retina of newborn infants, and of small amounts of these same fatty acids in human milk, has raised questions about the potential need for a source of these fatty acids for all infants, including those who are not breastfed. Newborn infants have the ability to endogenously synthesize AA from linoleic acid, and DHA from linolenic acid. However, researchers have not yet been able to quantify the amount of AA and DHA synthesis in infants. It may be that AA and DHA synthesis is too slow to meet tissue needs. Clinical studies have attempted to determine the need for a dietary source or for the addition to infant formulas of AA and DHA in infants, but have yielded inconsistent results (Innis *et al.*, 1996; Janowsky *et al.*, 1995; Makrides *et al.*, 1995).

Although it is reasonable to presume that infants not fed breast milk might benefit from dietary sources of AA and DHA, until the safety and efficacy of the sources of these fatty acids and of the formulas supplemented with them have been established, the routine addition of these nutrients to formulas designed for full-term infants is not recommended.

(ii) Nucleotides. Some formulas on the Canadian market contain added nucleotides at levels found in breast milk. Although there are data from *in vitro* and animal studies that demonstrate potential benefits to the immune and gastrointestinal systems, and on the fatty acid composition of serum lipids and erythrocyte membranes, definitive human data are lacking (Uauy *et al.*, 1994; Carver *et al.*, 1990; Delucchi *et al.*, 1987).

(iii) Level of iron fortification. Infant formulas sold in Canada either contain iron at the level found in human milk or are iron-fortified. The latter must contain at least 1 mg of iron per 100 kilocalories of formula. Current iron-fortified formulas on the market contain between 1.0 and 1.8 mg of iron per 100 kilocalories (0.7 and 1.2 mg per 100 mL of formula when ready to serve).

There is no evidence of any adverse effects of the levels of iron that are currently present in iron-fortified formulas. Formulas containing 1.0 mg of iron per 100 kilocalories are sufficient to prevent iron-deficiency anemia (Fomon *et al.*, 1997; Bradley *et al.*, 1993).

(iv) Phyto-oestrogens. The issue of phyto-oestrogens in soy-based infant formulas is controversial. Although a recent report (Setchell *et al.*, 1997) demonstrated that the levels of phyto-oestrogens in the plasma of infants fed soy-based formulas are much higher than those of infants consuming cow's milk or breast milk, the functional significance of this finding is not known. Soy-based formulas have been used for several decades without evidence of hormone-related acute toxic effects. Research is required to provide information on whether there are any long-term effects of phyto-oestrogens in infants who have consumed soy-based infant formula.

Other Fluids in Infant Feeding

Tap water, well water meeting established standards of safety and commercially bottled water, except mineral or carbonated water, are generally suitable for infants. Limit the use of "fruit juice" to avoid interfering with the intake of nutrient-containing foods and fluids. Herbal teas and other beverages are of no known benefit to an infant and may be harmful.

Recommendations:

19. Bring all water for feeding infants under 4 months of age to a rolling boil for at least 2 minutes to ensure that it is pathogen free.

20. Limit fruit juice to avoid interfering with the intake of breast milk or infant formula.

21. Do not use herbal teas or other beverages.

(i) Water. Water used in the feeding of infants, in the preparation of infant formulas or other infant foods, or for drinking, must be safe (i.e. clean and free of microbiological and chemical contamination). Tap water, well water that meets standards of safety and commercially bottled water (except carbonated or mineral water) are generally suitable for infant feeding. All three types of water, including commercially bottled water, are not sterile. To ensure pathogen-free water for infants under 4 months of age, it is recommended that water be brought to a rolling boil for at least 2 minutes (Health Canada, 1996a; Health Canada 1996b; Farber *et al.*, 1988). Boiled water can be stored for 2 or 3 days in the refrigerator in a sterilized, tightly closed container, or for 24 hours at room temperature in a sterile closed container.

(a) Tap water. Municipal drinking water systems are routinely inspected and monitored to ensure that the chemical and microbiological quality meets provincial standards (Health Canada, 1996). For the preparation of infant formulas or infant foods, or for drinking by infants, only water from the cold water tap should be used. Water from the hot water tap may contain more lead and other non-biological contaminants because hot water can dissolve or leach them more readily. To flush any build-up of contaminants such as lead and copper, which tend to accumulate in the water pipes overnight, let the water run freely for about 2 minutes every morning.

(b) Well water. Caution is indicated when using well water for infant feeding because it may have naturally high concentrations of nitrates, nitrites, arsenic, fluoride or other heavy metals. If well water is to be used, testing for these substances, as well as coliform bacteria, is recommended at least twice a year. Water containing more than the maximum acceptable concentration of nitrate (10 ppm) is a health hazard for infants, since it may result in methaemoglobinaemia, particularly in infants up to the age of 3 to 6 months. Nitrates are not eliminated by boiling water (Environmental Protection Agency, 1990). Water containing in excess of 1.5 parts per million (ppm) of fluoride may cause dental fluorosis and should not be used (Environmental Protection Agency, 1990). The local health department can be contacted for information on water testing and names of accredited laboratories.

(c) Commercially bottled non-carbonated water. All bottled waters legally sold in Canada are required to meet safety requirements set out under Canada's *Food and Drugs Act and Regulations*. The only commercially bottled non-carbonated waters suitable for use by infants are natural spring water drawn from underground springs, and treated water (low mineral content). Examples of commercial water unsuitable for infant feeding include mineral water, treated water with a high mineral content and carbonated water, including club soda. There are no clear indications for the use of distilled water. There are commercially bottled waters specifically for infants and these are labelled as such.

(d) Home water treatment equipment. The use of home water treatment equipment is not without risk. Some water softeners increase the sodium content of the water, and charcoal filters can increase the silver content of water or may contaminate the water with bacteria. The suitability of individual home water treatment equipment should be determined by contacting the Criteria Section, Bureau of Chemical Hazards, Health Canada, or the Canadian Water Quality Association, Waterloo, Ont.

(ii) Fruit juices. Fruit juices provide a source of vitamin C, energy and some variety in infants' diet. If fruit juices are given to infants, the volume should be limited to avoid interfering with the intake of breast milk or infant formula.

Although a limited intake of fruit juices is a common and acceptable practice in Canada, excessive consumption may indirectly contribute to inadequate intakes of needed nutrients and energy (Smith and Lifshitz, 1994). Because of the sorbitol and fructose content of fruit juices, excessive intake may lead to diarrhea, poor weight gain and failure to thrive (Smith and Lifshitz, 1994). Certain types of juice are likely

to increase the risk of diarrhea (Hockstra *et al.*, 1995). A randomized, double-blind, cross-over study showed less carbohydrate malabsorption with sorbitol-free white grape juice compared to clear apple juice (Smith *et al.*, 1995). Excessive fruit juice intake may also be associated with dental caries and nursing bottle syndrome (Navia, 1994).

The Recommended Nutrient Intake (RNI) for vitamin C for infants aged 6 to 12 months is 20 mg/day (Health and Welfare Canada, 1990a), an amount easily provided by breast milk, infant formula, and vegetables and fruits as they are introduced. Although dilution of juice is a common practice, there is no clear rationale for this maneuver. To satisfy thirst, or anticipated thirst, water is recommended.

(iii) Other beverages. Beverages containing caffeine and theobromine, a caffeine-related substance, are not recommended for infants. Caffeine and theobromine act as stimulant drugs in the body. Coffee, tea, some carbonated beverages such as colas, and hot chocolate contain these substances.

Sodas, fruit drinks, punches and sport drinks are not recommended for infants because of their high sugar content and lack of nutrients other than carbohydrates. As with fruit juice (see above), intake of these foods may increase the risk of dental caries and nursing bottle syndrome.

Beverages containing artificial sweeteners such as aspartame are not recommended for infants or young children. Infants are growing rapidly and require energy for growth; these products may interfere with the intake of energy-dense foods.

(iv) Herbal teas. A recent trend toward the use of "natural" substances and alternative medicine has increased interest in herbs and the sale of herbal teas. Because of their small size and rapid growth rate, infants are potentially more vulnerable than adults to the pharmacological activity of some of the flavouring and chemical substances occurring in herbal teas. Toxic effects of herbal teas have been reported in an infant fed herbal tea (Sperl *et al.*, 1995), as well as two breastfed newborns whose mothers were drinking large amounts of herbal tea mixtures (Rosti *et al.*, 1994). In Canada, at present, there is no requirement to label herbal teas regarding their suitability for use by infants. At this time, there is not enough scientific information on the safety of various herbs and herbal preparations to recommend their general use during pregnancy, lactation and for infants.

Transition to Solid Foods

Infants between 4 and 6 months of age are physiologically and developmentally ready for new foods, textures and modes of feeding. By 1 year of age, the ingestion of a variety of foods from the different food groups of Canada's Food Guide to Healthy Eating *is desirable.*

Recommendations:

22. Introduce complementary foods at 4 to 6 months to meet the infant's increasing nutritional requirements and developmental needs.

23. To prevent iron deficiency, iron-containing foods such as iron-fortified cereals are recommended as the first foods.

(i) Age of introduction. Determination of the most appropriate age for the introduction of weaning foods is not precise. In practice, the age is variable, reflecting varying infant-rearing practices of different ethnic, cultural and geographic origin. Despite this diversity, general recommendations for the appropriate time for introducing complementary foods are fairly consistent worldwide. These recommendations are usually based on perceived nutritional needs, physiological maturation, behavioural and developmental aspects of feeding, immunological safety and environmental influences. The WHO International Code for the Marketing of Breast-Milk Substitutes (1981) recommends that breast milk should be given exclusively for the first 4 to 6 months and that complementary foods should be introduced at this time to meet the energy and nutrient needs which are no longer met by breast milk.

Within the age range of 4 to 6 months, because infants develop at different rates, the decision about exactly when to start weaning foods should be individually determined. Traditionally, infants within this age range have been considered physiologically and developmentally ready for new foods, textures and modes of feeding. Most evidence suggests that introduction before 2 to 3 months or later than 6 months has more risks than benefits (Schmitz and McNeish, 1987). The early introduction of weaning foods may satisfy the hunger of the infant, resulting in less frequent breastfeeding and ultimately less milk production in the mother. Because iron absorption from human milk is depressed when the milk is in contact with other foods in the proximal small bowel, early use of weaning foods may increase the risk of iron depletion and anemia. It has been suggested, but with little proof, that early introduction of weaning foods may increase the risk of infections and allergies and predispose the infant to obesity, hypertension and arteriosclerosis later in life. On the other hand, potential risks of delayed weaning are faltering growth, nutrient deficiencies (iron, zinc, vitamins A and D) and the development of feeding problems, including reliance on fluids and refusal to progress to textured foods (Satter, 1990).

(ii) First foods. During the transition to solid foods, it is vital that infants continue to ingest an adequate volume of nutrient-dense milk (preferably breast milk or formula). Introduction of solid foods should be based on the physiologic and developmental maturity of the infant in combination with our understanding of nutrient requirements for the rapidly growing infant. Iron-containing foods are recommended as the first foods. The sequence of introduction most often followed in Canada is iron-fortified infant cereal, then vegetables, fruits, and finally meat and alternatives.

Because of the infant's relatively permeable intestinal tract would predispose the infant to uptake of foreign proteins with a resulting allergic reaction, it is customary to reduce the allergenic load as long as possible by using a single grain cereal as the first food (Fomon, 1993). The use of single foods makes it easier to identify the cause of an allergic reaction, were it to occur. In Canada, the most commonly used first food is iron-fortified rice cereal. Barley and oat cereals are usually offered next, followed by mixed cereals because they are the most likely to cause allergic reactions. Once it is known that single foods are tolerated, combinations of foods are added to widen the variety of nutrients ingested. Since all infant cereals are fortified with iron, they play a major role in preventing iron depletion and iron deficiency anemia (Walter *et al.*, 1993).

There is little nutritional or developmental benefit associated with the practice of adding infant cereals or other puréed foods to bottles containing formula or milk. In fact, an important reason for the introduction of solids is the developmental readiness of the infant to progress from sucking to spoon feeding and from ingesting liquids to more textured foods. Adding foods to the bottle dilutes the texture of the food and delays the progression to more advanced feeding skills. It is also thought that infants sucking food or thick liquids through a nipple may be at risk for choking and aspiration. Finally, there is no convincing evidence that the practice of adding cereal to the bedtime bottle helps infants sleep through the night (Fomon, 1993; Macknin *et al.*, 1989).

Vegetables and fruits add colour, flavour, texture and variety to infants' diets. It is common practice to introduce vegetables before fruits, because it is perceived that vegetables are better accepted when introduced before fruits. Traditionally, meat and alternatives is the last of the food groups introduced. The foods in this group include meats, fish, poultry, cooked egg yolks, and alternatives such as well-cooked legumes and tofu. Milk products such as cottage cheese, other cheeses and yogurt are also introduced at this time. Egg white which contains at least 23 different glycoproteins is not traditionally given to infants until 1 year of age to minimize any possible allergic reactions (Anet *et al.*, 1985; Langland, 1982).

(iii) Table foods. The transition to other solid foods, such as more textured purées, finger foods and table foods eaten by the rest of the family, takes place in the latter part of the second 6 months of life because infants are ready to chew and need more texture in their foods. Some infants go from semi-liquid cereals and puréed baby foods to finger foods and table foods in just a few months. Safe finger foods include bread crusts, dry toast, pieces of soft cooked vegetables and fruits, soft ripe fruit such as banana, cooked meat and poultry, and cheese cubes. At this time, most infants are developmentally ready to feed themselves and should be encouraged to do so (Hahn, 1993; Satter, 1990; Illingworth and Lister, 1964). Important feeding behaviours at this time include taking food from a spoon, chewing, self-feeding with fingers or a spoon, and independent drinking from a cup or bottle (Pridham, 1990; Satter, 1990). By 1 year of age, the ingestion of a variety of foods from the different food groups of *Canada's Food Guide to Healthy Eating* is desirable.

(iv) Home-prepared foods. Parents and caregivers may prepare their infant's solid foods by puréeing cooked fresh or frozen foods. In the

past, it was recommended that home-prepared carrots, spinach, turnip and beets, which could contain nitrates, not be fed to infants under 6 months of age because of the danger of methaemoglobinaemia. Very young infants may be particularly susceptible to nitrites because fetal haemoglobin is more readily oxidized to methaemoglobin than haemoglobin (Bruning-Fann and Kaneene, 1993). Current infant feeding practices (later introduction of solid foods) are not likely to result in an infant consuming sufficient plant nitrate to cause methaemoglobinaemia even in susceptible infants (AAP, 1970).

(v) Commercial baby foods. In response to consumer demands, the major infant food manufacturers have recently reformulated a large number of their products to remove added sugar and modified starches. Modified food starches are sometimes used in commercial infant food products. They provide a means of controlling viscosity, prevent solids from separating from liquids and impart what is considered to be a desirable "mouth feel" to these products. There is no toxicological basis for excluding these starches from infant foods. They provide a source of carbohydrate and energy in infant diets, although they may dilute other nutrients in the product.

Safety Issues Around Feeding

Foods provided to infants must be free of pathogens, appropriate in size and texture, nutritionally sound and fed safely.

Recommendations:

24. To prevent botulism, do not use honey in the feeding of infants under 1 year of age.
25. To prevent salmonella poisoning, cook all eggs well and do not use products containing raw eggs.
26. Hard, small and round, smooth and sticky solid foods are not recommended because they may cause choking and aspiration.
27. Ensure that infants and toddlers are always supervised during feeding.
28. Avoid feeding an infant using a "propped" bottle.

(i) Infant botulism. Honey is a risk factor for infant botulism (Spika et al., 1989) and, to date, is the only food directly implicated in infant botulism. Surveys of random lots of honey indicated approximately < 1 to 10 spores/kg, while honey implicated in infant botulism contains 10^3 to 10^4 *C. botulinum* spores per kg (Hauschild *et al.*, 1988; Midura *et al.*, 1979). Health Canada recommends that honey should not be fed to children less than 12 months of age (HC, 1995).

Unlike that for honey, the evidence for corn syrup as a risk factor for infant botulism is tenuous. A 2-year case control study indicated that ingestion of corn syrup may be a risk factor for infant botulism (Spika *et al.*, 1989). However, an epidemiological study in California did not find a correlation between corn syrup consumption and infant botulism (Arnon *et al.*, 1994).

While early studies indicated the presence of low levels of *C. botulinum* in corn syrup, more recent studies have failed to demonstrate contamination of syrups by *C. botulinum*. The first survey of corn syrup for *C. botulinum* found spores in eight of 40 samples (Kautter *et al.*, 1982). In an ensuing nationwide survey of corn syrup, *C. botulinum* spores were detected in five of 961 (0.5%) bottles examined. In a subsequent survey by the United States Food and Drug Administration, a total of 738 bottles of corn syrup and other products containing corn syrup were examined for the presence of *C. botulinum* spores. None of the products was found to contain spores of *C. botulinum* (Lilly *et al.*, 1991). None of the samples in a Canadian study of 43 random samples of corn syrup from nine provinces in Canada contained *C. botulinum* spores (Hauschild *et al.*, 1988).

Corn syrup has never been directly implicated in a case of infant botulism. Corn syrup solids or corn syrup are used in infant formulas. The heat processing that liquid infant formulas undergo would destroy any *C. botulinum* spores; moreover, no infant formula has ever been implicated in infant botulism. The conflicting evidence implicating corn syrup in infant botulism is not strong enough to classify corn syrup as a risk factor and, as such, we do not recommend against feeding corn syrup to infants.

(ii) Salmonellosis. Salmonella bacteria can occasionally be transmitted from infected hens directly into the eggs before the shells are formed. Also, cracks in egg shells can allow transfer of salmonella from the shell surface to the egg contents. Eggs contaminated with salmonella bacteria may cause salmonellosis. Avoid raw eggs and foods containing raw eggs to prevent salmonellosis (Luby and Jones, 1993).

(iii) Choking and aspiration. The risk of choking can be lowered when caregivers are aware of their toddlers' chewing and swallowing abilities, supervise infants while eating, avoid offering foods with the potential to cause choking, and know how to handle choking if it occurs.

(a) Supervision. The use of a "propped bottle" to feed an unattended infant is not recommended because of the danger of choking or aspirating as the flow of milk into the mouth may be too rapid. Supervision includes the infant sitting upright while eating, and not lying down, walking, running or being distracted from the task of safe eating. Eating in the car is considered unsafe since if choking should occur, it is difficult to pull over to the side of the road safely (Pipes and Trahms, 1993). In addition, there is the increased risk of choking if the car stops suddenly.

(b) Unsafe foods. Hard, small and round, smooth and sticky solid foods can block a young child's airway. The following foods are not safe for infants and children under 4 years of age: popcorn, hard candies, gum, cough drops, raisins, peanuts or other nuts, sunflower seeds, fish with bones, and snacks using toothpicks or skewers (Harris *et al.*, 1984). The following foods are safer for infants and young children when they are prepared as described: wieners diced or cut lengthwise, grated raw carrots or hard fruit pieces, fruits with pits removed, chopped grapes, and peanut butter spread thinly on crackers or bread. Peanut butter served alone, or on a spoon, is potentially unsafe because it can stick in the palate or posterior pharynx leading to asphyxia.

Nutrition in the Second Year

Healthy eating is important in the second year to: (a) provide the energy and nutrients needed to grow and develop; (b) develop a sense of taste and an acceptance and enjoyment of different foods; and (c) instill attitudes and practices which may form the basis for lifelong health-promoting eating patterns.

Recommendation:

29. Small, frequent, nutritious and energy-dense feedings of a variety of foods from the different food groups are important to meet the nutrient and energy needs during the second year.

The development of healthy eating skills is a shared responsibility: parents and caregivers provide a selection of nutritious, age-appropriate foods, and decide when and where food is eaten; toddlers decide how much they want to eat and, at times, even whether they eat (Satter, 1987). To encourage healthy eating skills, parents and caregivers have an obligation to recognize and respond appropriately to their toddler's individual verbal and non-verbal hunger cues (e.g. restlessness or irritability) and to satiety cues such as turning the head away, refusing to eat, falling asleep or playing (Satter, 1990). Infants can be encouraged to feed themselves at the beginning of a meal when they are hungry, but may need help if they tire later in the meal. Pressuring infants to eat by using excessive verbal encouragement (e.g. "empty your bottle [or cup]" or "clean your plate") may lead to negative attitudes about eating, poor eating habits or excessive feeding that may foster excess weight gain (Campbell, 1994; Birch, 1992).

(i) Small, frequent feedings. Small and frequent, nutritious, energy-dense feedings are important for meeting the nutrient and energy requirements of infants during the second year. The term "feedings" is used, rather than "meals and snacks," because it better reflects toddlers' need for food when they are hungry or willing to eat rather than at conventional meal and snack times (Heird, 1994). Older infants need four to six small feedings a day in addition to their milk source (Hendricks and Badruddin, 1992). Their appetites vary, not only according to growth and activity, but also according to factors like fatigue, frustration, minor illnesses and social context. Therefore, older infants should be given small servings, along with the opportunity to ask for more if they are still hungry.

(ii) Variety. Ingestion of a variety of foods daily from the food groups in *Canada's Food Guide to Healthy Eating* (Health and Welfare Canada, 1992) is recommended to prevent nutrient deficiencies (Hendricks and Badruddin, 1992). Seventy years ago, Davis (1928) and, more recently, Birch and co-workers (1991) demonstrated that most young children, if provided access to a varied diet of foods from each of the food groups, will consume adequate amounts of nutrients and energy. However, if they do not have access to foods from all food groups on a regular basis, self-selection of a nutritionally adequate diet is not possible (Heird, 1994). No single food, even if it is perceived as nutritious and healthful, should be consumed in excess (Smith and Lifshitz, 1994). As with all foods, moderation in fluid intake is recommended.

Other Issues in Infant Nutrition

(i) Food allergies

Whenever possible, allergies to food should be prevented.

Recommendation:

30. Encourage exclusive breastfeeding for at least 4 months to decrease the risk of allergy in infants with a positive family history.

Treatment of proven food allergies involves avoidance of foods known to cause symptoms.

Recommendation:

31. When food choices are restricted, ensure that dietary intake continues to meet nutrient and energy needs.

(ii) Colic

Dietary manipulations have had limited success in the treatment of colic.

Recommendation:

32. Ensure that any dietary modification or pharmalogical interventions are safe.

(iii) Constipation

In infancy, true constipation is infrequent.

Recommendation:

33. Parents need to be educated about the wide variation in normal bowel function in infants and toddlers to avoid overtreatment of normal variants.

(iv) Dietary fat

Dietary fat is an important source of energy and the only source of essential fatty acids.

Recommendation:

34. Dietary fat restriction during the first 2 years is not recommended because it may compromise the intake of energy and essential fatty acids and adversely affect growth and development.

(v) Dental caries

Prevalence of dental caries is lower where infants and children have access to fluoridated water and where long-term exposure of teeth to nutrient-containing liquids is avoided. Excessive fluoride intake can cause dental fluorosis.

Recommendations:

35. Fluoride supplementation is not recommended for infants less than 6 months of age.

36. For infants between the ages of 6 months to 2 years who are living in areas where the household water supply contains less than 0.3 ppm (μg/L) fluoride, daily supplementation with 0.25 mg fluoride is recommended. Where the principal drinking water source contains ≥ 0.3 ppm (μg/L) fluoride, supplementation is not recommended.

37. Avoid excessive intake of fluoride.

38. Avoid the use of a bottle during sleep time or as a pacifier. Avoid nocturnal and long-term use of baby bottles containing liquids other than water.

39. Do not dip pacifiers or nipples in sugar or honey.

(vi) Gastroenteritis

Manage mild to moderate dehydration associated with gastroenteritis with oral rehydration therapy (ORT). Prevent malnutrition.

Recommendations:

40. Manage mild to moderate dehydration with an oral electrolyte solution and early refeeding.

41. For infants who are breastfed, continue breastfeeding while supplementing fluid intake with an oral electrolyte solution.

(vii) Diabetes

The exact role of early infant nutrition as a possible etiologic factor for infants genetically at risk for diabetes has not been proven.

Recommendation:

42. There is no justification at this time to recommend changes to infant feeding practices for the purpose of preventing diabetes.

(viii) Iron deficiency anemia

Iron deficiency is preventable through appropriate feeding choices.

Recommendations:

43. Continue exclusive breastfeeding for at least 4 months.

44. Introduce complementary foods containing iron at 4 to 6 months of age.

45. Choose iron-containing formulas for infants who are not breastfed or for infants receiving formula as well as breast milk.

46. Delay the introduction of whole cow's milk until 9 to 12 months of age.

47. Continue to offer iron-fortified foods beyond 1 year of age to provide sufficient iron.

48. Where informed parents choose not to adhere to these recommendations, screen for anemia at 6 to 8 months of age and provide medicinal iron drops if necessary.

(ix) Vegetarian diets

Nutritional needs can be met by most well-planned vegetarian diets. For vegetarian diets that are limited in variety and nutritional quality, professional advice regarding supplements is appropriate.

Recommendations:

49. For vegan infants who are not breastfed, promote commercial soy-based infant formula during the first 2 years of life.

50. After dietary assessment, recommend nutrient supplements for vegan diets which are found to be nutritionally incomplete.

(i) Food allergies. Adverse food reactions are divided into two general categories: food intolerance and food hypersensitivity. An allergic reaction to a food involves the immunologic system. The incidence of food allergies has been estimated at 8% in the first year of life, and decreases as children get older; however, most further qualify it to be in the 1% to 2% range (Bock, 1987). The risk of developing food allergies is largely related to genetic predisposition and the age at which the food is introduced, with the chance of sensitization greatest in the first year of life. Young infants are especially prone because their immature intestinal system is more permeable to absorption of food allergens and lacks local immune defences (Burks and Sampson, 1993). Most allergens are proteins of large molecular size, therefore food

allergy commonly presents in infancy with the first introduction of milk, egg or peanut (Burks and Sampson, 1993). These three foods, as well as soy, nuts and wheat, are responsible for about 95% of food allergies in infants (Bock and Atkins, 1990). It is rare for an infant to have allergies to more than two or three foods (Bock and Atkins, 1990). In an exclusively breastfed infant, the source of these allergens can be the mother's diet. The proteins pass into her breast milk and thus are ingested by the baby (Jakobsson 1991).

Diagnosis of food hypersensitivity requires a careful history to exclude other causes of adverse food reactions, selective skin prick testing or radioallergosorbent test (RAST) (when IgE mediated disorder is suspected), appropriate removal of the food from the diet, and a subsequent challenge test (Bock and Sampson, 1994; Burks and Sampson, 1993).

Treatment of food hypersensitivity involves avoidance of foods proven to cause symptoms. Food-related allergies tend to disappear with age, therefore rechallenging with the offending food is recommended at regular intervals (Bock, 1986). Allergies to peanut, nuts, wheat, fish and seafood are the most severe and tend to be lifelong (Burks and Sampson, 1993). In the case of multiple food allergies or severe reactions to food, the assistance of a dietitian with expertise in food allergies may be beneficial.

The ability to prevent food hypersensitivity is being debated. Exclusive breastfeeding for at least 4 months has been shown to decrease the risk of allergy in infants at increased risk of food allergies. The use of protein hydrolysate formulas and the delayed introduction of solid foods have been studied for prophylaxis of food hypersensitivity. Many of the studies are conflicting. (For further discussion of this topic, see the sections on breastfeeding and the prevention of allergies, and protein hydrolysate formulas.) A single recent study showed that exclusive breastfeeding, or feeding a formula containing a partially hydrolyzed whey-hydrolysate, was associated with lower incidence of atopic disease and food allergy compared to feeding soy or conventional cow's milk formulas (Chandra, 1997).

(ii) Colic. Colic occurs in approximately 13% of infants independent of how they are fed (Lehtonen and Rautava, 1996). Despite a number of theories, the cause of colic remains unknown. It typically begins before 3 to 4 weeks of age and lasts until the infant is about 3 to 4 months of age. Although the cure, or permanent treatment, for colic is unknown, cuddling, rocking, stroking and massaging are common ways to soothe infants with colic. Early introduction of solid foods has not proven beneficial while the replacement of cow's milk protein has met with varying success (Lehtonen and Rautava, 1996; Hill *et al.*, 1995). For the breastfed infant, overfeeding or an overactive milk ejection reflex may cause symptoms like colic (CICH, 1996). Gulping of milk may lead to excessive air swallowing or excess ingestion of lactose from foremilk (resulting in mild carbohydrate malabsorption) which may lead to abdominal pain. In such cases, changes in feeding routine and pattern are worth considering.

Various pharmacological treatments have been tried but none has been proven to be of definite benefit. Simethicone, a defoaming agent, has been most extensively studied. It is said to accelerate the passage of intestinal gas by decreasing the surface tension of gas bubbles.

Controlled studies show varying results, although most did not show any benefit (Becker *et al.*, 1988; Sethi and Sethi, 1988; Dugger and Inchaustegui, 1963; Danielsson and Hwang, 1985). Most recently, Metcalf *et al.* completed a randomized, placebo-controlled, multicentre trial which demonstrated that simethicone was no more effective than a placebo (Metcalf *et al.*, 1994). Because colic is associated with gastrointestinal discomfort and certain herbal teas have been cited as having antispasmodic activity, herbal teas have been used to treat colic. Weizman and colleagues recently demonstrated in a prospective double-blind study that a herbal tea containing chamomille (*Matricaria chamomilla*), vervain (*Verbena officinalis*), licorice (*Glycyrrhiza glabra*), fennel (*Foeniculum vulgare*) and balm mint (*Melissa officinalis*) appeared more effective than a placebo in improving infant colic (Weizman *et al.*, 1993). This study was limited in that the measure of outcome was based on parents' subjective evaluation and the study duration was short. Further studies are needed before this intervention can be routinely recommended since the safety of some herbal teas if taken in large amounts has not been established.

(iii) Constipation. The definition of constipation in early childhood is elusive (Forsyth *et al.*, 1985). Stool patterns vary normally from child to child. In infancy, true constipation is infrequent. There is wide variation in the "normal" number of bowel movements per day, ranging from a bowel movement days apart, to one after each feeding (Rappaport and Levine, 1986). Normal bowel function occurs even when an infant appears to be in extreme discomfort as evidenced by straining and reddening of the face. There is no evidence that inadequate fluid or carbohydrate intake is the cause of constipation in infants; nor is there evidence that treating constipation with fruit juices or corn syrup is efficacious. Educating parents about the wide variation in normal bowel function seems essential for avoiding the overtreatment of normal variants.

Hard and painful bowel movements signal a mild to moderate problem in bowel function, whereas abdominal distention requires further work-up and medical intervention. The use of prune juice (with its high sorbitol content) and/or increasing the fibre content of the diet may be helpful for infants older than 6 months. A varied intake of fibre-containing foods such as whole grain breads and cereals, fruits, vegetables and cooked legumes is suggested rather than the routine use of fibre supplements (Agostini *et al.*, 1995). There are no data regarding the amount of fibre needed for normal laxation during the first 2 years of life. Recent recommendations on dietary fibre intake for children (age plus 5 g/day) apply to children older than 2 years (Williams *et al.*, 1995). These recommendations to a large extent reflect current dietary intake of fibre by children in North America. They are not based on evidence of disease prevention. Concerns related to increased consumption of fibre in infants and toddlers include a possible decrease in caloric intake resulting in inadequate growth and development, decreased bioavailability of minerals, and an increase in intestinal gas and abdominal discomfort. Studies in older children and adults suggest that these concerns may be unfounded (Dwyer, 1995).

(iv) Dietary fat. The optimal amount of fat in the diet is related to the infant's stage of development and requirement for energy. Energy and nutrient requirements are particularly high in the first 2 years of life. Thus, dietary fat restriction

would potentially compromise both energy and essential fatty acid intake and is not advised. There is no evidence that restricting fat intake in children reduces illness in later life or provides benefit to children during childhood (Health Canada and CPS, 1993; Health and Welfare Canada, 1990a).

(v) Dental caries.

(a) Fluoridation supplementation. Fluoridation of the water supply is the most effective, cost efficient means of preventing dental caries. In areas with low fluoride levels in the water source, fluoride supplements are recommended. An increase in the availability of fluoride (fluoridated water, foods or drinks made with fluoridated water, toothpaste, mouthwashes, vitamin and fluoride supplements) has led to an increasing incidence of very mild and mild forms of dental fluorosis in both fluoridated and non-fluoridated communities (Clark, 1993a; Levy, 1994). The effect of dental fluorosis is cosmetic only, ranging from white striations or specks to areas of pitting or brown-gray staining. The teeth remain resistant to caries and there are no known associated health risks.

This sign of excess fluoride intake has led to modifications in fluoride recommendations such that fluoride supplements are no longer recommended from birth, and doses have been decreased during the first 6 years of life. The difficulty lies in knowing how far to lower fluoride supplementation without jeopardizing the benefits of caries prevention. The diversity in drinking water supply and dental hygiene practices in Canada, and the lack of comprehensive epidemiological data, have made it difficult to reach agreement on the best way to provide the right amount of fluoride to all Canadian children.

Recently the Canadian Paediatric Society (CPS) and the Canadian Dental Association (CDA) participated in a consensus conference organized to unify an approach to fluoride supplementation for infants and children living in Canada. The proposed new recommendations (CDA, 1998) would replace the existing CPS (CPS, 1995) and CDA (Clark, 1993) recommendations; they include a decision-algorithm for use by health care providers as well as a new recommended dosage schedule of daily fluoride supplementation (see Table 1). The goal is for all organizations to work together to implement this uniform fluoride supplement schedule in Canada.

Table 1. Dosage Schedule for Dietary Fluoride Supplements (mg/d)

	If fluoride concentration of principal drinking water source is:	
Age of child	<0.3 ppm (µg/L)	≥0.3 ppm (µg/L)
Birth - 6 mo	none	none
6 mo - 2 y	0.25 mg/d	none

Canadian Dental Association. Personal Communication. 1998

As more information becomes available from monitoring trends in dental fluorosis, the optimal timing and dose of fluoride supplements needed to prevent dental caries, and avoid dental fluorosis, may require further revision. It should be noted that “ready-to-serve” infant formulas in Canada are not fortified with fluoride.

(b) Nursing bottle syndrome. The etiology of nursing caries is multifactorial. Nursing bottle syndrome has been attributed to giving a bottle of sugar-containing beverage during sleep time or to pacify an infant, bottle feeding past 12 months of age and the use of sweetened pacifiers. Bathing teeth in nutrient-containing liquids (milk, fruit juices and fruit drinks, or carbonated, sugar-containing beverages) provides a continuous supply of nutritional substrate for dental bacteria to proliferate. This may result in carious teeth. When an infant is asleep, liquid can pool in the mouth, and salivary flow and oral cleaning are diminished (Herrmann and Roberts, 1987). Children who fall asleep with a bottle in their mouth are at significantly greater risk of caries than infants who discard the bottle before falling asleep (Schwartz *et al.*, 1993). The use of bottles or pacifiers dipped in sugar, syrup or honey during the day or night can also cause damage to the infant's deciduous (primary) teeth (Fomon, 1993). The effectiveness of preventative dental counselling in inducing dietary change has been questioned; however, for the prevention of nursing caries it seems clinically sensible to recommend counselling parents to avoid nocturnal and long-term use of baby bottles containing liquids other than water (Lewis and Ismail, 1994).

(vi) Gastroenteritis. Oral rehydration therapy (ORT), combining the use of oral electrolyte solutions (OES) with early refeeding, has proven to be safe and efficacious for restoring and maintaining hydration and electrolyte balance in infants with mild and moderate dehydration, including those with vomiting (US Department of Health and Human Services, 1992). Oral electrolyte solutions containing specific concentrations of carbohydrate, sodium, potassium and chloride promote fluid and electrolyte absorption, while fluids such as juices, carbonated soft drinks, tea, sports beverages, Jello or broth do not. Human milk is well tolerated during diarrhea and may reduce its severity and duration (Haffejee, 1990); therefore, breastfeeding should continue throughout the diarrhea with additional fluids given as OES. Early and rapid refeeding should occur as soon as rehydration is achieved and vomiting stops (ideally within 6 to 12 hours of beginning treatment). Infants treated with OES and early refeeding have reduced stool output, shorter duration of diarrhea and improved weight gain (Brown, 1991; Brown *et al.*, 1988). Routine change to lactose-free or diluted feedings is unnecessary in well-nourished infants with mild to moderate gastroenteritis (Brown *et al.*, 1994). The Canadian Paediatric Society Nutrition Committee (CPS, 1994b) has recently published recommendations on ORT and early refeeding in the management of childhood gastroenteritis.

(vii) Diabetes. Insulin-dependent diabetes mellitus (IDDM) is the most severe form of diabetes and the most common chronic disease of childhood. For disease to occur, there must be genetic susceptibility and interaction with as yet undefined environmental factors, possibly viruses and foods. Early infant nutrition involving a lack of, or short duration of, breastfeeding and early exposure to cow's milk have been implicated but the case-control data show considerable variation and the evidence implicating the cow's milk protein, bovine serum albumin (BSA) has been seriously challenged (Ronningen *et al.*, 1995; Atkinson *et al.*, 1993, 1994). A recent meta-analysis showed that

although there is a weak effect of lack of breastfeeding and early exposure to cow's milk-based formulas, the only studies where prospectively recorded data were available showed no association with IDDM (Norris and Scott, 1996). Results from an ongoing study in very young genetically high-risk siblings and offspring of persons with IDDM showed early exposure to cow milk was not associated with diabetes autoantibodies (Norris *et al.*, 1996). Studies in diabetes-prone animals indicate there may be several food diabetogens, and that timing and duration of exposure is important. In diabetes-prone rats, wheat and soy are potent and consistent promoters of diabetes, whereas the diabetogenic potential of cow's milk varies greatly from batch to batch; exposing these animals to known diabetogenic diets as late as puberty can still induce diabetes (Scott, 1996). Thus, long-term exposure to food diabetogens, considerably past the time of infancy, is required for diabetes to develop.

The timing of the diet-IDDM interaction in humans remains to be established. Although hydrolyzed casein-based diets are diabetes-retardant in animal models of IDDM, the use of hydrolyzed casein-based infant formulas for prevention of diabetes in high-risk human infants is not recommended because prevention of diabetes may require avoiding diabetogenic foods long past the time of infancy and these formulas are unpalatable and expensive. Knowledge of the food diabetogens, and particularly the mechanisms by which they cause diabetes, is still incomplete, making it difficult to justify dietary intervention trials in children at this time. Until more definitive data are available on the timing, duration of exposure and the exact identity of all the foods that may promote diabetes, it is inappropriate to recommend changes to infant feeding practices.

(viii) Iron deficiency anemia. Iron deficiency is most common among infants between the ages of 6 and 24 months. The major risk factors for iron deficiency anemia in infants relate to socioeconomic status, the early discontinuation of breastfeeding and include the early consumption of cow's milk, and inadequate funds for appropriate foods (Canadian Paediatric Society, 1991; Gray-Donald *et al.*, 1990). Other high-risk groups include low birth weight and premature infants (Friel *et al.*, 1990; Shannon, 1990), and older infants who drink large amounts of milk or juice, and eat little solid food (Feightner, 1994). The importance of preventing rather than treating anemia has been emphasized by findings that iron deficiency anemia is a risk factor for what may be irreversible developmental delays in cognitive function (Lozoff *et al.*, 1991, 1996; Walter *et al.*, 1989).

Healthy full-term infants are born with neonatal iron stores which can meet iron needs until 4 to 6 months of age (Calvo *et al.*, 1992; Saarinen and Siimes, 1977). At this time, the absorption of highly bioavailable iron in human milk may no longer be adequate to meet the demands for erythropoiesis. Therefore, introduction of iron-fortified infant cereals is recommended as a good source of available dietary iron at 4 to 6 months of age (Fuchs *et al.*, 1993; AAP, 1992b; CPS, 1991). For non-breastfed infants, switching from a non-fortified to iron-fortified formula around 4 to 6 months of age would meet the need for supplemental iron. However, parents may forget or ignore the need for a change in formula; therefore, as a preventative measure, it is recommended that for non-breastfed infants, an

iron-fortified formula be used from birth (CPS, 1991). Although dietary iron is not used for hemoglobin synthesis in the first few months of life, its early use contributes to iron stores and helps to prevent later development of iron deficiency. In communities where the majority of formula used is iron-fortified, the prevalence of iron deficiency anemia is very low. The perception by parents and some health professionals that low-iron formulas are associated with fewer gastrointestinal symptoms has not been demonstrated in controlled clinical trials. No difference in gastrointestinal symptoms or stool characteristics (with the exception of colour) has been detected in infants fed low-iron and iron-fortified formulas (Nelson *et al.*, 1988; Oski, 1980).

Infants weaned from breastfeeding before 9 months of age should receive iron-fortified formula. Non-fortified formula and cow's milk are unsuitable alternatives as they contain very little natural iron which is poorly absorbed. When milk is combined with other dietary sources of iron, such as iron-fortified infant cereals, puréed liver, meat, fish, legumes and egg yolk, it may be possible to avoid iron deficiency and anemia. However, there are limited data to support or refute this estimation. After 9 months of age, when a wider variety of foods is being ingested, the introduction of cow's milk is not associated with any risk of iron deficiency. Despite recommendations to the contrary, many Canadian infants receive cow's milk or evaporated milk in the second 6 months of life because of convenience and relatively low cost. For infants of informed parents who choose not to adhere to these guidelines, one may either provide medicinal iron drops starting at 6 months of age, or screen for anemia around 6 to 8 months of age.

For children more than 1 year of age, iron-containing foods, such as those listed above, provide iron in sufficient amounts. Supplemental iron is not required unless the diet is lacking in these foods.

(ix) Vegetarian diets. With careful planning, vegetarian diets for infants and children can be nutritionally adequate (Sanders, 1995; Sanders and Reddy, 1994). For vegan infants who are not breastfed, commercially prepared soy-based infant formula is recommended during the first 2 years of life to provide adequate nutrients and energy for growth and development. For older infants, a carefully selected vegetarian diet can meet all the requirements of a growing child; however, deficiencies of iron, vitamin B_{12}, vitamin D and energy have been reported in vegetarian children (Sanders, 1995; Jacobs and Dwyer, 1988). The guidelines presented for introducing solid foods (see Transition to Solid Foods) apply to all healthy infants, including vegans. Parents who feed their infant vegan diets in the first 2 years of life may benefit from consultation with a dietitian or nutritionist to ensure the adequacy of their infant's food (nutrient) intake, and to assess the need for nutrient supplements.

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