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NUTRITION

By

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Nutritional intakes of infants, children, and adolescents should provide for maintenance of current weight and support the normal growth and development. The infancy growth period is rapid, critical for Neuro-cognitive development, and has the highest energy and nutrient requirements relative to body size compared with other periods of growth (reaching up to four times that of an adult).

The early baby nutrition depends on a single food, either breast milk, formula feeding, or mixed.

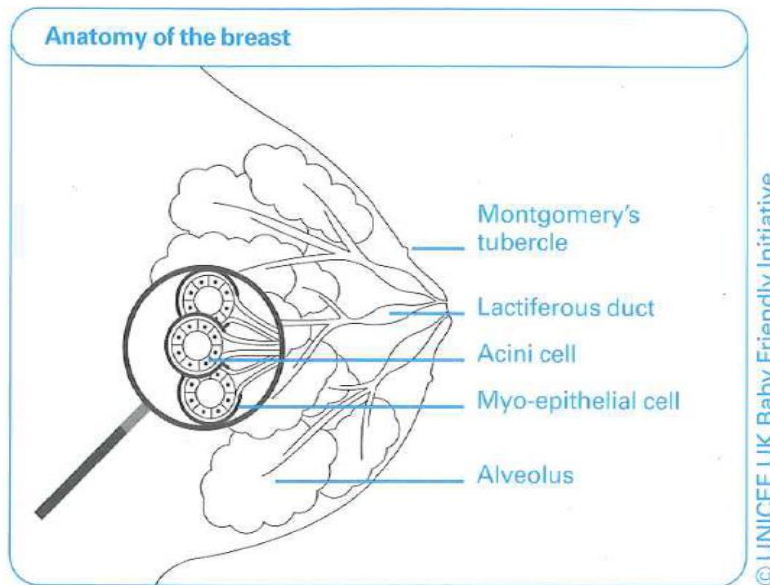
BREAST-FEEDING

Breastfeeding has documented short- and long-term medical and neuro-developmental advantages and rare contraindications. Thus the decision to breastfeed should be considered a public health issue and not only a lifestyle choice.

The AAP (American Academy of Pediatrics) and the WHO recommend that infants should be exclusively breastfed or given breast milk for 6 months. Breastfeeding should be continued with the introduction of complementary foods for 1 year or longer, as desired by mother and infant.

Anatomy of the breast

It is the largest exocrine gland, specialized for secretion of milk. Each breast consists of 16-18 lobules embedded in fat & connective tissue in the chest wall, each lobule is consisted of thousands of secreting units called alveoli, the alveoli are surrounded by profuse blood supply & myoepithelial cells & lined by specific secreting cells (acini cells) that secrete the milk to the alveolar lumen. Contractions of the myoepithelial cells push the milk to the lactule, ductile, ducts, & finally to the lactiferous ducts & sinuses that opens in the nipple each lobule with an isolated opening.



Mechanism of milk production

Lactogenesis starts in the 5th mo of gestation under the effect of prolactin hormone, but full lactation during pregnancy is prevented by the elevated maternal progesterone level (which decreases after labor) that antagonizes the prolactin action.

Breast milk secretion in the alveoli is directed after birth by neurohormonal mechanism, started by the infant sucking of the breast, which results in afferent impulses to the mother's hypothalamus and then to both the anterior and the posterior pituitary, stimulation of the anterior pituitary gland will lead to secretion of prolactin (thus called milk production reflex), while stimulation of the posterior pituitary gland leads to secretion of the oxytocin, which contract the myoepithelial cells to push the famed milk out of the alveolar lumen, making it available to the baby (this called milk ejection or let down reflex), when this reflex is functioning well, it can lead to spontaneous milk flow from the opposite breast.

Factors affecting breast milk production

- Certain drugs, e.g., chlorpromazine & metaclopramide stimulate the prolactin secretion, while bromocriptin suppress its secretion & reduce milk production.
- Maternal status, e.g. tension, pain, fatigue & emotional distress, leads to failure of let down reflex & decrease of breast milk production.

Breast Milk Composition

It is isotonic with plasma & composed of protein, fat & lactose. During the 1st postpartum days, lactation started with colostrum, it is higher than the mature breast

milk in sodium, protein, & cells & is lower in fat, lactose, & potassium. Then, during the 1st 2-3 wk of lactation, the protein continues to decrease, while the fat & lactose increase, so passing the transitional period to reach the mature milk.

Milk from the mother whose diet is sufficient and properly balanced will supply all the necessary nutrients, but the following to be recommended:

- If the water supply is not adequately **fluoridated** (≤ 0.3 ppm), the breast-fed infant should receive it.
- Begin daily oral vitamin D drops (400 IU) at hospital discharge post delivery.
- The **iron** content of human milk is somewhat low, but more biological than cow milk iron, so well absorbed. Most normal infants have sufficient iron stores for the first 6 mo of life; by 4-6 mo of age or when the body weight double, the breast-fed infant should be supplemented with iron-fortified complementary foods or a ferrous iron preparation.
- The **vitamin K** content of human milk also is low and may contribute to hemorrhagic disease of the newborn. Parenteral administration of 1 mg of vitamin K at birth is recommended for all infants, and this is especially important for those who will be breastfed.

Establishing & Maintaining the Milk Supply

The most satisfactory stimulus to the secretion of human milk is early (during the 1st few days after birth), regular, and complete emptying of the breasts. Infants should room in with the mother and should not be offered other milks or water supplements. Infants who can't be fed on demand should be brought to the mother for feeding approximately every 3 hours during the day and night.

The infant should empty at least 1 breast at each feeding; otherwise, the breast will not be stimulated sufficiently to refill.

- Treat maternal problems as soon as possible, these may include;
- Appropriate care for **sore nipples** should be instituted before severe pain from abrasions and cracking develops. Because if nipple is painful, the milk-ejection reflex may be delayed and this will makes the infant vigorously feeding, which further injures the nipple and areola area.

Treatment: Exposing the nipples to air; applying pure lanolin; avoiding soap & alcohol; changing disposable nursing pads frequently; feeding more frequently; manually expressing milk; & nursing in different positions are recommended. If

- Retracted and/or inverted nipples are not contraindications to breastfeeding, it usually benefits from daily manual breast-pump suction during the later weeks of pregnancy.

- To reduce engorgement, the breasts should be softened prior to infant feeding with a combination of hot compresses and expression of milk. Between feedings a supportive bra should be worn, cold compresses applied, and oral non-steroidal anti-inflammatory medications administered.

- Mastitis occurs (unilateral, localized warmth, tenderness, edema, and erythema with breast pain, myalgia, fever, fatigue, nausea, vomiting, and headache). Organisms include mainly *Staphylococcus aureus*. Oral antibiotics and analgesics with the promotion of breastfeeding or emptying of the affected breast.

The 1st 2 weeks after birth are important for establishing breastfeeding.

Technique of Breast Feeding

At feeding time, the infant should be hungry, dry, and neither too cold nor too warm. It should be held in a comfortable, semi-sitting position to prevent vomiting with eructation. The mother, too, should be comfortable.

The infant should be supported comfortably with the face held close to the mother's breast by 1 arm and hand while the other hand supports the breast, making the nipple easily accessible to the infant's mouth without obstructing nasal breathing.

The nipple is approached to the baby's mouth using the **rooting reflex** on smelling of the milk or by stroking the cheeks, while the **sucking reflex** will evacuate the breast by its compression against the hard palate, & **swallowing reflex** will swallow the taken milk.

Some infants will empty a breast in 5 min; others will nurse for 20 min or longer.

At the end of the nursing period, the infant should be held erect over the mother's shoulder or on her lap, with or without gentle rubbing on the back to assist in expelling swallowed air.

Determining the Adequacy of Breast Feeding

The milk supply is sufficient if the infant is:

- 1- Satisfied after each nursing.
- 2- Sleeps 2–4 hour between feedings especially in early infancy, unless awakened & crying due to other cause.
- 3- Gains weight adequately (start gaining weight by the end of the 2nd week).
- 4- Urinate a adequately.

Advantages of Breastfeeding vs Formula-Feeding.

- 1- Human milk is uniquely adapted to the infant's needs.
- 2- Breast milk is always available at the proper temperature & requires no preparation time, in addition to its economic benefits.
- 3- Breastfeeding is associated with fewer feeding difficulties incident to allergy and/or intolerance to bovine milk.
- 4- Decreasing incidence of infections, this due to many causes:
 - a- It is fresh and free of contaminating bacteria.
 - b- Human milk contains bacterial and viral antibodies, including relatively high concentrations of secretory IgA that prevents microorganisms from adhering to the intestinal mucosa.
 - c- Macrophages, lactoferrin, low pH, bile salt- stimulated lipase in human milk.
- 5- It reduces the liability of sudden infant death syndrome & later diabetes mellitus.
- 7- Psychological advantages of breastfeeding for both mother and infant.

For mothers, it enhances the involution of the uterus through the release of oxytocin, method of contraception, & decrease the incidence of breast cancer.

Disadvantages of Breast Milk

- 1- It is not possible to see how much the baby takes.
- 2- It needs a discrete place to expose the breast for feeding.
- 3- Women wishing to return to work will find it is difficult to fit with it.
- 4- Some times, breastfeeding may be impossible due to the medical illness of the mother.

Contraindications of breast feeding

- 1- Some inborn errors of metabolism of the baby:** due to breast milk constitutes, e.g. galactosemia.
- 2- Maternal Infections:** HIV, active TB (until 2 wk of treatment), CMV (in preterm infants), & herpes simplex (when active lesions are present on breast).
- 3- Chemotherapy and radiopharmaceuticals.**

FORMULA-FEEDING

Indications of Bottle Feeding

In healthy infants, bottle feeding can be used by one of the following 3 methods:

a- Complementary feeding:

Where breast feeds are completed by bottle feeds. It is indicated when breast milk is *insufficient* for normal growth (scanty breast milk secretion). In this case, the breast milk should be given first, then the feed is completed by the bottle.

b- Supplementary feeding:

Where some breast feeds are replaced by bottle feeds. It is indicated in two conditions; *working mother* (where the mother is absent part of the day) & *twin delivery* (where the breast milk is not enough to feed both babies).

c- Substitutive feeding:

Where breastfeeding is completely replaced by bottle feeding. It is indicated in three conditions; *absent* breast milk secretion, *chronically sick mother* & mothers who are *unwilling* to breast feed their babies. In the last condition, the reason should be explored & the advantages of breast feeding should be explained. When she insists, encourage her on artificial feeding & do not let her to feel guilty.

Technique of Formula Feeding

The setting for formula-feeding should be similar to that for breastfeeding; the baby should be held as though being breast-fed. The nipple holes should be of a size that allows the milk to drip slowly, and the bottle should be held so that milk, not air, channels through the nipple. The bottle of formula is usually warmed to body temperature. This may be tested by dropping milk onto the wrist. Eructation of air swallowed during feeding is important for avoiding regurgitation and abdominal discomfort, especially during the 1st 6–7 mo of life. All infants occasionally regurgitate or “spit up” a small amount of milk after feeding, a fact that the mother should know. Spitting up seems to occur more often in the formula-fed than in the breast-fed infant.

A feeding may last from 5–25 min, depending on the age and the vigor of the infant. Because the infant's appetite varies from 1 feeding to another, each bottle should contain more than the average amount taken per feeding, but in no case

should the infant be urged to take more than desired. The excess formula should be discarded.

The number of feedings required daily decreases throughout the 1st year of life from 8 or more shortly after birth to only 3 or 4 at 1 yr of age.

Preparation of Milk

The dried milk should be properly reconstituted to provide the proper concentration. Small scoop of milk (4 gm) needs 1 oz (30 ml) of water, giving 20 kcal, a large scoop of milk (8 gm) needs 2 oz (60 ml) water giving 40 kcal.

Sterilization of Bottle

The bottle should be boiled with water for 10-15 minutes and the teat for 5 minutes only, after that it can be used or kept in a refrigerator to be used later on.

Complementary foods & weaning

Complementary foods should be introduced in a stepwise fashion to both breastfed and formula-fed infants, beginning about the time the infant is able to sit, usually at 6 mo of age. Avoid starting with foods with high allergenic potential (cow's milk, eggs, fish, nuts, soybeans), Cereals, a good source of iron, is usually introduced 1st, followed by vegetables and fruits, then meats, and finally, eggs. Only 1 new food should be introduced every 3–4 days to allow detection of any adverse reaction to each newly introduced food.

Weaning can be initiated when mutually desired by the mother and infant by substituting formula or bovine milk by bottle or cup for part and, then, for all of a breastfeeding. These changes should be made gradually and should be a pleasant experience, not a conflict, for both the mother and the infant.

Dietetic Errors

Several dietetic errors may occur in breast fed infant & if uncorrected early they will lead to nutritional disorders as the following:

- Scanty breast milk with no supplementation: Undernutrition.
- Scanty breast milk with wrong supplementation (more CHO): kwashiorkor.
- prolonged breastfeeding without vitamin D: Rickets.
- prolongedbreast feeding without additional foods or iron: IDA

Comparison among constitutes of Breast Milk, Cow Milk, & Formula milk

Water: relatively the same.

Calories: may vary slightly, but in average is 20 kcal/oz.

Protein: in breast milk is about 1.3 % (1.3 gm/dl), in cow milk is 3.3 %, in formula milk is about 1.45-1.6 g/dl. Its type in breast milk casein: whey protein is 25:75, while casein is usually more in both cow & formula milk.

CHO: Breast milk contains 6.7 % lactose, cow milk 4.5 %, formula milk is about 7.5 %.

Fat: is about 3.5 % in all.

Iron: it is lower in breast milk than the other, but it has more biological value by better absorption.

Calcium: is more in both cow & formula milk than breast milk, but the incidence of hypocalcaemia is more with the formers due to high phosphorus.

Sodium, chloride, & potassium: they are more in cow & formula milk.

MALNUTRITION

It is one of the leading causes of morbidity & mortality in childhood. The greatest risk of undernutrition occurs from conception to 24 mo of age, and this early damage to growth and development can have adverse consequences in later life on health, intellectual ability, school achievement, work productivity, and earnings; therefore they advised to focus interventions on this critical window of opportunity.

It may be *primary* (due to inadequate dietary intake, more in developing countries) or *secondary* (due to inadequate absorption, increased metabolism, or an abnormal loss, more in developed countries).

Milder degrees over a prolonged period result in *failure to thrive* with *growth retardation*, whereas severe deficiencies cause protein-energy malnutrition.

Types of malnutrition, according to the deficient nutrient,

- Macronutrient malnutrition: Def. of CHO, protein, or fat, also called Protein Energy Malnutrition (PEM).
- Micronutrient malnutrition: Def. of vitamins or minerals.

Assessment of Nutritional State

Clinical assessment of nutritional status should be an essential step in examination of every infant or child. Severe disturbances are readily apparent, but mild one may be overlooked, it needs careful evaluation.

- Careful dietary history: With good *nutritional history*, an alert physician can detect nutritional disorders very early at the stage of dietetic errors.

- Physical examination: for Anthropometric measures, include:

- . Wt/ Ht (wasting): indicate acute malnutrition.
- . Ht/ age (length/ age for children <2 yr) (stunting): indicate chronic malnutrition.
- . Wt/age (underweight): indicate combined acute & chronic malnutrition.
- . OFC: affected only in severe cases especially during the 1st 2 years of life.
- . Skin fold thickness: for subcutaneous fat.
- . Mid arm circumference : for muscle mass.
- . BMI (body mass index): for overweight & obesity.
- Regional examination: full body examination from above downward for signs of macro- & micro-nutrient malnutrition.
- Biochemical tests: albumin, hemoglobin, electrolyte, vitamins, & amino acids.
- Radiological examination: for signs of vitamin C & D deficiencies.

Classifications of Malnutrition

WHO classification

It uses standard deviation (SD, Z score) of displacement from the median.

- Every 5 % decrease from the standard Ht /age = 1 z score (1 SD).
- Every 15 % decrease from the standard Wt /age =1 z score (1SD).
- Every 10 % decrease from the standard Wt /Ht =1 z score (1SD).

So, - If the reading was more than 2 SD below median
 moderate malnutrition.

- If it was 3 SD below median..... severe malnutrition.

- If the child has malnutrition with edema...severe malnutrition.

Wellcome classification

Concentrate on Weight for age & presence of edema, here malnutrition divided into:

- 1- underweight: weight is 60-80% of median wt/age with no edema.
- 2- Kwashiorkor: weight is 60-80 % of median wt/age with edema.
- 3- Marasmus: weight is less than 60 % of the median wt/age with no edema.
- 4- Marasmic- kwashiorkor: weight is less than 60% of the median wt/age with edema.

Note: the median for certain age and sex is the reading at the 50th percentile on the growth chart, roughly we can calculate approximated median from the following equations:

- Median body weight:

$$\text{(from 2 mo - 12 mo)} = (\text{age in month} + 9) / 2$$

$$\text{(above 1 yr)} = \text{age in year} \times 2 + 8$$

- Medians height= age in year \times 6 +77

PROTEIN-ENERGY MALNUTRITION (PEM)

It includes both Marasmus & kwashiorkor & a third disorder, marasmic kwashiorkor, which has features of both disorders.

NON- EDEMATOUS PEM (MARASMUS)

Most common forms of PEM

Mainly due to caloric depletion.

More common in young infant.

Less common in breastfeeding infants.

It occurs due to insufficient diet, also severe impairment of any body system may lead to marasmus.



Clinical manifestations

-It is characterized by failure to gain weight followed by weight loss until emaciation results, making the weight below 60 % with no edema

- At first, the infant may be fretful with increased appetite, but later the appetite diminishes

- The subcutaneous fat disappears making the skin loses its turgor and becomes wrinkled and loose especially over the thigh, buttock, & shoulders, loss of fat from the sucking pads of the cheeks often occurs late in the course of the disease; thus, the infant's face may retain a relatively normal appearance compared with the rest of the body, but this, too, eventually becomes affected.

- Infants are often constipated, but may have starvation diarrhea, with frequent, small, greenish mucoid stools.

- The abdomen is flat, but may be distended, with the intestinal pattern readily visible.

- There are muscle atrophy and resultant hypotonia.

- The basal metabolic rate tends to be reduced, as the condition progresses, the temperature usually becomes subnormal and the pulse slows.

- Marasmus is divided into 3 clinical grades:

Grade 1 : loss of subcutaneous fat over the abdominal wall.

Grade 2 : loss of subcutaneous fat over the buttocks & thighs.

Grade 3 : loss of subcutaneous fat over the face (senile face).

EDEMATOUS PEM (KWASHIORKOR)

Mainly due to protein deficiency, less common than Marasmus. It may become evident from early infancy to about 5yr old, usually after weaning from breastfeeding, so called kwashiorkor (means deposed child).

It occurs due to insufficient intake of protein of good biological value, this may be accompanied by abnormal absorption, synthesis, or loss of protein.

Clinical manifestations

- Initially, it may present as vague manifestations include lethargy, apathy, or irritability with loss of appetite. When advanced, there is a failure to gain weight, then weight loss, edema (usually develops early and may mask the failure to gain weight, it is often present in internal organs before it is recognized in the face and limbs), muscle wasting, hypotonia, flabby subcutaneous tissues.

- Abdominal distention & Liver enlargement may occur early or late in the course of disease due to fatty infiltration.

- Dermatitis is common, it usually occurs in irritated areas, not in areas exposed to sunlight (in contrast to pellagra). Dyspigmentation (darkening) may occur after desquamation in these areas, or it may be generalized.

- The hair is sparse and thin, easily extractable, and in dark-haired children, it may become red or gray, in chronic cases become coarse in texture. A flag sign may be present.

- Starvation diarrhea.

Complications of kwashiorkor

- Increased susceptibility to infections: measles (may be fatal), T. B., parasitic infections, HIV.

- In severe cases, mental & physical retardation.

- Eventually, if untreated, stupor, coma, and death.



TREATMENT OF MALNUTRITION

1st phase: Stabilization phase: (1st 24 - 48 hours to 7 days)

The child with malnutrition is liable for life threatening sequelae that must be considered immediately, those include:

1- *Hypoglycemia* (<3 mmol/L): prevent hypoglycemia by feeding every 3 hours day & night.

* If it is developed & the patient is conscious, treat him by giving 50 ml of 10 % GW orally or 1 teaspoon sugar under the tongue, then start feeding.

** If the child is unconscious, give 5 ml /kg of 10 % GW intravenously & start feeding orally or by nasogastric tube.

2- *Hypothermia* (axillary temp. less than 35 °C): treated by warming the child by skin by skin contact with carer “kangaroo technique”, or use hot water bottle or warm incubator.

3- *Infection*: it is often silent, give broad spectrum antibiotic even without signs of infection

4- *Anemia*: if severe or associated with respiratory distress, give a blood transfusion slowly with furosemide.

5- *Dehydration & electrolyte disturbances*: Because of the difficulty of estimating hydration, oral rehydration solution is better than IV fluid. Malnourished child has low body potassium & high sodium; therefore give ReSoMal solution instead of ORS (half Na & double K content), if ReSoMal

solution is not available, give WHO ORS diluted in 1.5 liter. Give IV fluid if the child is in shock.

** in this phase feeding started with frequent small amounts of F75 (especial formulated low-lactose milk with 75 kcal and 0.9 g protein per100 mL to which potassium, magnesium, and micronutrients are added) orally or by nasogastric tube.

2nd phase: Nutritional rehabilitation: (2nd week- 6th week)

- Replace F75 with an equal volume of F100 (100 kcal and 3 g protein per 100 ml) for 2 days and then increase each successive feed by 10 ml until reaching 150-220 kcal/kg/day. If breastfed, encourage continued breastfeeding.

- In general, feedings are initiated with higher frequency and smaller volumes; over time, the frequency is reduced and the amount is increased.

- Monitoring is needed for electrolyte imbalances, poor cardiac function, edema, or feeding intolerance, if any of these developed , further increase is stopped until stabilization.

- If diarrhea starts or fails to resolve and lactose intolerance is suspected, a non-lactose-containing formula should be substituted. If milk protein intolerance is suspected, a soy protein hydrolysate formula can be used.

- Children with severe malnutrition have developmental delays, so social care during and after treatment are essential to aid recovery of brain function.

- Early iron therapy usually is not started until this phase of treatment to prevent binding of iron to transferrin and this decreasing protein's host defense mechanisms, also free iron may exacerbate the oxidant damage, precipitating for kwashiorkor in malnourished child.

Follow up : to prevent recurrence.