Infant Formula Products

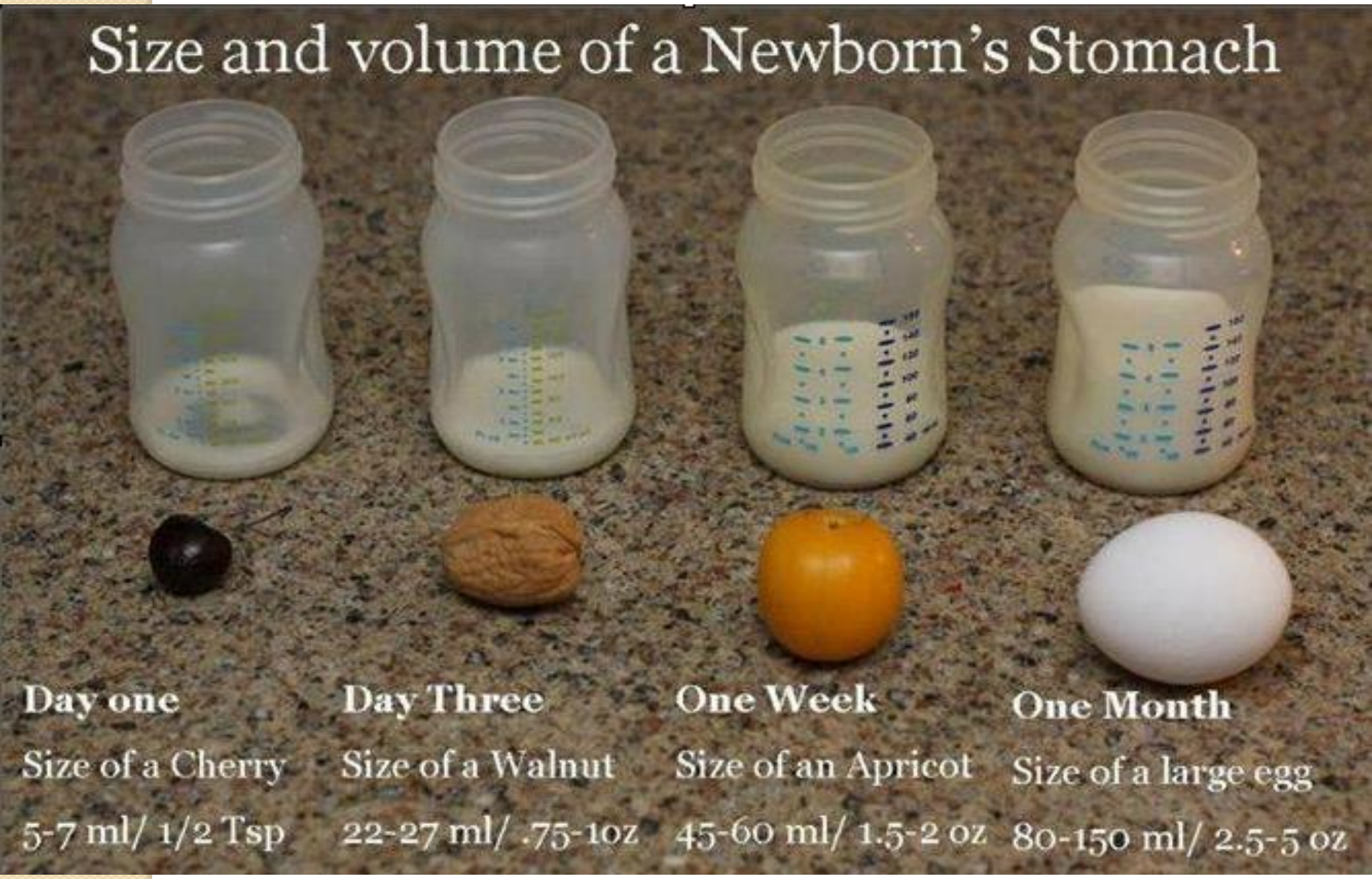

17/03/2006

Infant Formula Products: Introduction

Infant physiology and growth

Early infancy:

- Liquid nutrition only
- Frequent feeding: limited stomach capacity: 20-90 ml at birth, 90-150 ml at 1 month
- CHO digestion: lactase, sucrase, maltase, isomaltase, glycoamylase are mature.
- Lactase activity may be immature in premature infants.
- Pancreatic amylase activity and glucose transport are low in both full term and premature infants
- Low lipase concentration, bile salt synthesis is low (lingual and gastric lipase are present)
- Protein digestion and absorption are mature


Size and volume of a Newborn's Stomach
Day one
Size of a Cherry
5-7 ml/ 1/2 Tsp
Day Three
Size of a Walnut
22-27 ml/ .75-1oz
One Week
Size of an Apricot
45-60 ml/ 1.5-2 oz
One Month
Size of a large egg
80-150 ml/ 2.5-5 oz

Growth

- Average birth weight: 3.5 Kg
- 6-10% weight loss after birth, due to water loss
- Weight gain: 20-25gm daily till 4th month, 12gm/day for the coming 8 months
- Double wt: 4 months, triple: at 1 year
- Changes in body composition occurs as well: at birth, total body water is 70% and decreases to 60% at 1 year.
- Adipose tissue increases

Normal values are expressed as percentiles: see growth charts

Components of a healthy infant diet

1. **Fluid:**

- Water intake in the first 6 months is derived from breast milk or formula
- From 6 months and above when solid food is introduced, water intake remains high, because most children's food contain 60-70% water.
- 100ml/kg per day for the first 10 kg + 50ml/kg for each additional kg.

2. CHO:

- 40-50% of total calories.
- Lactose is the primary source.
- Adequate fiber intake is favorable to ensure regular stool frequency.
- premature infants are relatively lactase deficient and are prone to lactose intolerance
- Lactose intolerance: lactase deficiency
  Congenital lactase deficiency is rare
  Secondary lactase deficiency: in some cases of gastroenteritis

3. **Protein and amino acids:**

- 2.2gm/kg/day (birth-6 months), 1.6gm/kg/day (6-12 months)

Composition

- Essential a.a.: isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine
- Conditionally essential a.a.:cystein, taurine, tyrosine, histidine

- For **premature infants**, the content of serum proteins is **higher** in formula than in breast milk and this is especially needed in this case to meet expected intrauterine growth rates.
- The adequacy or protein intake is related to the growth rate of a child.

4. Fat and essential fatty acids

- Most dense source of calories in the diet
- Supplies 40-50% of the energy intake of infants
- Linoliec acid: *The diet must contain small amount of linoleic acid*, the polyunsaturated fatty acid) that has been proven to be an essential nutrient. Linoleic acid and its derivatives, including *arachidonic acid*, *enable optimum calorie intake and proper skin composition*.
- Linoliec acid deficiency: increased metabolic rate, hair loss, dry flaky skin and impaired wound healing
- Recently, docosahexanoic acid (DHA) and arachidonic acid (ARA) have been added to formulas

5. Micronutrients

- Vitamins

Infant formulas are supplemented with adequate amounts of vitamins and minerals to meet the needs of most term and premature infants

- **Biotin, choline and Inositol**
- Biotin is needed for efficient enzyme systems and considered as an essential vitamin.
- Choline and inositol are both components of cell membranes phospholipids and lipoproteins.

- **The need for vitamin and mineral supplements**
- Breast fed-full term infants:
- 1. *Vitamin D might be needed as a supplement if the mothers' diet is not balanced and contains inadequate amounts of vitamin D*.
- 2. Iron is well absorbed from breast milk, however ***after 4-6 months the iron stores become depleted and iron deficiency anemia might develop***. So an additional iron supplement is needed.

- **Formula fed full term infants**
- *Full term infants who consume adequate amounts of an iron fortified formula do not need vitamin and mineral supplement.*
- Infants 7-12 months who were fed formula and solid food had a more balanced intake of nutrients than infants fed cow milk and solid food.
- *Vitamins and minerals supplement is not needed after 6 months of age when the infant receive a diet of formula, mixed feedings and increased amount of table food.*
- A multivitamin with minerals may be needed if the infant is at a nutritional risk.

Preterm infants

- ***Preterm infants, either breast fed or formula fed, need vitamin and mineral supplementation.***
- Their nutrient needs are proportionately greater than those of full term infants, because of their rapid growth, inability to ingest an adequate volume of liquid and decreased intestinal absorption (Until they reach 2.5 kg of weight).

- *A multivitamin supplement should include vitamin E, folic acid, calcium and phosphorus, vitamin D).*

Minerals

- **Calcium and Phosphorus**
- These are crucial for the development and maintenance of the human skeleton.
- Formulas designed for full term infants are deficient in calcium and phosphorus relative to the needs of premature infants.
- *For these infants, additional calcium and phosphorus in special formulas are necessary*

- Iron
- Iron is a component of Hb and several enzymes. A large proportion of iron is present in the liver, spleen and bone marrow.
- *FDA requires that all formula milk contain the lower level of iron present in human milk (0.3-0.5 mg/l).*
- ***Infants are at risk of iron deficiency anemia and should be given formulas supplemented with iron (6-12 mg/L)***
- Formulas for LBW infants and premature infants contain equal or less amounts of iron

Iron-Fortified Infant Formula

- The American Academy of Pediatrics (AAP) *recommends that iron-fortified cow's milk-based infant formula is the most appropriate milk feeding from birth to 12 months for infants who are not breastfed or who are partially breastfed.*
- Use of an iron-fortified infant formula ensures that formula-fed infants receive an adequate amount of iron, an important nutrient during the first year.
- *Standard iron-fortified infant formulas are fortified with approximately 10 to 12 milligrams of iron, in the form of ferrous sulfate, per liter*
- *Iron deficiency is associated with poor cognitive performance and development in infants*

Proteins in human milk :

- The total protein concentration in human milk is approximately 0.9 g/dl.
- Two fractions: casein and whey.
- **Casein:** precipitated at low pH, constitutes 20–30% of human milk proteins. A heterogeneous group of proteins, molecular weights: 20 000–30 000
- **Whey:** contains a large number of proteins, which are derived from both milk and plasma.

Whey: مصل اللبن

The fluid portion of milk that separates from curd.

Lipids in human milk

- Human milk contains approximately 2.1–3.1% fat.
- *The major components (98%) of human milk lipids are triglycerides*

Variation in milk composition

- *Milk composition is not constant.*
- Affected by the timing within an individual feeding and the duration of nursing postpartum
- Within an individual feeding, the initial milk expressed (fore milk) is low in fat. *Fat content increases within a feeding, with disproportionately high concentrations of fat at the end of the feeding (hind milk).*
- Protein content remains relatively constant throughout a feeding, but pH increases as feeding progresses.

Colostrum: secreted from shortly after birth until approximately 5 days postpartum.

- High in protein content (immunoglobulins) and low in lactose and fat.
- **After 2 weeks: fat levels approximately double, while protein concentrations fall by a factor of four, to reach levels in mature milk.**

Cow's Milk is *NOT SUITABLE* To Humans

Contents of various milks

Human milk vs. whole cow milk

- Both contain more than 200 ingredients in the fat and water soluble fractions.
- Quantity and availability of nutrients is different
- Both have similar amount of water, calories
- calorie source is different (proteins supply 7% of calories in human milk, 20% in cow milk).
- *Lactose supplies 42% in human milk and 30% in cow milk, % of calories from fat is the same.*

- **CHO**: lactose in both cases, cow milk<<human milk

- **Proteins**: cow milk 3X minerals and protein, composition is different
- *Whey: casein ratio: Human milk (60:40), cow milk (20:80)*
- Whey protein is highly soluble, casein is relatively insoluble and forms curd.
- *The large amounts of casein in cow milk mixes with hydrochloric acid in the stomach to produce curd.*
- *These slow gastric emptying rate and may cause GI distress.*
- Human milk contains less casein and forms soft flocculating curds that are easy to digest.
- a.a. content is inappropriate to the immature enzyme systems (*The newborn has limited ability to metabolize different amino acids present in abundance in cow milk*

Fat:

- both have similar total fat content
- Human milk contains 3-4.5% fat that consists of triglycerides (98-99% of total milk fat), phospholipids, and cholesterol.
- Cholesterol level is different (higher in human milk
- The fat composition of human milk changes during lactation,: triglycerides concentration rises and phospholipid and cholesterol concentration decrease during the transition from colostrum to mature milk.

- Fat in human milk is different from cow milk in 2 ways:
  1. TG types: cow milk, short and long chain FA, in human milk medium chain
  2. Degree of saturation: human milk: PUFA, cow milk: saturated FA (butter fat)

  - LCPUFA (ARA + DHA)

  - *Lipoprotein lipase: Both cow milk and human milk contain additional lipoprotein lipase, but human milk contains additional lipase that contributes significantly to higher percentage of absorption of human milk fat*

Medium chain fatty acids:

1. a well–utilized fat in situations where conventional long chain dietary fats are malabsorbed.
2. medium chain triglycerides enhance the absorption of long chain triglycerides.
3. *do not require emulsification with bile,*
4. are more rapidly and more easily hydrolyzed than longer chain fats, and
5. ***are directly absorbed into the portal system***

Minerals and electrolytes:

- The total amount of calcium and phosphorus in cow milk is approximately four and seven times more than human milk. However, cow milk provides less calcium relative to phosphorus than does human milk.
- **In cow milk based formulas, the total conc. of calcium and phosphorus are reduced, but the calcium to phosphorus ratio imbalance remains and infants receive a phosphorus load.**

- The iron content of human milk decreases from 0.5 to 0.3 mg/L when the infant is between 2 weeks ad 5 months of age. Levels of iron in cow milk remain at 0.5 mg/l. Because iron in **human milk is more bioavailable, an infant should be able to absorb approx. 50% of the iron in human milk (versus only 10% in cow milk).**

- *Zinc content in human milk is less than that of cow milk, but it is more bioavailable. Zinc binds strongly to casein in cow milk, whereas binding in human milk is minimal.*

- Cow milk contains more sodium, potassium and chloride than human milk. These higher electrolytes together with the high protein content in cow milk result in a smaller margin of safety against hyperosmolar dehydration.

Part 2

TYPES, USES AND SELECTION OF COMMERCIAL INFANT FORMULAS

Types of commercial infant formulas

1. **Milk based formulas:** *prepared from nonfat cow milk*.

- **Vegetable oils is added** (The most widely used vegetable oils are are corn, coconut, sunflower and soy. Replacement of butter fat with vegetable oil allows better fat absorption)
- **lactose** is added.
- Supplemented with vitamins and minerals, iron and zinc

2. Milk based formulas **with added whey protein** When whey protein is added to nonfat cow milk, the ratio of whey protein to casein can be altered to approximate human milk.

3. **Therapeutic formulas**
   a. Soy protein formula
   b. Casein hydrolysate based formulas
   c. Amino acid based formulas
   d. Whey hydrolysate formula
   e. Low birth-weight and preterm infants
   f. Anti-regurgitation formulas

Soy protein formula *(isomil)*

- Used for infants with milk allergy, lactose intolerance, galactosemia or those of vegetarian parents
- *Contain soy protein instead of animal protein. Vegetable oils provide fat content and corn syrup and or sucrose supply the carbohydrate*
- Additional minerals and vitamins are added. Taurine, carnitine (low concentration in food from plant origin)
- **Soy formula is not suitable for feeding preterm and LBW infants**. Additional calcium and phosphorus is needed

Soy protein formula *(isomil)*

- **The use of soy-based infant formulas has no proven benefit in the following situations:**
- ☐ Healthy infants with acute gastroenteritis in whom lactose intolerance has not been documented
- ☐ Infants with colic
- ☐ Prevention of allergy in healthy or high-risk infants and
- ☐ Infants with documented cow's milk protein induced enteropathy or enterocolitis.


The good news is that you don't have mad cow's disease. The bad news is you're lactose intolerant.

Casein hydrolysate based formulas *(Pregestimil)*

These are effective in nutritional management of infants with a variety of severe GI abnormalities:

- Severe diarrhea,
- severe food allergy,
- sensitivity to intact protein,
- disaccharidase deficiency,
- protein malabsorption and so on.

Casein hydrolysate based formulas

Casein hydrolysate based formulas *(Pregestimil)*

- These products use enzymatic hydrolysates of casein as the protein source
- **They contain non-antigenic proteins with low molecular weight**
- Casein hydrolysate formulas are fortified with three amino acids: L cysteine, L tyrosine and L tryptophan, because the concentration of these amino acids are reduced during treatment of the protein.

Casein hydrolysate based formulas *(Pregestimil)*

- The CHO source is usually corn syrup, corn starch, dextrose
- Glucose polymers in corn syrup, modified corn starch are useful for children with malabsorption disorders who are frequently intolerant to lactose, sucrose and glucose.
- Glucose polymers are a low osmolar form of CHO and contribute little to the osmolar load.
- This is an advantage on infants with intestinal disorders
- Fat source is usually medium chain triglycerides, 25% soy oil, 10% corn oil, and 10% high oleic safflower or sunflower oil.

Amino acid based formulas

- *These are suitable for infants who are intolerant to casein hydrolysate and require amino acid free formula.*
- Used for infants with cow milk protein allergy, multiple food protein allergies, or intolerance to casien hydrolysate formula
- Fat is supplied from medium chain and long chain fatty acids.
- The CHO source are maltodextrin, sucrose and corn syrup solids

IV. Whey hydrolysate formula

- Enzymatic hydrolysis of whey protein.
- GI intolerance to cow milk but not allergic to it.
- Better accepted than casein hydrolysate formula in taste and appearance by parents and infants

V. Low birth-weight(<2.5kg) and preterm infants

- human milk is insufficient in proteins, phosphorus and calcium.
- The goal is to achieve postnatal growth that approximated the in-utero condition

- Special formulas are present for these infants: **whey protein is predominat.**
- *Mixture of CHO source is present, lactose, corn syrup solids, and glucose polymers, fat mixture (long, medium and short TG).*
- These infants are specially susceptible to iron deficiency aneamina, because their stores have lower content (only 2 months in contrast to 6 months of full term infants). Therefore iron supplement is needed.

LBW Infants

1. Do not have a fully active sucking reflex,
2. limited capacity to consume high volumes of formula,
3. Fat absorption in the intestine is less efficient, as bile salts concentrations are reduced.
4. LBW infant's inability to properly absorb, digest, and achieve metabolism of food has severe implications.
5. The renal system and liver are not fully developed:
   - Immature liver: reduced glycogen storage.
   - Less developed kidneys will not be able to obtain normal absorption mechanisms.

Low birth-weight and preterm infants

1. whey protein is predominant
2. Mixture of CHO source is present, lactose, corn syrup solids, and glucose polymers,
3. fat mixture (long, medium and short TG)
4. These infants are specially susceptible to iron deficiency aneamia (**WHY**?) Therefore iron supplement is needed
5. *Fortified with extra Ca, Mg, P, and LCPUFA*

Low-Iron Infant Formula

- In 1997, the AAP Committee on Nutrition recommended that the manufacture of infant formula containing less than 4 milligrams of iron per liter be discontinued.
- Some of the most commonly used milk-based infant formulas are also available with reduced iron content.
- These low-iron infant formulas now contain approximately 5 milligrams of iron per quart of formula.

Low-Iron Infant Formula

- *There are no known medical conditions for which the use of iron-fortified infant formula is contraindicated.*
- Some caregivers request low iron infant formula for their infants because they believe that the iron in the infant formula causes gastrointestinal problems, such as colic, constipation, diarrhea, or vomiting.
- However, studies have demonstrated that gastrointestinal problems are no more frequent in infants consuming iron-fortified than low-iron infant formula.
- As noted above, for the partially or non-breastfed infant, iron-fortified infant formula is the formula of choice to assure that an infant's iron needs are met.

REGURGITATION

- Mild regurgitation is a common occurrence in infancy.
- Often considered to be a normal physical phenomenon of early development.
- Usually no serious health risks.
- Spontaneously resolves with time.
- Often considered as a source of parental anxiety
- 15-30% of infants suffer from GER.
- Baby can’t thrive on formula that won’t stay down

SYMPTOMS

- Common symptoms

  -Regurgitation

  -Esophagitis

  -Excessive crying

  -Feeding problems

  -Parental anxiety

- Unusual Symptoms

  -Failure to thrive

  -Respiratory problems

  -Hematemisis

REFLUX & REGURGITATION

- "Young infants are prone to GER due to immaturity of the esophageal sphincter which controls the passage of food into the stomach." (A problem disappears by the age of 18-months)
- Reflux: Backward flow of gastric juices out of the stomach up through esophagus.
- Regurgitation: Backward flow of undigested food 'spitting-up'

  - **The use of thickened feeds is considered as**

" A safe approach with good clinical results, since in most infants the observed symptoms of regurgitation and emesis decreases

Pre-thickened milk-based Formulas

- **An iron fortified formula that contains:**

1. Carbohydrate blend of lactose (57%), rice starch (30%) and maltodextrin (13%)
2. High amylopectin rice starch for thickening

- Before ingestion: the AR formula has a viscosity *10 times that of ready-to-use standard formula*
- ***After ingestion (at low pH)→viscosity increases dramatically -equal to formula plus cereal combination***


easy scoop
Nestlé
NAN
A.R.
Thickened Infant Formula
with Probiotics For Babies
with Regurgitation
GENTLE START
reuteri
LR
Regurgitation
Net weight
800g
Suitable from birth


S-26
GOLD®
AR
NURTURING GENERATIONS OF BABIES
S-26®
TRUSTED BY
GENERATIONS
OF MUMS
Specialty
From
Birth
For babies with regurgitation
NET 900g Powder e
Thickened Premium Infant Formula

Hypoallergenic Infant formula

- A number of infant formulas have been developed and marketed for infants with allergies or intolerances to milk or soy-based infant formulas or those with a family history of allergies.
- Infant formulas manufactured and labeled for infants with allergies vary in the degree to which the allergy-causing protein has been modified.
- **They may contain partially hydrolyzed protein, extensively hydrolyzed protein, or free amino acids**.
- Extensively hydrolyzed and free amino acid-based infant formulas have been demonstrated to be tolerated by at least 90 percent of infants with documented allergies.
- Currently *available partially hydrolyzed infant formulas are not hypoallergenic and should not be used to treat infants with documented allergies*

Hypoallergenic Infant formula

- The AAP recommends that the use of hypoallergenic infant formulas should be limited to infants with well-defined clinical indications.
- If hypersensitivity is diagnosed, a physician may change the infant formula prescribed.
- The AAP states that formula-fed infants with confirmed cow's milk allergy may benefit from the use of hypoallergenic (extensively hydrolyzed or, if symptoms persist, a free amino acid-based infant formula) or soy-based infant formula

Hypoallergenic Infant formula

- Hypoallergenic infant formulas are significantly more expensive than either milk based or soy-based infant formulas.
- In addition, their taste is altered significantly during hydrolysis of the protein and they may not be well accepted by some infants

Lactose-Free Infant Formula

- Lactose is the major carbohydrate in cow's milk based infant formulas. Lactose intolerance may lead to excess gas, diarrhea, or fussiness.
- A very small number of infants produce insufficient amounts of lactase, the enzyme needed to break down lactose.
- *Congenital lactase deficiency is extremely rare.*
- Premature infants may have lower levels of lactase than term infants, proportional to their degree of prematurity, since lactase activity develops during the last trimester of pregnancy.

Lactose-Free Infant Formula

- Lactose intolerance may develop in later childhood (>2 years of age in some susceptible populations) or adulthood, but very few term infants have true lactose intolerance.
- Transient lactose intolerance may occur following acute diarrhea, but enzyme activity is restored quickly and switching to lactose-free infant formulas is usually not necessary
- Several cow's milk-based infant formulas are now available for infants with documented lactose intolerance
- In addition, soy-based infant formulas are lactose-free and may be used for infants with documented lactose intolerance


Similac
Lactose Free
Infant Formula
with IRON


ΝΕΑ
Nestlé
NAN
lactose free
Για βρέφη με συμπτώματα δυσανεξίας στη λακτόζη και μετά από διάρροια. Από τη γέννηση
✓ Ελεύθερο λακτόζης και σουκρόζης
✓ Χαμηλή οσμωτικότητα
✓ Με νουκλεοτίδια
✓ DHA / ARA
400g e
ΤΡΟΦΗ ΓΙΑ ΕΙΔΙΚΟΥΣ ΙΑΤΡΙΚΟΥΣ ΣΚΟΠΟΥΣ

PART 3

Arachidonic Acid (ARA) and Docosahexaenoic Acid (DHA)

- Long-chain polyunsaturated fatty acids include the essential fatty acids, linoleic acid (LA), and α-linolenic acid (ALA) along with their derivatives, arachidonic acid (ARA) and docosahexaenoic acid (DHA).
- Since formula-fed infants have been observed to have lower plasma levels of ARA and DHA, interest has arisen about the formula-fed infant's ability to synthesize these fatty acids.
- ARA and DHA are major fatty acids in the brain and retina. *Research demonstrating better cognitive function in breastfed infants has led some to support the addition of ARA and DHA to infant formula*.
- ***This issue remains controversial; the FDA's does not recommend either a minimum or maximum content of ARA and DHA in infant formula***
- The AAP has taken no official position on their addition. Most infant formula manufacturers currently offer products containing added ARA and DHA.

Nucleotides, Prebiotics, and Probiotics

- Nucleotides are metabolically important compounds that are the building blocks of ribonucleic acid (RNA), deoxyribonucleic acid (DNA), and adenosine triphosphate (ATP), and are present in breast milk.
- *It is thought that they may enhance immune function and development of the gastrointestinal tract and may be beneficial when added to infant formula*

Probiotics and Prebiotics in Pediatrics, From the American Academy of Pediatrics

- This clinical report reviews the currently known health benefits of probiotic and prebiotic products, including those added to commercially available infant formula and other food products for use in children.
- Probiotics are supplements or foods that contain viable microorganisms that cause alterations of the microflora of the host.
- Use of probiotics has been shown to be ***modestly effective*** in randomized clinical trials (RCTs) in
- (1) treating acute viral gastroenteritis in healthy children; and
- (2) preventing antibiotic-associated diarrhea in healthy children.
- There is some evidence that probiotics prevent necrotizing enterocolitis in very low birth weight infants (birth weight between 1000 and 1500 g), but more studies are needed.
- The results of RCTs in which probiotics were used to treat childhood *Helicobacter pylori gastritis, irritable bowel syndrome, chronic ulcerative colitis, and infantile colic, as well as in preventing childhood atopy, although encouraging, are preliminary and require further confirmation.*

Probiotics and Prebiotics in Pediatrics, From the American Academy of Pediatrics

- Probiotics ***have not been proven to be beneficial*** in treating or preventing human cancers or in treating children with Crohn disease.
- *There are also safety concerns with the use of probiotics in infants and children who are* ***immunocompromised, chronically debilitated, or seriously ill with indwelling medical devices***.

Probiotics and Prebiotics in Pediatrics, From the American Academy of Pediatrics

- *Prebiotics are supplements or foods that contain a nondigestible food ingredient that selectively stimulates the favorable growth and/or activity of indigenous probiotic bacteria*.
- Human milk contains substantial quantities of prebiotics.
- There is a *paucity of RCTs examining prebiotics in children*, although there may be some long-term benefit of prebiotics for the prevention of **ATOPIC ECZEMA** and common infections in healthy infants.
- **Confirmatory well-designed clinical research studies are necessary.**

ABSTRACT

BACKGROUND: Dietary nucleotides are nonprotein nitrogenous compounds that are found in high concentrations in breast milk and are thought to be conditionally essential nutrients in infancy. A high nucleotide intake has been suggested to explain some of the benefits of breastfeeding compared with formula feeding and to promote infant growth. However, relatively few large-scale randomized trials have tested this hypothesis in healthy infants.

OBJECTIVE: We tested the hypothesis that nucleotide supplementation of formula benefits early infant growth.

PATIENTS AND METHODS: Occipitofrontal head circumference, weight, and length were assessed in infants who were randomly assigned to groups fed nucleotide-supplemented (31 mg/L; n = 100) or control formula without nucleotide supplementation (n = 100) from birth to the age of 20 weeks, and in infants who were breastfed (reference group; n = 101).

RESULTS: Infants fed with nucleotide-supplemented formula had greater occipitofrontal head circumference at ages 8, 16, and 20 weeks than infants fed control formula (mean difference in z scores at 8 weeks: 0.4 [95% confidence interval: 0.1–0.7]; P = .006) even after adjustment for potential confounding factors (P = .002). Weight at 8 weeks and the increase in both occipitofrontal head circumference and weight from birth to 8 weeks were also greater in infants fed nucleotide-supplemented formula than in those fed control formula.

CONCLUSIONS: Our data support the hypothesis that nucleotide supplementation leads to increased weight gain and head growth in formula-fed infants. Therefore, nucleotides could be conditionally essential for optimal infant growth in some formula-fed populations. Additional research is needed to test the hypothesis that the benefits of nucleotide supplementation for early head growth, a critical period for brain growth, have advantages for long-term cognitive development.

Key Words:
• nucleotides • infant growth • occipitofrontal head circumference

WHAT'S KNOWN ON THIS SUBJECT:

Potential Problems with infant formulas

- **Diarrhea**
- Infants particularly prone to dehydration
- Fluid depletion by vomiting or diarrhea may quickly (within 24 hours) produce severe dehydration with fluid and electrolyte imbalances, shock and possible death
- Potential cause of diarrhea and vomiting is the improper dilution of a concentrated liquid or powdered formula

Diarrhea- Patient Counseling

- Frequency of stool
- Duration of diarrhea
- Preparation method of formula
- If the infant is clinically ill (fever, lethargy, anorexia, irritability, dry mucous membranes, decreased urine output, or weight loss)→ Doctor

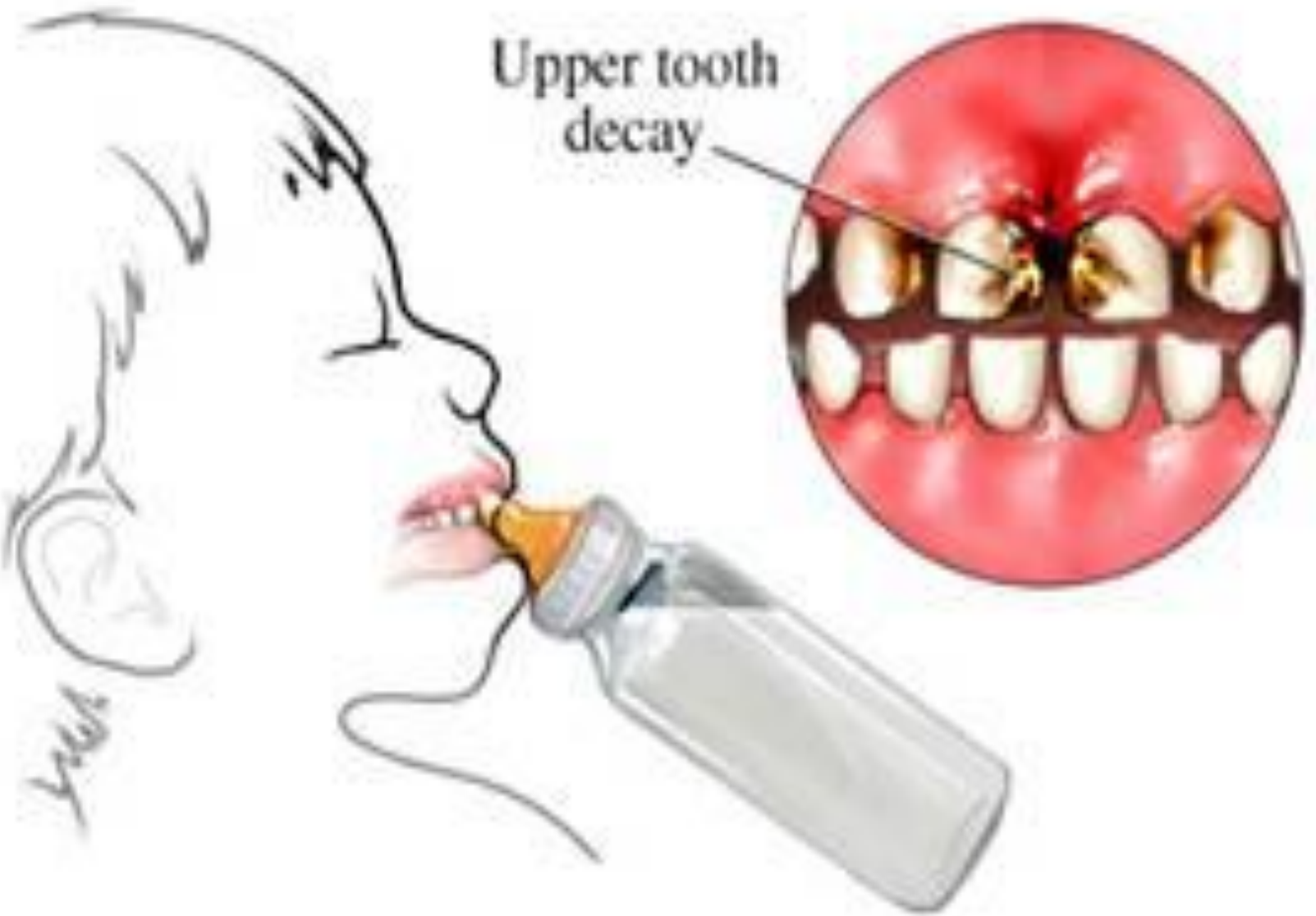
Diarrhea- Patient Counseling

- Mild diarrhea may resolve without medical measures, but the infant should be observed closely for signs of dehydration
- Temporarily discontinuing usual dietary intake- unnecessary except 4-6 hr of ORT
- ORT may be used cautiously for short term
- It should not replace formula or human milk intake
- *Lactose free diet can be considered for severe diarrhea, however, a full strength lactose containing formula can be used in most infants*
- Advice parents to seek medical advice if sudden increase in stool output occurs with resumption of feeding

Tooth decay

1. In children who are bottle-fed beyond the typical weaning period
2. Who sleep with their bottles after 1 year of age
3. Sipping on a bottle frequently during the day

- Caries in children younger than 2 y/o
- May involve: maxillary incisors, molars and canines


Upper tooth
decay

Preventing tooth-decay:

1. Wash their mouth
2. Avoid bottle while asleep
3. Substituting plain water for carbohydrate containing formula
4. Ensuring adequate fluoride intake
5. Weaning 10-12 months of age
6. Going to sleep with bottle should be actively discouraged for all infants

Feeding Infant Formula in the First Year

- The amount of infant formula needed by an infant over a 24-hour period will vary depending on the infant's age, size, level of activity, metabolic rate, medical conditions, and other source(s) of nutrition (breast milk and/or complementary food).
- Infants have the ability to regulate their food intake relative to their nutritional needs. In doing so, they *express signs of hunger and satiety and expect their caregiver to respond to these cues*
- Thus, unless medically indicated otherwise, *infants should be fed on demand, i.e., fed when they indicate their hunger, and not forced to follow a strict feeding schedule, nor to finish a bottle when no longer hungry*. Infants placed on strict feeding schedules in the early months of life stand a greater chance of being either overfed or underfed.

Feeding Frequency and Amount

- Newborn formula-fed infants are generally fed infant formula as often as exclusively breastfed infants are fed for a total of 8 to 12 feedings within 24 hours.
- These young infants need to be fed small amounts of infant formula often throughout the day and night because their stomachs cannot hold a large quantity.
- ***If a newborn infant sleeps longer than 4 hours at a time, the infant should be awakened and offered a bottle.***
- From birth to 6 months of age, infants grow rapidly and will gradually increase the amounts of infant formula they can consume at each feeding, the time between each feeding, and the total amount of infant formula consumed in 24 hours.
- Encourage parents or caregivers to prepare 2 ounces (60 ml) of infant formula every 2 to 3 hours at first. More should be prepared if the infant seems hungry, especially as the infant grows.

Feeding Frequency and Amount

- The partially breastfed infant will consume less infant formula than given in these examples, depending on the frequency of breastfeeding.
- *At 6 months old, infants begin to shift from dependence on breast milk or infant formula as the primary nutrient source to dependence on a mixed diet including complementary foods.*
- Thus, the consumption of breast milk or infant formula tends to decrease as the consumption of complementary foods increases.

Sleepy or Placid Infant

- An exception to using the demand feeding approach is for a young infant who is sleepy or placid.
- Some infants may either fall asleep after feeding on a bottle for a short time, may not be easy to wake for feeding every 2 to 3 hours, or do not show signs of hunger normally
- *To assure that such infants obtain sufficient nourishment, it is advisable for mothers to wait no more than 4 hours (or sooner if the infant's health care provider indicates) between feedings until the infant's first well check up* (between 2 and 4 weeks old).
- At that time, the infant's health care provider should be consulted to determine whether to recommend continuation of that practice based on the infant's weight gain.

Sleepy or Placid Infant

- To wake a sleepy infant, a mother can try these methods:
- ☐ Stroking the infant's cheek with the nipple
- ☐ Holding the infant in an upright position (sitting or standing) while supporting the chin with one hand, several times
- ☐ Rubbing or stroking the infant's hands and feet
- ☐ Unwrapping or loosening blankets
- ☐ Giving the infant a gentle massage
- ☐ Undressing or changing the infant's clothing or diaper or
- ☐ Playing with and talking to the infant

- Feeding throughout the night is not usually necessary for the older infant with a normal growth rate.
- Refer an infant, whose caregiver complains of the infant's sleepiness or lack of hunger signs, to a health care provider for further assessment

Preparing and Storing Bottles:

- Ensure that bottles and accessories are clean and sanitary.
- ☐ Do not allow bottles of breast milk or infant formula to stand at room temperature to prevent spoilage. Refrigerate prepared bottles until ready to use.
- ☐ *For those infants who prefer a warm bottle, hold the bottle under running warm (not hot) water immediately before feeding.*
- ☐ **Shake a bottle of breast milk before feeding because breast milk separates when it is stored.**
- ☐ Never use a microwave oven to heat bottles of breast milk or infant formula. They may explode or the milk may get too hot. Since the liquid heats unevenly, it can be much hotter than it feels. Microwave heating can destroy special substances in breast milk.

Preparing and Storing Bottles

- ☐ Do not put cereal or other foods in a bottle. This practice replaces breast milk or infant formula with food that may not be needed by the infant, teaches the infant to eat complementary foods (solids) incorrectly, and increases the infant's risk for choking.
- ☐ Throw out unused breast milk or infant formula left in a bottle and wash the bottle with soap and hot water immediately. Clean and sterilize bottles and accessories before reusing them.

Sterilizing Water and Bottles

- *Infants 3 months of age and younger are more likely to contract illnesses from micro-organisms in bottles and nipples* that are improperly cleaned, cleaned in contaminated water, or filled with contaminated water
- Therefore, *for infants less than 3 months old, glass or hard plastic bottles and bottle parts (nipples, caps, rings) should first be thoroughly cleaned using soap, hot water, and bottle and nipple brushes, and then either be sterilized in boiling water for 5 minutes, or washed in a properly functioning dishwasher machine*

Sterilizing Water and Bottles

- ***As a precaution, it is generally recommended to boil the water used for infant formula preparation during the first 3 months of life.***
- *Caregivers should consult their health care providers regarding whether the water used for preparing infant formula or for feeding should be boiled for the infant older than 3 months*
- **Caregivers can boil water to make infant formula by bringing the water to a rolling boil, boiling it for 1–2 minutes, and then letting it cool**
- The terminal sterilization of infant formula, which involves filling clean bottles with properly diluted infant formula first and then boiling all the formula-containing bottles in water, is not recommended because boiling destroys certain nutrients (e.g., folate and other water-soluble vitamins).

Sterilizing Water and Bottles

- It is very important to prepare infant formula properly.
- *Increasing the water-to-formula ratio is never recommended because it will yield a lower calorie formula, which will not meet the infant's calorie requirements.*
- Decreasing the water-to formula ratio may be recommended for infants who are failing to thrive, but it should only be done when recommended by the infant's health care provider.
- Infants consuming incorrectly reconstituted infant formula may develop serious health problems.

Sterilizing Water and Bottles

- *Under-diluted infant formula (containing too little water) puts an excessive burden on an infant's kidneys and digestive system and may lead to dehydration.*
- This problem becomes worse if the infant has increased fluid needs due to fever or infection
- *Over-diluted infant formula (containing too much water) may contribute to growth problems, nutrient deficiencies, and water intoxication*

Storing Infant Formula

- Prepared infant formula is a highly perishable food that must be stored properly for safe consumption.
- The following guidelines are recommended to prevent spoilage of infant formula:
- Store bottles of prepared infant formula in a properly functioning refrigerator until ready to use. Bacterial growth is reduced when infant formula is kept in a refrigerator at temperatures at 4 C or below. (Use a special thermometer to test if the refrigerator is at the appropriate temperature.)

Storing Infant Formula

- Caregivers should always consult their health care provider and follow the manufacturer's label instructions for infant formula storage procedures. In general, it is recommended that caregivers:
- ☐ Use refrigerated bottles of concentrated or ready-to-feed infant formula within 48 hours of preparation or
- ☐ Use refrigerated bottles of powdered infant formula within 24 hours of preparation.
- ☐ Opened cans of concentrated or ready-to-feed infant formula should be covered, refrigerated, and used within 48 hours. Freezing infant formula is not recommended

Storing Infant Formula

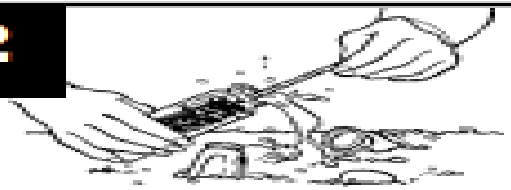
- ☐ Powdered infant formula should be tightly covered and stored in a cool, dry place and used within a month after opening.
- ☐ *Discard any infant formula remaining after a feeding. The mixture of infant formula with saliva provides an ideal breeding ground for disease-causing micro-organisms.*
- ☐ *Infant formula that is removed from refrigeration should be used within 1 hour or discarded.*

Preparation Checklist for Standard Powdered Iron-Fortified Infant Formula (using glass or hard plastic bottles)

1

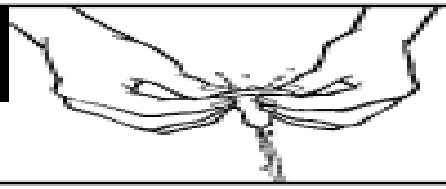
Wash your hands, arms, and under your nails, very well with soap and warm water. Rinse thoroughly. Clean and sanitize your workspace.

2



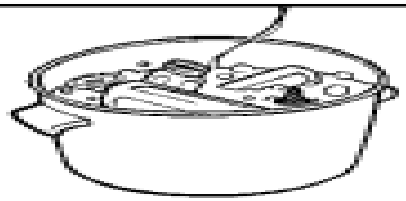
Wash bottles and nipples, using bottle and nipple brushes, and caps, rings, and preparation utensils in hot soapy water before using. Rinse thoroughly.

3



Squeeze clean water through nipple holes to be sure they are open.

4



Put the bottles, nipples, caps, and rings in a pot and cover with water. Put the pot over heat, bring to a boil, and boil for 5 minutes. Remove with sanitized tongs, allow the items to cool, and air dry.

Preparation Checklist for Standard Powdered Iron-Fortified Infant Formula (using glass or hard plastic bottles)

5

For formula, bring water to a very bubbly boil. Keep it boiling for a minute or two, then let it cool. Use this water to mix the formula. Use water from a source approved by the local health department. If tap water is used for boiling, collect only cold tap water allowed to run for 2 minutes first.

6

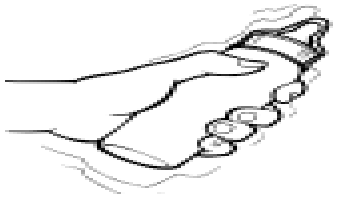
Remove plastic lid; wash lid with soap and clean water and dry it. Write date on outside of plastic lid. Wash the top of the can with soap and water, rinse well, and dry. Wash the can opener with soap and hot water. Open the can and remove scoop. Make sure that the scoop is totally dry before scooping out powdered formula. Only use the scoop that comes with the formula can.

7

For each 2 ounces of cooled boiled water added to a clean bottle, carefully add 1 level scoop of powdered formula. Thus, if 8 ounces of water is poured into the bottle, 4 level scoops of formula should be added.

Preparation Checklist for Standard Powdered Iron-Fortified Infant Formula (using glass or hard plastic bottles)

8

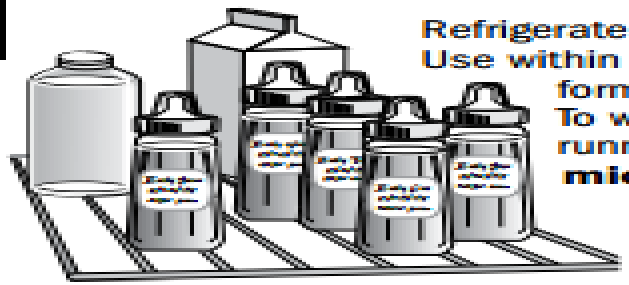


Attach nipple and ring to the bottle and SHAKE WELL. Feed prepared formula immediately.

9

If more than one bottle is prepared, put a clean nipple right side up on each bottle and cover with a nipple cap. Label each bottle with the baby's name and the date and time that it was prepared.

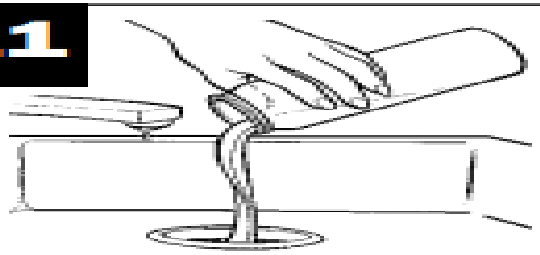
10



Refrigerate until feeding time. Use within 24 hours. Do not leave formula at room temperature. To warm bottle, hold under running warm water. **Do not microwave bottles.**

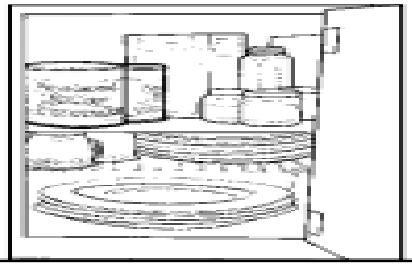
Preparation Checklist for Standard Powdered Iron-Fortified Infant Formula (using glass or hard plastic bottles)

11



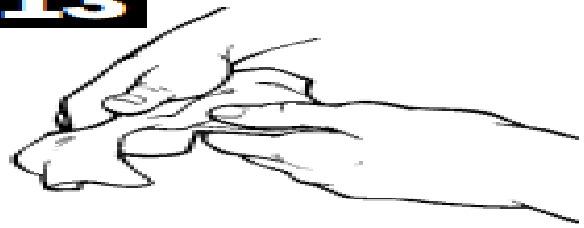
Throw out unused formula left in bottle after feeding or which has been unrefrigerated for 1 hour or more.

12



Make sure that no water or other liquid gets into the can of powder. Cover opened can tightly and store in a cool dry place (not in the refrigerator). Use within 4 weeks after opening to assure freshness.

13



To be used again, the scoop should be washed with soap and hot water, rinsed thoroughly, and allowed to air dry. When making formula again, the scoop should be totally dry before using it to scoop powder out of the can. Store unopened cans in a cool, dry indoor pantry shelf. Use before the expiration date.

Warming Infant Formula

- The following guidelines are recommended to warm refrigerated infant formula:
- ☐ For infants who prefer a warmed bottle, warm the bottle immediately before serving.
- ☐ A safe method of warming a bottle is to hold it under running warm tap water.
- *Shake the bottle before testing the temperature.*
- Always test the temperature before feeding to make sure that it is not too hot or cold (test by squirting a couple of drops onto the back of your hand).

Warming Infant Formula

- ☐ Warm only as much infant formula as you think will be needed for a feeding.
- ☐ Never use a microwave oven to warm infant formula because this practice is dangerous.
  - *Liquid in a bottle may become very hot when heated in a microwave oven and remain hot afterwards even though the bottle feels cool*.
  - Infants have been seriously burned while being fed liquids warmed in microwave ovens.
  - Covered bottles, especially vacuum-sealed and metal-capped bottles of ready-to-feed infant formula, ***can explode when heated in a microwave oven.***