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From Breast Milk to Weaning and Beyond

Mothers' perception that their infant is not satisfied by breast milk alone is consistently cited as one of the top three reasons why mothers decide to stop breast-feeding, regardless of the age at which the infant is weaned, according to a US study.

Dr. Ruowei Li, Centers for Disease Control and Prevention, Atlanta, Georgia, and colleagues analyzed self-reported data from 1323 mothers who participated in the Infant Feeding Practice Study II (*Pediatrics* 2008;122:S69-S76). Questionnaires were mailed to mothers two to 12 months after their child's birth, in which they were asked to rate the importance of 32 different reasons why they might have decided to stop breast-feeding. The three main reasons why mothers who stopped breast-feeding within the first month or between the first and second months concerned infants' difficulties sucking and latching; that breast milk alone did not satisfy the infant; and that mothers did not have enough milk.

"Among mothers who discontinued breast-feeding when their infant was aged 3 to 8 months, perception of the infant's lack of satisfaction by breast milk alone (approximately 49%) and concern about not having enough milk (between 43% and 54%) continued to be important," the authors added. Infants who lost interest in nursing or who began to wean themselves was the third most frequently cited reason for stopping breast-feeding in this maternal group.

Among mothers who weaned their infant starting at 9 months of age, again, the mothers cited infants had not been satisfied with breast milk alone; the infant was losing interest in nursing; or infants was starting to bite as the most frequent reasons why mothers stopped breast-feeding.

"When a mother does not have confidence that she is providing an adequate quantity or quality of milk for her infant, she is likely to stop breast-feeding regardless of her infant's age," investigators wrote. "Our findings about why mothers are most likely to stop breast-feeding at various infant ages can be used by doctors, nurses and lactation consultants to help mothers overcome breast-feeding barriers."

Weaning infants off breast milk: Canadian Paediatric Society tip sheet

According to a statement from the Canadian Paediatric Society (CPS), health care professionals need to explore a mother's reasons for wanting to wean her infant off breast milk and provide her with the information she needs in order for her to make an educated decision about weaning. "Weaning from the breast is a natural, inevitable stage in a child's development," the CPS observed, "[but] it is a complex process involving nutritional, immunological, biochemical and psychological adjustments." The following is a short summary of the CPS statement on the process of weaning (*Paediatr Child Health* 2004;9:249-52).

At 4 to 6 months, an infant is ready to accept solid foods. Sucking and chewing are complex behaviours and oral stimulation is integral to the learning process. If a stimulus is not applied at the right time, the infant may become a poor eater.

By 4 to 6 months of age, iron stores from birth are diminishing. Delaying the introduction of solid foods much beyond 6 months is likely to put the infant at risk for iron deficiency anemia and other micronutrient deficiencies. Mothers should introduce an iron-fortified infant cereal as the first solid food by 6 months of age. Towards the end of the first year of life, breast milk no longer supplies enough protein so additional sources of protein must be provided.

Weaning can begin by substituting the child's least favourite feeding with either a cup or bottle. Pumped breast milk, formula or cow's milk can be given when age-appropriate. Whole cow's milk should be avoided until an infant is at least 9 months but preferably 12 months of age, and then they should be given no more than 720 mL (24 oz.) of milk per day. If giving fruit juice, the amount should be limited to no more than 60 to 120 mL (2 to 4 oz.) per day.

A second substitute feeding can be given when the baby accepts the cup or bottle well. This can take time, as determined by the mother and infant together. If the infant is

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not old enough to hold their own bottle, the bottle should not be propped. Ideally, mothers should hold the infant while they feed to maintain closeness.

Solid foods can be offered at developmentally appropriate times. Initially, infants can be given a few teaspoonfuls once a day, the amount and number of servings increasing with time.

Partial weaning is an option for the mother who wishes to continue with some breast-feeding. This can work well for mothers who need to be outside the home for substantial periods of time each day. While away, mothers can express their milk for later feeding which should sustain milk production.

Weaning should be a gradual process. Abrupt weaning should be avoided wherever possible. It is traumatic for the infant, uncomfortable for the mother and may result in blocked ducts, mastitis or breast abscesses.

Closing the Gap Between Infant Formula and Breast Milk: Focus on Gastrointestinal Tolerance

According to an international study carried out in 17 countries, stool frequency and consistency in infants fed a then new formula, Similac Advance, was closest to that of infants fed human milk. Regurgitation was also less frequent among infants in the new formula group than in all other feeding groups. "Perceived intolerance to infant formula is a frequently reported reason for changing formula," investigators under lead author Dr. Pedro Alarcon, Abbott Park, Illinois, observed, "and some infants may be switched from one formula to another because of colic, excessive spit-up, or changes in the frequency or consistency of the infants' stools."

In an open-label study (*Nutrition* 2002;18:484-9), investigators compared the gastrointestinal (GI) tolerance of the new formula to other commercially available infant formulas as well as to human milk. The new formula was formulated to provide an appropriate blend of lipids, simulate the whey:casein ratio and nucleotide concentrations of mature human milk. Infants were between 28 and 98 days of age, had a gestational age of 38 to 42 weeks and a birth weight of at least 2500 g. GI tolerance was evaluated in infants on one of five feeding regimens: human milk only (HM); new formula only (NF); other commercial formulas only (OF); human milk supplemented with new formula; or human milk supplemented with other formulas. "GI tolerance was evaluated in terms of stool consistency and frequency, the frequency of regurgitation, and the incidence of GI intolerance indicators which were recorded in a diary by the subject's parents or guardian," investigators observed. A total of 6999 subjects were evaluable: 979 on HM only; 1695 on HM plus NF; 635 on HM plus OF; 2677 on NF only and 1013 on OF only.

Comparison of stool consistency between feeding groups

Comparison	Mean stool consistency*	*P* value
HM vs. OF**	2.59 vs. 3.27	<0.001
HM vs. NF	2.59 vs. 2.99	<0.001
NF vs. OF**	2.99 vs. 3.27	<0.001
NF vs. EF	2.99 vs. 3.23	<0.001
NF vs. SF	2.99 vs. 3.38	<0.001

*Based on a score of 1=watery, 2=loose/mushy, 3=soft, 4=formed, 5=hard.
**Enfalac and S-26

Stool consistencies

As investigators reported, infants who were fed human milk had average stool consistencies of semi-liquid to soft while infants fed other formula had average stool consistencies of soft to formed. "Subjects who received NF only had softer stools than those who received OF only (P<0.001), but harder stools than those who received HM only (P<0.001)," the authors added. Infants who received NF only also had significantly softer stools than infants who received either of two OFs only. Infants in the exclusive HM group had the most frequent stools at 3.15/day while infants in the NF group averaged 2.22 stools a day. Infants in the OF group had the least frequent stools at 1.82 stools/day.

As investigators pointed out, there were significant differences among all feeding groups in the mean frequency of regurgitation. For example, infants fed the NF had significantly fewer episodes of regurgitation than infants fed either HM or OF only, while infants fed HM plus NF also regurgitated less than those who were fed HM plus OF. "In addition, infants fed HM plus NF had fewer episodes of regurgitation than did infants fed HM plus SF (S-26)," investigators added.

The overall incidence of GI intolerance was generally low but infants fed NF only had fewer episodes of general intolerance, spit-up and colic than those fed OF exclusively, as did those fed HM and NF compared with infants fed HM and OF.

Composition of iron-fortified formulas affects stool frequency, consistency

One of the concerns that parents may have about weaning their baby to infant formula is the change in the baby's stool consistency. In fact, many parents are still under the false impression that iron in infant formulas is constipating. However, this has never been proven and in fact, the Canadian Pediatric Society recommends that all babies who are not breastfed be given iron-fortified infant formula.

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Lloyd and colleagues (*Pediatrics* 1999;103:e7) analyzed two separate studies in which measures of tolerance were compared between exclusively breast-fed infants and those who were formula-fed. In the first study, 82 healthy, full-term infants who had been exclusively breast-fed upon study enrolment were assigned to either formula A (Similac with Iron Powder) or formula B (previously available Enfamil with Iron Powder).

"Parents completed daily records of tolerance during exclusive breast-milk feeding, during the weaning period and for a two-week exclusive formula-feeding period," investigators noted. On average, infants consumed roughly equal amounts of either formula (between 775 and 780 mL/day) during the exclusive formula-feeding period but the use of non-formula food did not differ between the feeding groups.

As the authors also noted, average weight gain for infants fed either formula was similar. During the weaning period, infants fed formula A gained 32 g/day and they gained 26 g/day during exclusive formula-feeding. Infants fed formula B gained an average of 26 g/day during both the weaning and the exclusive formula-feeding periods. There were no significant differences in the incidence of spit-up or vomiting between the feeding groups.

Yet as infants progressed from exclusive breast-feeding to exclusive formula-feeding, several changes in stool characteristics occurred in both feeding groups. "Stool frequency significantly (P<0.05) decreased from the exclusive breast-milk period to weaning," the authors noted, "and stools also became firmer as infants moved from breast milk to weaning to exclusive formula-feeding (P<0.05)."

Between-formula differences consisted largely in stool colour and consistency. Infants fed formula B had significantly fewer brown stools than those fed formula A during both the weaning and the exclusive formula-feeding interval and more yellow stools during exclusive formula-feeding. Infants fed formula B in turn had significantly less frequent stools than those fed formula A—"and this difference persisted during the two weeks of exclusive formula-feeding," the authors added. Infants fed formula B also had significantly firmer stools than did infants fed formula A during both feeding intervals.

The second study involved full-term infants who had been exclusively formula-fed at the time of enrolment (by 2 weeks of age). All infants were fed standard cow milk-based formula (previously available Similac with Iron Powder) for one week and were then randomized to receive the same formula A or formula B as used in the first study for another two weeks.

In contrast to the first study, stool frequency and colour did not differ between infants fed formula A or formula B during the study feeding period. On the other hand, infants fed formula B again had significantly firmer stools than those fed formula A, and had a significantly greater percentage of hard and formed stools and a significantly lower percentage of watery and loose stools than those fed formula A.

Palm olein oil

As the authors speculated, the source of lipids contained in the two test formulas may explain the differences in stool consistency and frequency. "Both formulas contain soy and coconut oils but differ in other lipids," they observed. Formula A contained high-oleic safflower (HOS) oil and formula B contained palm olein oil (PO). As other investigators have reported, PO-containing formulas appear to be associated with greater fat excretion and less fat absorption than formulas that do not contain PO. PO is used in infant formulas to emulate the palmitic acid found in breast milk. However, they are not the same and studies show that they don't have the same results in the infant. PO is actually poorly absorbed by the infant. "Unabsorbed palmitic acid tends to react with calcium to form insoluble soaps," investigators explained, and the level of fecal fatty acid soaps is highly correlated with stool hardness. "Perceived bowel dysfunction in infancy, particularly among those fed formula, is a common cause of parental anxiety," study authors observed, "and if parents view formula A as less constipating, this could reduce concerns regarding iron-fortified formulas and help eliminate the use of low-iron formulas."

Absorption of fat and calcium by infants is lower when PO provides a substantial proportion of formula fat than when formula does not contain PO, according to results from a randomized, crossover study.

Dr. Steven Nelson, University of Iowa, Iowa City, and colleagues carried out metabolic balance studies with each of the two study formulas under evaluation (*J A Coll Nutrition* 1998:17:327-2). "The two study formulas were similar in composition except for the source of fat," study authors observed. Formula PO provided fat from a blend of PO (45%), soy oil (20%) and coconut oil (20%) and high-oleic sunflower oil (15%), while formula HOS contained a blend of high-oleic safflower oil (42%), coconut oil (30%) and soy oil (28%).

Infants averaged 919 g/day with formula PO and 945 g/day with formula HOS, a difference which was not statistically significant. "Fecal excretion of total fat averaged 0.55 g/kg/day when formula PO was fed, but averaged only 0.09 g/kg/day when formula HOS was fed," investigators reported, "and the difference was statistically significant (P<0.001)"

Absorption of fat averaged 5.09 g/kg/day when infants were fed formula PO and 5.66 g/kg/day when they were fed formula HOS, again a statistically significant difference between the two formulas (P<0.05). "Expressed as a percentage of intake, fat absorption was on average 90% with formula PO and 98.5% with formula HOS," they added. Calcium intake was similar when infants were fed either formula, as the authors noted. In contrast, "fecal excretion of calcium was substantially higher with formula PO than with formula HOS," the authors pointed out. Consequently, calcium absorption, whether expressed as

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mg/kg/day or as per cent of intake was significantly (P<0.001) lower from formula PO than from formula HOS. "The results of this study confirm our previous finding that PO is poorly absorbed by infants from a milk-based formula," the authors concluded.

Soy Protein-based Formulas: Alternatives for Infants with IgE-mediated Cow's Milk Allergy

Soy protein-based formulas are safe to use in the great majority of children with proven IgE-associated cow's milk allergy (CMA) as only a small percentage of them will also be allergic to soy. Soy protein-based formulas have been available for almost 100 years and are still widely used as a milk substitute for infants unable to tolerate a cow's milk protein (CMP)-based formula. Although all food proteins have the potential to be allergenic, approximately 90% of food allergies are triggered by milk, eggs, fish, crustaceans, wheat, peanuts, tree nuts and soy.

After reviewing a range of clinical, animal and laboratory studies in which the relative allergenicity of soy was compared with other major food proteins, investigator Christopher Cordle, Columbus, Ohio (*J Nutr* 2004;134:1213S-9S), concluded that soy protein has consistently been shown to be significantly less reactive than CMP, with a >100-fold difference between the safe protein dose for soy than other food allergens.

Rigorous controlled trial

These observations suggest that the incidence and relative severity of true soy protein allergy may have been significantly overstated. Results from a rigorous double-blind, placebo-controlled trial would appear to confirm this. For the study, 93 infants and toddlers between the ages of 3 and 41 months with confirmed IgE-associated CMA were randomized to a minimum of 6 to 8 fluid oz. of soy formula per day for one year (*J Pediatr* 1999;134:614-22). IgE-associated CMA was established by a history of an immediate reaction—within 4 hours—to CMP, a positive skin prick test response to CM or CM-IgE, and either a positive double-blind, placebo-controlled food challenge or an open challenge response to CM. Infants who had a history or more than one immediate anaphylactic reaction to an isolated ingestion of CM within five months of study were also diagnosed with IgE-associated CMA.

"Of the cohort, 88% had been exposed to soy formula before enrolment," the authors noted. At study entry, allergy to soy was definitely diagnosed in 13% (n=12) of the cohort via various criteria; the remaining children (n=81) were then followed up for one year. When possible soy allergy was diagnosed at study exit in one child, "this IgE-associated CMA cohort had a maximum concomitant soy allergy prevalence of 14%," the authors confirmed. Soy formula feeding in those not allergic to soy at study entry was well tolerated and significant improvements in National Center for Health Statistics (NCHS) z-scores for weight and height occurred during follow-up.

"The findings of this study suggest that a soy-based formula is generally a safe formula for infants and toddlers with IgE-associated CMA, consistent with recent recommendations of the Committee of Nutrition of the American Academy of Pediatrics (AAP)," the authors concluded. "Given the lower cost and greater palatability of soy compared with extensively protein hydrolysate formula and the improved growth in height and weight with one year of soy formula... soy formula may be considered a first-choice alternative formula in children with IgE-associated CMA and documented negative soy challenge responses."

The AAP still recommend soy protein-based formula if secondary lactose intolerance occurs but soy formulas are not recommended for preterm infants nor for the prevention or management of colic or fussiness, and they should not be used in infants with documented CMA-induced enteropathy or enterocolitis.

In contrast, the Canadian Paediatric Society's recent position paper (*Paediatr Child Health* 2009;143:109-13) indicates that if a non-IgE-mediated CMA can be satisfactorily ruled out, the use of soy formula is not contraindicated. Soy protein-based formulas are not indicated in infants with non-IgE-mediated reactions to CMP because a large percentage of these infants will be allergic to soy.

▶ **Postscript:** It is important to note that the AAP have recently changed recommendations regarding the use of soy protein-based formulas from their last recommendations in 1998; namely, where they did indicate that soy formulas were safe and effective alternatives for normal growth and development in term infants whose nutritional needs are not being met by breast milk or cow-milk-based formulas. In their latest recommendations (*Pediatrics* 2008; 121:1062-8), the AAP now indicate that EPH formulas should be used for infants with documented CMA because a small number of these infants will also have a soy protein allergy (as per the study above, no more than 14% of infants with CMA are also allergic to soy).

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Feeding Difficulties in Infants and Young Children: Diagnostic Principles and Practical Tips

It is estimated that up to 25% of infants and young children develop some sort of feeding problem during their maturation including eating too little, restricted food preferences, delay in self-feeding, objectionable mealtime behaviours and unusual food habits. Furthermore, severe feeding problems that lead to poor weight gain occur in 1 to 2% of infants under the age of 1 year and 70% of these infants continue to have feeding problems four and six years later. "Feeding disorders also have been linked to later deficits in cognitive development, behavioural problems and eating disorders," confirmed Dr. Irene Chatoor, Children's National Medical Center, George Washington University, Washington, DC (*Child Adolesc Psychiatr Clin N Am* 2002;11:163-83).

Based on her own extensive work, Dr. Chatoor developed a classification system enumerating diagnostic criteria for feeding disorders in infants and children, focusing in on six specific feeding disorders.

Diagnostic criteria for feeding disorder of state regulation

- Infant has difficulty reaching and maintaining a state of calm alertness for feeding; is either too sleepy or too agitated or distressed to feed.
- Infant's feeding difficulties start in the newborn period.
- Infant fails to gain adequate weight or shows weight loss.

Diagnostic criteria for feeding disorder of reciprocity (neglect)

- Infant shows lack of developmentally appropriate signs of social responsivity (visual engagement, smiling, babbling) during feeding.
- Infant shows significant growth deficiency.
- Growth deficiency and lack of relatedness are not solely caused by a physical disorder or pervasive developmental disorder.

Diagnostic criteria for feeding disorder associated with concurrent medical condition

- Child readily initiates feeding but over the course of feeding shows distress and refuses to continue feeding.
- Child has a concurrent medical condition that is believed to cause the distress.
- Medical management improves but does not fully alleviate the feeding problems.
- Child fails to gain adequate weight or may even lose weight.

Diagnostic criteria for sensory food aversions

- Child refuses to eat specific foods with specific tastes, textures, smells and appearances.
- Onset of the food refusal occurs during the introduction of a different type of food.
- Child eats better when offered preferred foods.
- Child must have specific nutritional deficiencies or oral motor delay or both.

Diagnostic criteria for infantile anorexia

- Child refuses to eat adequate amounts of food for at least one month.
- Onset of food refusal often occurs during the transition to spoon- and self-feeding, typically between 6 months and 3 years of age.
- Child does not communicate hunger and lacks interest in food but shows strong interest in exploration and interaction across caregiver contacts.
- Child shows significant growth deficiency.
- Refusal of food did not follow a traumatic event.
- Food refusal is not caused by an underlying medical illness.

Diagnostic criteria of post-traumatic feeding disorder

Food refusal follows a traumatic event or repeated traumatic insults to the oropharynx or GI tract (choking, severe vomiting, insertion of nasogastric or endotracheal tubes, suctioning) that trigger intense distress in the infant. Consistent refusal to eat manifests in one of the following ways:

- Child refuses to drink from the bottle but may accept food offered by spoon (may drink from the bottle when sleepy or asleep).
- Child refuses solid food but may accept the bottle.
- Child refuses all oral feedings. Reminders of the traumatic event cause distress, as manifested by one or more of the following:
  - Child may show anticipatory distress when positioned for feeding.
  - Child shows intense resistance when approached with bottle or food.
  - Child shows intense resistance to swallowing food placed in the mouth.
- The food refusal poses an acute or long-term threat to the child's nutrition.

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Feeding principles encourage healthy eating habits in young children

World renowned pediatric gastroenterologist, Dr. Benny Kerzner, Children's National Medical Center and Professor of Paediatrics, George Washington University School of Medicine, Washington, DC, delivered a series of lectures in 2008 on oral feeding resistance in young children. Based on his lectures, a key set of feeding principles emerged that parents can use to encourage healthy eating habits in young children. "Parents need to feed their children well but should avoid being fanatical about eating," Dr. Kerzner noted. "There are other things in the life of a child that are just as important as nutrition."

- Avoid distractions while eating; food should be eaten in a calm environment.
- Adopt a neutral attitude to eating behaviour; avoid excessive praise, criticism, stimulation and coercion.
- Feed at specific intervals and avoid snacking to encourage appetite; feed 3 to 4 hours apart and nothing in between.
- Limit the duration of meals; meals should last between 20 and 30 minutes or 15 if the child is not eating.
- Use age-appropriate foods: teeth come in at 5 months and so should solids.
- Introduce novel foods one at a time and expose the child to the food up to 15 times before assuming it will not be taken.
- Encourage independent feeding.
- Tolerate age-appropriate messiness when eating.

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