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THE IMPORTANCE OF BREAST-FEEDING

by

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I INTRODUCTION

The mammary gland, the milk-secreting organ together with hair furnish the prime distinguishing characteristics of mammals. The mammalian lactatory apparatus is both efficient and species specific. The average number of breasts found in the female animal and milk composition¹⁶⁷ are closely correlated with the usual size of the litter, its rate of growth and level of maturity.

In the mammalian world, the offspring is born with its own ready made food. Anticipatory preparation for this purpose is mostly achieved during the prenatal period. In the early months of life, the milk of each species seems to be a complete food for its young. Breast-feeding, the natural way of feeding, satisfies an instinctive urge, and has assured continuity of life and healthy progeny. Motherly interest and care are almost synonymous with the course of lactation. Maternal responsibility for fetal nutrition, previously undertaken via the umbilical cord continues through breast-feeding. Weaning from the breast with the attainment of mature feeding mechanisms and behaviour, also means weaning from maternal care. The dependence of the mammalian offspring on the mother for food and care in the early phase of life is particularly remarkable when it is recalled that no analogous process occurs in non-mammalian creatures.¹⁰⁸

Originally, breast-feeding was universally accepted by all human societies and cultures as the only suitable pattern for infant feeding. In nomadic and agrarian societies breast-feeding, actually, had no competitor, human milk has been regarded as sacred or "God made", and the ideal food for the infant. Lactation and its adequacy asserted the fitness of the female to perform her biologic role. Breast-feeding was identified with motherly care, lactation management was fully integrated with mothercraft and infant rearing; rules and mores guiding breast-feeding practices on individual and community basis were reflected in religious teaching, social values and folklore. In the early months of life, supplementation or substitution of mother's milk by human milk from wet nurses, or by milk

from a variety of animal sources (e g. cow, goat, ass, sheep, buffalo, Llama, reindeer, mare and camel) were restricted to actual need, dictated by the death, or severe illness of the mother, or by her total inability to produce milk and to breast-feed, but under normal conditions, neither cows' milk, nor the milk of any other animal species had displayed a competitive role.

In industrialized cultures, however, the natural food of the human infant and the natural way of feeding are being phased out by artificial baby foods and artificial ways of feeding, advanced by skilled manufacturers, and applied on an extensive scale by health personnel. In modern infant feeding, the actual struggle for supremacy lies between the woman and the cow as a source of milk, and between the human mammary gland and the bottle as the appropriate means for feeding. In the past, the use of bovine milk had to be justified for acceptance, but now justifications have to be made in support of human milk. In fact, what was once an exceptional feeding practice has almost become an accepted rule. Only recently, Hold and Snyderman⁹³ asserted that in the American culture the "psychologic hurdle", which once supported breast milk feeding to premature infants, was passed. Thus, "Oliver Wendell Holmes famous dictum - 'that these two orbs - the breasts were more skillful at compounding a feeding mixture than the hemispheres of the most learned professor's brain' was no longer universally accepted".⁹³

The radical change from natural to artificial food and ways of feeding in the early months of life, indeed, marks a new phase in the evolutionary development of the human species, which necessitates drastic adjustments. Prolonged disuse of an organ is known to end in its partial atrophy. Would the human mammary gland follow a course similar to that of the appendix? Would the mammary gland be conserved because of its natural function, or would it only serve as an accessory organ and a potential focus for neoplastic growth, known to threaten the life of the human female?

Breast-feeding, accessory as it might appear to industrialized societies, still remains a necessity for the developing countries, especially that in the face of a rapidly expanding population, these countries are not able to make the necessary adjustments for mass production and mass application of artificial baby foods. If the developing countries are to benefit from the available scientific knowledge in the area of infant feeding, the application of such knowledge needs to be adapted to the local economy and culture. Instead of disrupting a natural pattern that has stood the test of time, the acquired knowledge should help to minimize existing problems of lactation management and dietary supplementation associated with early weaning. The overwhelming problem of protein-calorie malnutrition at the root of much disease and death in early infancy, can best be prevented by improving, rather than disrupting current breast-feeding practices.

The purpose of this paper is to present some aspects of the lactating process and its management, the incidence of lactation failure and related factors, advantages and disadvantages of breast-feeding; mixed feeding and supplementation, weaning problems and their amelioration.

II THE LACTATION PROCESS: ANATOMY AND PHYSIOLOGY

The success of the lactation process is primarily dependent on the intact physical state of the mammary gland, and the physiologic mechanisms which control its development and functional capacity. Thus, the establishment and maintenance of lactation are determined by the following three factors.^{44, 124.}

1. The anatomical structure of the mammary gland, and development of alveoli, ducts and nipples.
2. Initiation and maintenance of milk secretion.
3. Ejection or propulsion of milk from the alveoli to the nipple.

A knowledge of the above factors is essential for proper lactation management and the prevention of lactation failure.

Anatomy of Lactation

The mammary gland consists of the nipple surrounded by the Areola, interstitial tissue and fat, alveolar or glandular tissue, ducts, and sinus lactiferi. The nipple is not firmly seated, but is protractile and can be easily drawn into the infant's mouth so that his gums bite on the periphery of the areola where the lactiferous sinuses are. The skin over the central part of the breast is elastic to permit milk storage between feeds. The actively secreting breast is made up of about twenty segments converging upon the nipple. The secreting glandular tissue is more peripheral. The secretory epithelium of the active gland resembles thyroid tissue, myoepithelial cells in the alveolar walls have smooth muscle fibers, and by their active contraction the milk is conveyed to the nipple. The ducts leading from the alveolar tissue converge and unite forming larger ducts which join to form the single duct leading from the segment to open on the surface of the nipple. As the single duct passes deep to the areola it widens to form the sinus lactiferous which can be distended to a diameter of about 0.5-1.0 cm^{42,44}

At puberty visible development of the female breast occurs under the stimulus of ovarian estrogens. At this stage, development is chiefly of the nipple, interstitial tissue and fat, with little development of the duct system. However, the alveolar tissue does not develop until pregnancy occurs, and is chiefly responsible for the enlargement of the breast which becomes most visible by the end of the third trimester.

During pregnancy, estrogens and progesterone, mainly derived from the placenta induce additional changes. They probably act on the pituitary to cause it to produce hormones (mammogens) stimulating the growth of the breast.

In the resting phases, the duct epithelium consists of only one layer. During the early months of pregnancy there is increase of the existent duct system and formation of new ductules by budding. From the third month,

the newly formed ductules begin to throw off the superficial of their two lining cell layers, and the deeper layer remains as a unicellular secretory epithelium. By the end of pregnancy the gland is fully developed, but apart from a small amount of secretion which may exude from the nipple or be intentionally expressed, milk is not secreted until after delivery of the infant.

Although partial agalactia may occur due to anatomical factors, total agalactia resulting from anyone, or all such factors, is very rare. Anatomical factors, more likely to limit the lactation ability of the mother are: absent or inverted nipples, nipple fissures; breast engorgement; and deficiencies in the alveolar tissue.

In domestic animals good powers of lactation are known to be hereditary, being transmitted by the male.⁴² Wide variation in the structural composition of the human breasts has been observed in the puerperium. Some breasts contain little secretory tissue; some large breasts contain less glandular tissue than much smaller organs. Engel⁴² reported that in a series of 26 lactating breasts, only 16 showed what appeared to be adequate amounts of alveolar tissue.

Physiology of Lactation

The secretion of milk is to a minor degree affected by the composition of the blood as that is influenced by the diet of the mother. It is not under direct nervous control but under hormone control, which is affected by nervous and emotional factors.⁴⁴

Lactation: Initiation and Maintenance

Full lactation does not start as soon as the baby is born. During the first two or three days of the puerperium, a small amount of colostrum is secreted. About the fourth day there is a rapid increase in the amount of milk secreted, and in favourable cases, by the end of the first week lactation becomes established. In primiparae, however, the establishment of lactation may be delayed until the third week or, even, later. Thus, the first two or three weeks are a period of initiation and this is followed by

the longer period of maintenance of lactation. These two phases are not caused by the same stimuli.

Lactation can be initiated by suckling, probably due to a reflex secretion of a lactogenic hormone, prolactin, secreted by the anterior pituitary.²⁹ Skin stimulation of the nipple is an important contributory factor in initiating lactation and in determining maternal behaviour. Putting an infant to the breast has induced lactation in women many years after their last pregnancy, and even in men.⁴⁴ The reflex may also be inhibited by a variety of emotional and psychologic factors.^{30,31}

Maintenance of milk secretion is said to be produced by another galactopoietic factor of the anterior pituitary, which is also released by nervous stimuli arising in the nipple skin at sucking. If sucking is discontinued during the lactation period, milk secretion usually stops in the next few days and the alveoli shed their cells and atrophy.^{32, 44}

Estrogens also affect the secretion of milk, probably acting through the pituitary. However, the type of effect on the anterior pituitary varies with the level of estrogens in the blood. When the blood estrogens level is low, as in the virgin, there is no prolactin secretion. If the blood level is suitable, as occurs after parturition, the pituitary can discharge prolactin, but if raised to a higher level, as occurs in pregnancy, then the output of prolactin is inhibited. Thus, estrogens are used to arrest lactation where it is undesirable, as after a stillbirth, or in case of severe engorgement of the breast. The inhibitory effect of estrogens on milk production is less in the period of established lactation than in the early weeks of the period of initiation.⁴⁴

Other hormones may play a part in milk production. In some animals lactation does not occur if the adrenal cortex is removed, and the administration of thyroid extract or iodised protein, though harmful, increase milk production of cows.

Milk Production. Secretion and Propulsion or Ejection

The production of milk consists of two separate stages: the stage of secretion of milk into the alveolar lumen and the ducts, and the stage of propulsion or ejection whereby the milk passes along the duct system to the nipple

The ejection phase of milk production is partly under nervous control.³¹ It cannot be produced by sucking alone. The "milk-ejection reflex" or "let-down reflex"^{149, 150} is a neurohormonal mechanism, regulated in part by central nervous system factors. The primary stimulus is suckling applied to the nipple, which triggers the discharge of oxytocin from the posterior pituitary gland that is carried out to the myoepithelial cells around the alveoli, causing them to contract, and thus pushing out the milk where it is easily available to the baby.¹⁵⁴

The milk-ejection reflex appears to be sensitive to small differences in oxytocin level; minor emotional and psychologic disturbances may influence the degree to which breast milk is available to the baby. Weiderman²¹⁴ and co-workers found that the intravenous threshold dose of oxytocin needed for response was 0.25 to 1.0 mu.

It has long been known that if frightened or roughly handled, cows will not let-down to yield milk. The psychologic importance of the "milk-ejection reflex" in human beings was first demonstrated by Waller^{211, 213, 155} who used case histories to illustrate the fact that milk-ejection can be inhibited by embarrassment and can be conditioned, so that it is set off by the mere thought of the baby while far away from the mother. At a later date, this observation was confirmed by experimental inhibition of the reflex in nursing mothers performed by Newton and Newton.^{149, 155} Clinical signs demonstrating the relation of the "milk-ejection reflex" to the success of breast-feeding and lactating ability, may be easily recognized by the mother. The signs include:- 1) milk dripping from the breasts before the baby starts nursing; 2) milk dripping from the breast opposite to the one being nursed; 3) uterine cramps during nursing due to the action of oxytocin on the uterus.¹⁵⁵

The "draught reflex"^{4,104,211} also plays a part in the propulsion of milk. Shortly after the baby starts to feed, many mothers feel a prickly sensation in the breast which is called "the draught". Milk is not always ejected from the more distal parts of the duct system to the lactiferous sinuses beneath the areola, from which the infant can easily get the milk by sucking.¹⁰⁴ If the child is not fed after "the draught" has been stimulated, there may be difficulty in getting a full amount of milk, since the draught reflex may not be obtained again for some time.

Sucking stimulation is often stated to be the best galactagogue. It is believed to be of more importance for the success of breast-feeding than, even, the milk ejection reflex. There is considerable evidence in human beings that the restriction of sucking actually inhibits lactation. Artificial sucking stimulation in the form of emptying the breast or machine has been repeatedly recommended as a method of increasing milk yield. Egli,⁴¹ by reducing feedings from six to five daily caused the "not enough milk" syndrome in about a third of the studied primiparae as well as in a few multiparae. Salber observed¹⁸⁴ 1 057 neonates during their hospital stay. After initial weight loss, babies on true self-demand feeding showed the most rapid weight gain, and were nearest their birth weight at one week as compared to the three or four-hour scheduled infants. Illingworth and Stone¹⁰¹ also reported that self-demand neonates ate more frequently, gained significantly more weight by the ninth day, caused only half as much nipple soreness in the mothers and were significantly more likely to be breast-feeding at one month than those who followed a rigid schedule.

The End of Lactation

The duration of lactation varies according to local patterns of breast-feeding. If sucking is continued lactation does too. However, there is usually a gradual fall in the amount of milk after twelve months, but the chief cause of cessation of supply of milk is reduction of demand and cessation of recurrent stimulation of the nipple by the infant. Ford⁵¹ in his survey of 64 pre-literate cultures, found records of weaning age in 46. None of these cultures normally weaned any baby before six months.

In 31 cultures the earliest recorded age of weaning any infant from the breast was two or three years.

Weaning should be gradual, as sudden cessation of sucking will lead to overfilling of the breast and painful engorgement, and possibly to permanent reduction in the capacity of the breast at a subsequent lactation.⁴⁴

III HUMAN MILK COMPOSITION AND VARIATIONS

Milk consists of a solution of protein, sugar and salts, in which fat is suspended.¹⁸¹ It supplies all the food needed by a young infant except for some vitamins and trace elements.

Milk is not constant in composition from one human or animal to another, at all periods of lactation, or even hourly through the day.^{72,73,96} The composition of milk is related not only to the amount secreted and the stage of lactation, but also to the timing of its withdrawal (whether early or late in the feeding or pumping), and to the individual variations among lactating mothers. These latter variations may be affected by such variables as maternal age, parity, health and social class. A significant and comprehensive literature^{62,117,125} is available concerning variations in the nutrient content of individual samples of human milk, however, the general picture is the same throughout the world. Except for its vitamin and fat content, the composition of human milk appears to be largely independent of the state of nutrition of the mother. Even after prolonged lactation for two years or more, the quality of African women's milk appears to be well maintained, though the quantity produced may be small.¹⁰⁷ Severely undernourished women in times of famine often manage to feed their babies well.

Colostrum and Transitional Milk

In the first few days after parturition the breasts secrete a small amount of fluid which is called colostrum. It is yellowish, transparent, and contains more protein, less sugar and much less fat than milk, as well as some endothelial cells. The globulin content is high. Thus, colostrum is

often described as an extremely rich solution of globulin in a fluid which otherwise resembles milk. Human colostrum has a lower mean energy value during the first five days (58 cal/100 ml) than does mature milk (71 cal/100 ml).¹²⁵ The total ash content of human colostrum is relatively high. The concentrations of sodium, potassium and chloride are greater in colostrum than in mature milk.⁹⁶ Variations in the composition of human colostrum on any one day and from one day to the next, are strikingly wide.

Colostrum changes to milk between the third and the sixth day, at which time the protein content is still rather higher. Major changes from colostrum to mature milk are completed by the tenth day. By the end of the first month the protein reaches a constant level which does not fall again until near the end of lactation. While the content of protein falls, that of lactose rises.⁴⁴

Mature Milk

a. Protein: Different animal species show great differences in the rate of growth, and this is reflected in the composition of their milk. The slowest rate of growth and the lowest milk protein content are encountered in man.^{135, 167} The proteins found in milk are casein (curd-protein) and lactalbumin (whey-protein). Milk also contains a number of other simple proteins built only from amino acids, and are present in very small amounts (e.g. proteose-peptone fraction, peroxidase and xanthine oxidase enzymes). Their nutritional importance has not been elucidated.

Mature human breast milk contains 1.5 gm protein per 100 ml. of whole milk, as compared with 3.5 gm in cow's milk. The casein content of human milk is only about 1/6 of that of cow's milk, but whey-protein content, both relative and absolute, is higher.¹³⁵

It was long believed that protein of human milk was nutritionally superior to that of cow's milk. Casein (the predominant protein constituent of cow's milk) was thought to have a lower biologic value than whey-protein. However, the determination of the amino acids in milk has been of particular value in modifying this concept. Jeans¹⁰⁶ maintained that the essential

amino acids (methionine and cystine necessary for fur-bearing animals) in casein were lacking. This was not borne, however, by chemical analysis. The amino acid pattern of the proteins of the two milks is, in general, quite similar, and both adults and babies have been kept in nitrogen balance when fed equivalent amounts of both casein or lactalbumin ^{7,46,47,64,65,141,142.} Thus, the concept once held that lactalbumin of human milk was superior is no longer tenable. ⁸⁹

Despite the similarity in the amino acid pattern of the proteins of human and cow's milk, some qualitative differences between the two types of proteins have been demonstrated. These relate to the elemental composition, enzymatic hydrolysis, and physico-chemical aspects of casein. It was also reported that only mature human milk contains a significant amount of the slowly migrating fractions of the whey. ¹³⁵

Fomon ⁴⁸ has shown that in breast-fed 112 day old infants, the mean serum concentration of albumin (determined by electrophoresis on cellulose acetate) was significantly higher than that of infants fed evaporated milk. Although the nutritional implications of these findings are not, as yet, known, Fomon maintains that the serum concentration of albumin may prove to be a more sensitive index of the nutritional superiority of human milk protein than nitrogen balance studies and rates of gain in length and weight.

b. Lipids: Lipids are important constituents of whole milk. In addition to their nutritive value as a source of calories, they are carriers of the fat-soluble vitamins A,D,E, and K and the precursors of vitamins A and D. ¹⁸¹ Most of the lipids of milk are found in the fat globules and the adsorbed surrounding membrane, but small amounts are also found in the milk serum.

The total lipid content of the milk varies considerably from one woman to another, and even more from one phase of nursing to another in the same woman. Gunther and Stanier ⁷² seem to have established that there is a diurnal variation in the fat content apart from the higher percentage found in the after-milk. After an ordinary milking, 20 percent of the milk remains in

the gland and this contains 50 per cent of the fat. Hytten⁹⁶ suggests that this phenomenon is due to the adsorption of the fat globules to the large surface of the alveoli

The composition of milk fat depends on the diet of the mother. It has been shown that the fatty acid pattern of human milk resembles that of the maternal diet within as short a time as two days.

In both human and bovine milk, the triglycerides (esters of fatty acids with glycerol), generally called milk fat, form the bulk of the lipids and constitute about 98 per cent of their total.¹⁸¹ Small amounts of phospho-lipids, cholesterol, and free fatty acids are found in both types of milk, but the fatty-acids composition of the lipids differs greatly between them.¹³⁵ The content of linoleic acid, the only fatty acid known to be essential for the infant, is considerably greater in human milk than in cow's milk. The content of oleic acid is also greater in human milk than in cow's milk, while the content of shorter-chain saturated fatty acids (C₄ to C₈) is greater in cow's milk.

c. Carbohydrates. Lactose (milk sugar, a disaccharide), long believed to be the only carbohydrate in milk, is the main carbohydrate. The use of paper chromatography has shown milk also contains trace amounts of glucose, galactose, glucosamines, and other nitrogen-containing oligosaccharides.

Lactose occurs in two forms - A-lactose and B-lactose. It is relatively insoluble, is slowly digested and absorbed from the intestines. Its presence in the intestines stimulates the growth of micro-organisms that produce organic acids and synthesize many of the B vitamins. The acids help to check the growth of undesirable bacteria and favour increased absorption of calcium, phosphorus, magnesium and other metals

Lactic acid, a product of lactose fermentation present in fermented milk (yoghurt or leban), has a favourable influence on intestinal flora.

Galactose is necessary for the synthesis of the galactosides of brain and medullary sheaths of nerve tissues and the myelination of cerebrocides in infants. Thus, galactose has, in some way, the qualities of an indispensable carbohydrate.

Human milk contains much more lactose than cow's milk (7 and 4.8 per cent, respectively), as well as considerable quantities of nitrogen-containing oligo-saccharides (0.4 per cent and only 1/100 of this amount in cow's milk). The latter type of sugars have a lactobacillus bifidus^{75,76} promoting activity. L. bifidus have the property of breaking down lactose into lactic acid and acetic acid. Thus, it is responsible for the acid reaction of the intestinal contents of breast-fed infants, which may interfere with the growth of many enteropathogenic organisms.

d. Minerals: The major minerals found in mature human milk are potassium, calcium, phosphorous, chlorine and sodium. Iron, copper and manganese which are concerned with blood formation, are present in traces only, and children fed for too long on milk alone become anemic. There are also minute amounts of zinc, magnesium, aluminum, iodine and fluorine.

The total mineral content of milk is fairly constant, but the amounts of specific minerals may vary considerably, with the diet of the mother and stage of lactation, though not to the same extent as the concentration of vitamins. Iron calcium, however, are thought to be the most stable, despite maternal dietary variations.¹⁸¹

Milk is a good source of calcium and phosphorous, two major bone-building elements, but is a poor source of iron and a variable source of iodine.

One of the most striking differences between human and cow's milk lies in the mineral composition. As with the protein, it is believed that this difference may be related to the rate of growth of the species for which the milk is intended. There is six times more phosphorous, four times more calcium, three times more total ash, and three times more protein in cow's milk than in human milk. These differences have important implications on the solute or osmolar load which derives from the electrolyte and protein content of the food.^{89,93}

Of all the minerals present in milk, iron is practically the only element which does not differ much in both types of milk. (0.05-0.06 mg per 100 ml. of human milk and 0.04 mg per 100 ml in cow's milk).

The copper content of human milk varies from 0.6 to 1.05 mg per liter in the first weeks of lactation. Cow's milk contains less copper, with values from 0.015 to 0.4 mg per liter of homogenized milk being reported.¹⁴⁵

e. Vitamins: Milk is an important source of vitamins. All the vitamins essential for good nutrition and health are supplied in milk provided the diet of the mother is adequate. Vitamins are potent organic substances which act as biochemical regulators. Many of them function as coenzymes and are involved in the control and coordination of specific chemical reactions in the body.

Fat-soluble vitamins: Milk is an outstanding source of Vitamin A and its precursors. Its concentration, however, is strongly influenced by the quality and quantity of the dietary elements consumed by the mother. The vitamin A content of breast milk is generally much lower in some developing countries (India, Ceylon, Indonesia, Jordan) than in the West.^{163, 226}

The maternal serum A levels are also low. The intake is generally higher in the spring and summer months due to greater supplies of green leafy and yellow vegetables.

Milk, as produced, is low in vitamin D, and contains only small amounts of vitamins E and K. Human milk has about 50 IU per liter of vitamin D, and rickets may occur in breast-fed infants without supplementation, even though calcium intake is adequate.^{145,174,204,205} In developing countries the vitamin D content of breast milk has not been investigated. It is not increased by high and continued maternal intake, except when the dosage is enormous.³⁹ In the sub-tropics and tropics almost the only source of vitamin D for most of the infant population is the sunlight, which irradiates the provitamin, 7-dehydrocholesterol of the skin.¹⁰⁸

Water-soluble vitamins: The vitamins whose deficiencies in maternal diet are most markedly reflected in breast milk content are ascorbic acid, riboflavin and thiamine.³⁹ Belavady and Gopalan¹² produced a significant increase in their concentration by dietary supplementation.

The level of ascorbic acid in breast milk is subject to variations in dietary intake, and the seasonal availability of citrus fruits. In well nourished mothers, human milk supplies an average of 4 mg per liter of vitamin C.¹⁴⁵

Unless the maternal intake is adequate, the milk content of ascorbic acid may be reduced to a low level, and supplementation would be required. Among other important functions, ascorbic acid is necessary for the prevention of scurvy and for the maintenance of folic acid in the reduced form through enzymes called folic acid reductases. Infants on an unsupplemented milk diet (especially the artificially-fed) may develop megaloblastic anemia because of combined folic acid and ascorbic acid deficiencies.¹⁴⁵

Milk is one of the richest sources of riboflavin, provided the maternal diet is adequate. In South India, Gopalan and Belavady¹² found an average of only 17.2 micrograms of riboflavin in breast milk as compared with a value of about 25 micrograms found by Kon and Mawson¹¹⁷ in Great Britain.

The thiamine content of breast milk in areas with a high incidence of infantile beriberi has been found to be low and to be due to insufficient maternal intake.¹⁰⁸ According to Clements,²⁶ after the twelfth week of lactation, a concentration below 11.8 micrograms produces unsatisfactory growth, and when it is less than 5.8 micrograms tends to arrest growth completely.

Niacin in breast milk seems not to depend on maternal diet. Although human milk is low in actual niacin, it has a high niacin value because this vitamin may be synthesized from tryptophan.²²⁶

Pantothenic acid, pyridoxine, biotin, folic acid and vitamin B12 are all found in milk.¹⁸¹

f. Other Constituents of Breast Milk: Milk also contains a pigment, lactochrome, traces of creatine, creatinine, urea, xanthine, uric acid, ammonia, citric acid, and a number of enzymes.^{24,44,135}

g. Volume and Calories: Information on the volume of milk secreted at various stages of lactation is meagre. However, the WHO Expert Committee

on Nutrition in pregnancy and lactation accepted an average milk yield of 850 ml (600 calories) per day, and considered that adequacy of lactation could best be judged by satisfactory growth of the infant during the period when it is exclusively breast-fed. Under such conditions, "A gain of 800 g. \pm 20 per cent per month during the first six months of life or the doubling of the birth weight by about the end of the fourth month of life may be regarded as satisfactory" ²²⁴

While maternal undernutrition does not greatly affect the protein and carbohydrate (lactose) concentrations of the milk, fat and other constituents may be lowered, and the total volume is generally decreased.

In human milk 90 per cent of calories is derived from fats and carbohydrates and 10 per cent from protein. Whereas, in cow's milk, 85 per cent come from fats and carbohydrates and 15 per cent from proteins. ^{24,135} When cow's milk is used to supply two-thirds of the calories required, it is sufficient for all nutrients except lactose, fat, linoleic acid, iron, vitamin A, vitamin E, ascorbic acid and niacin.

h Lactation: Maternal Diet and Maternal Health: The first objective in achieving adequate breast-feeding is to ensure an adequate diet for the lactating mother. This becomes of relevant importance in developing countries, where, on the whole, the dietary intake of the general population and lactating mothers, in particular, is deficient in total calories, animal protein and other nutrients, where multiple pregnancies and lactation deplete the maternal body stores, where the nutritional status of mothers may be adversely affected by hard work, infections and parasitic disease; and where customs, food habits and other cultural blocks hinder the lactating mother from obtaining an adequate share of the family diet to meet her own requirements and the requirements of the nursing infant. ^{49,222,224,225}

Breast-milk adequacy, both quantitative and qualitative, is largely dependent on the maternal diet during pregnancy and lactation. In effect, maternal diet in these two phases, should be viewed as an integral part of infant feeding. Preparations for lactation begin during pregnancy.

Apart from the development and growth of mammary gland, maternal energy reserves (fat) are laid down during the earlier part of pregnancy in a well-nourished woman and may be available, in whole, or in part, to subsidize lactation. However, an undernourished woman may lay down a much smaller reserve and use it all up before the end of pregnancy. Under such conditions, the immediate needs for lactation may be met from maternal tissues, although some evidence indicates that absorption and utilization of nutrients may be improved during lactation, but not as much as during pregnancy.²²⁴

Additional calories are needed to meet the energy costs of lactation, as well as protein and other nutrients. In regard to calories, the requirements of lactation are proportional to the quantity of milk produced. Thus, it is recommended that under the most favourable conditions, the calorie intake should be supplemented by approximately 120 calories for each 100 ml of milk produced. With an accepted average milk yield of 850 ml/day between one and four months, an additional allowance of 1 000 calories/day was considered appropriate. If the lactating mother increases her activities in the post-partum period due to the care of the infant and additional household activities, an additional allowance may be necessary.^{49,144,145,224}

The estimation of protein requirement²²⁵ for lactation is based on the fact that a liter of breast milk contains approximately 12 gm of protein. The efficiency of conversion of dietary protein to milk protein is estimated at 50 per cent. Thus, an additional 25 gm is postulated, and the allowance of 40 gm of protein daily during lactation is recommended.

In developing countries, where low protein intakes are common, protein supplementation may have little direct effect on lactation, but a marked increase in positive nitrogen balance has been observed by Gopalan,⁶² indicating that the principle effect was a correction of tissue deficit.

Special allowances have also been recommended for other nutrients: iron,²²¹ calcium,²²³ vitamin A, niacin, riboflavin and thiamine.²²⁶

IV ADVANTAGES OF BREAST-FEEDING

The advantages of breast-feeding for the infant have been widely recognized. The indicators for human milk adequacy may be summarized under four headings: 1) favourable growth and development in the early months of life; 2) good health, immunity and relatively low morbidity and mortality rates; 3) digestibility, low solute load and a variety of known and unknown protective and health promoting factors and 4) emotional satisfaction. Although the first three advantages have lost some of their prestige in developed countries, their impact continues to be very meaningful for infants in the developing countries.

Breast-feeding is also advantageous to the mother, if adequately nourished and her body stores are not depleted by a large number of pregnancies. The known maternal advantages are, at least, five in number: 1) a low incidence of breast cancer, 2) baby-spacing, 3) emotional satisfaction, 4) simplicity and convenience, human milk is readily available, easy to administer, no preparation or bottle-boiling are required, and 5) the cost required for its synthesis by the mammary gland is compatible with the purchasing power of even low-income mothers.

A. Growth and Development

Weight curves are the simplest indicators of the adequacy of lactation, although they do not necessarily reflect the value of a diet. Weight gain or weight loss is more a function of total energy intake rather than of individual nutrients. A close relationship exists between weight gain and ash content of food rather than between weight gain and protein content. Under favourable conditions, artificially-fed infants gain about the same weight from birth to three or four months as breast-fed infants although nitrogen retention is higher in the artificially-fed infants.²⁴ But from the fourth month artificially-fed infants gain weight at a more rapid rate.

Other anthropometric measurements,⁴⁵ such as total height or body segments, head and chest circumferences, and skinfolds are also useful but difficult to carry out. Bone age is a sensitive indicator,¹³⁵ but the

age of eruption of deciduous teeth has not been shown to be a reliable indicator .

There is abundant evidence^{45,67,84,137,190,217} from widely scattered areas that breast-fed infants usually do well and show satisfactory gains in weight during the first six months or so of life, even when the lactating mothers are inadequately nourished. In some instances, they also appear to grow better than artificially-fed infants in Western countries. However, from the sixth month onward, the growth curves show a rapid falling-off in weight gain.

The infant grows well while the flow of breast milk is both abundant and adequate for its needs, but when a diet of even a maximal output of breast milk, with occasional supplementation with predominantly carbohydrate semi-solids, is quite unable to supply its nutritional requirements, in particular its protein needs, he starts to manifest evidence of failure to thrive.¹⁰⁸

At this time factors other than dietary inadequacy become important. These relate to feeding malpractice and an associated increase in the incidence of gastro-enteritis. Indeed, this phase of artificial feeding is very hazardous. Gordon,⁶⁶ in the study of Indian infants has emphasized the importance of partial weaning and its implications on health and growth. Weaning diarrhea appeared to him as a synergism of nutrition and infection.

A comparative analysis of the growth rates in relation to the feeding pattern based on longitudinal observations of Lebanese infants (birth - 18 months)¹⁸ showed that the partially weaned had lower mean weight increments than both the breast-fed and artificially-fed infants from one month onward. The results of this study confirmed the evidence for the interplay of multiple factors-dietary inadequacy, infection, feeding malpractice- in the process of partial weaning in developing countries.

B. Morbidity and Mortality

Human milk may not be sterile, but it is safe for the baby. Breast-fed babies tend to have their earliest illness later, to have fewer and milder illness and to show a lower mortality rate than bottle-fed babies.¹²⁴

Numerous papers emanating from many parts of the world support this view, but as far as we know, there are no papers which suggest that morbidity rates are higher in breast-fed infants. In this regard, Illingworth¹⁰³ affirms, "There seems in fact, to be no difference of opinion on the subject. There is no doubt at all that by far the safest way of feeding a baby, particularly if the social circumstances, hospital arrangements or sanitary conditions are poor, is direct from the mother's breast." In poor homes the illness rates are certainly higher among bottle-fed infants. When an attempt was made to introduce formula feeding of infants among village people of Southern Egypt, almost every baby died¹⁸⁹ However, Powers¹⁶⁹ indicates that for an individual healthy normal baby in a good home, the danger of bottle-feeding for illness and death is not important, even with premature infants.

Grulee⁷⁰ reviewed the morbidity and mortality in 26 061 babies under the care of the Infant Welfare Society of Chicago between 1924 and 1929, and found the following results:- the incidence of infections in the breast-fed infants was 37.4 per cent as compared with 63.6 per cent in the artificially-fed, 5.2 per cent of breast-fed babies and 16 per cent of the artificially-fed had gastro-intestinal disorders, in the breast-fed the mortality rate was 1.54 per 1 000 as compared with 84.36 per 1 000 in the artificially-fed infants.

Proof that morbidity and mortality of artificially fed infants are much higher than in the breast-fed came also from the study performed by Robinson.¹⁷⁵ A comparison between the morbidity and mortality of 2 295 babies who were entirely, or partly artificially-fed, and of 2 412 babies who were fully breast-fed showed that the mortality from infections was 30 per 1 000 in the infants who were being artificially fed at the time of the onset of the fatal illness, as compared with 3.3 per 1 000 in those who were being breast-fed, 17.9 per cent of the breast-fed infants had some illness in the first seven months, as compared with 40.7 per cent of the artificially-fed ones. The latter also had a higher incidence of measles

and whooping cough, and a three times greater incidence of otitis media. When breast-fed babies became ill, the duration and severity of the illness was less than that of the artificially-fed.

Douglas,⁴⁰ in a study based on 4 669 infants, born in March, 1946, and followed for a two-year period, found no mortality differences between artificially-fed and breast-fed infants, and no differences in the incidence of whooping cough, chicken pox, or German measles. The one striking evidence in this study, however, was that the incidence of measles in the breast-fed infants was significantly lower than that in the artificially-fed infants, and that this difference was striking only in the 10 to 24-month old infants, and the diminished frequency of measles was seen in the highest social class as well as among the less privileged group.

Stevenson¹⁹⁷ drew attention to the fact that in babies artificially-fed for the first six months there is a higher incidence of respiratory infections (colds, bronchitis, pneumonia) than in breast-fed babies, not only in the first six months but also in the second six months of life. It appeared as if the breast-fed baby obtained something in the first six months which provided him with greater resistance to infection in the second six months, when he was on ordinary mixed feeds.

In the Norrbotten study based on a comparison of four groups of infants divided according to the period of plain breast-feeding (Group A early weaned - birth to two weeks; Group B and C intermediate; Group D weaned late - 6 1/2 months or more) Mellander and Vahlquist¹³⁵ found that the combined incidence of upper respiratory infections, otitis media, and diarrhea was significantly higher among the babies weaned early (Group A) than the babies weaned late (Group D).

Naish,¹⁴³ working in a general practice in New York, found that there was a lower morbidity rate in breast-fed babies, necessitating fewer visits for the doctor. The average number of visits which had to be paid to babies breast-fed beyond three months was 1.39 in the first year, compared with 6.48 visits for babies who were artificially fed at or before 1 month of age.

Of all premature babies discharged alive and well from the obstetric wards, Crosse³³ showed that 4 per cent of those breast-fed for six months were dead after one year, compared with 10 per cent of those entirely artificially-fed. Gordon and Levine⁶⁵ advocated modified cow's milk for premature babies, largely on the grounds that they gain weight faster than on human milk. In a very well equipped hospital with an adequate and properly trained staff that may be true, but it would not be true for many other hospitals, nor for infants reared at home and under poor hygienic conditions, as is the case in most of the developing countries.

While the higher frequency of gastro-intestinal disorders in artificially fed infants may be explained on the basis of feeding malpractice and poor hygienic conditions, differences in the incidence of other infection (e g., respiratory, measles, etc.) are difficult to interpret. Numerous investigations have been performed to detect some of the factors which may be responsible for the superior quality of human breast milk observed on clinical ground. The current concepts regarding this matter will be briefly considered.

1. Immune Bodies

In the human species milk is not a significant channel for the transmission of ordinary immune bodies from mother to child. They are transmitted before birth.^{127, 134, 164}

In the newborn infant, passive immunity is almost exclusively dependent on the prenatal supply of antibodies conveyed across the placenta or through the amniotic fluid during the second half of gestation, whereas the postnatal supply of antibodies conveyed through colostrum and mature milk is of negligible importance.²⁰⁸

At birth, the concentration of many antibodies in the cord blood of the human infant are as high as, or even higher than, in the maternal blood, while certain animal species have negligible or undemonstrable antibody levels. In the first three days postpartum, however, human colostrum has much lower antibody concentrations than bovine colostrum, and is produced

in relatively smaller amounts (100 gms per kg of body weight of offspring in the woman, as compared with 1000 gms in the cow).

The antibodies that have been demonstrated in human colostrum and, in some instances, also in mature milk have been summarized by Vahlquist²⁰⁸ as follows: "isoagglutinins (anti-A and Anti-B), agglutinins of immune type (RH, anti-A and Anti-B), diphtheria antitoxin, tetanus antitoxin, antistreptolysin, antistaphylolysin, antibodies against hemophilus pertussis, typhoid O and H, dysentery, and E. Coli-Protective factors, such as neutralizing poliomyelitis virus, Japanese B encephalitis, influenza virus, parotitis virus, and vaccinia have also been reported"

In general, the antibody content in human colostrum decreases within a few days. Although some types of antibodies may be obtained in a low titre in mature milk. Furthermore, in only a small number of cases it was possible to demonstrate absorption of antibodies in minimal quantities after the ingestion of human or bovine colostrum or mature milk. After an extensive review of the literature, including the work of Nordbring,^{158,159} Vahlquist²⁰⁸ says in this regard, "... Human colostrum contains various types of antibodies, but in most cases the concentrations are low from the very beginning, as compared with those in the mother's serum, and quickly decline during the first few days of the infant's life. Antibodies in mature milk can be demonstrated only in trace quantities .. In the isolated cases in which an absorption could be shown after oral ingestion, relatively large quantities of antibodies were supplied during the first few days of life" - Thus, " Available data refute the concept that human milk is any appreciable importance as a source of protective antibodies for the child. The possible role of cow's milk in this connection needs no further discussion. Even were heterologous antibodies absorbed under certain conditions, both the minimal amounts in the milk and its treatment in preparing the formula would probably militate against any possible benefit to the child".

2. Bacteriocidal and Other Factors

Antibacterial properties have been found in human milk.¹³⁵ Though these factors may help to explain early immunity from infection, they do not explain the immunity continuing for months after breast-feeding has stopped.¹²⁴ It is probably the absence of organisms from breast-milk which is important in relation to the early alimentary ailments

Sabin¹⁸² found an anti-poliomyelitic factor in human milk, probably not of antibody nature, which was only detected in very few of the specimen's of cow's milk examined.

Lysozyme is present in human colostrum and milk but not in cow's milk.¹²⁴ Gyorgy^{74,75,76} described a "specific growth factor" (the bifidus factor, a N-containing polysaccharide), which promotes the growth of *Lacto-bacillus bifidus* and is a special constituent of human milk. It is present in human milk in forty times higher concentration than in cow's milk. In contrast to the acid reaction of the feces of normal breast-fed infants, the pH of feces of infants fed with cow's milk is alkaline or neutral. Acid fecal reaction and the prevalence of *Lactobacillus bifidus* flora may be beneficial to the human infant by suppression of pathogenic bacteria such as coliform or proteolytic organisms.

McGrath^{12,20} and colleagues have observed that, on a milk diet, rats were resistant to malarial infection. This may explain why infants in their first three months rarely suffer from malaria. An antibody to malaria seems to be a less likely explanation than that a nutrient essential for the parasite is lacking in milk and is supplied when the child starts a mixed feeding.

The lower morbidity of breast-fed infants, however, may be due to a factor (or factors), of a type completely different from antibodies or bacteriocidal substances. Human milk may contain proteins and amino acids in the proportions and structures which are optimum for absorption and subsequent metabolism into specific antibody substances.¹²⁴

C. Emotional Satisfaction

Breast-feeding is now recommended for its psychological advantages,^{73,152,153} although these have not been clearly established. Breast-feeding provides a closer, more intimate, and more satisfying relation between mother and infant than is achieved by bottle-feeding or by wet nursing.²⁰²

It satisfies an instinctive urge and gives the mother a feeling of having been indispensable.⁸² Bakwin's⁶ work on "loneliness in infants" showed how infants suffer when deprived of the attention of their mothers. The close contact with the mother and her loving attention give the breast-fed infant extra happy associations with the act of feeding, which are likely to be important in the lasting establishment of appetite and the development of his relations with other people.

D. Solute Load and Digestibility

1. Solute Load: A major problem in present-day infant feeding that requires special consideration is the solute or mineral content of the feeding the baby may be receiving.^{89,93} The differences in the solute load between human and cow's milk are rather striking due to the higher protein and mineral content of the latter. This has two important implications.

First: The highest osmolar load occurs in undiluted cow's milk, and the lowest in human milk. Even when cow's milk is diluted half with water, there is still considerable excess of phosphorus and calcium over that in undiluted human milk. The magnitude of the solute load under conditions of excessive extrarenal water losses as occur in diarrhea, vomiting, febrile states, and in hot weather is of considerable importance. If the solute load received by the infant exceeds available body water for renal excretion, hypertonic or hypernatremic dehydration results. Thus, Hill⁸⁹ concludes, "... If milk is to be given at all to infants with diarrhea or with excess losses of fluid from other causes, it would seem preferable to give half-strength boiled milk, or some other low solute-containing solution."

Second: Tetany of the newborn rarely if ever occurs in breast-fed infants. But if cow's milk is used in the first week or two of life (either as fresh whole milk or in the form of evaporated or powdered milk), without the appropriate degree of dilution with carbohydrates, tetany of the newborn may occur. The generally accepted mechanism for this condition is that renal and parathyroid immaturity may not permit renal excretion of the phosphorous in a concentrated formula. Consequently, hyperphosphotemia and hypocalcemia may result. The baby may have subclinical symptoms of irritability and fussiness, or may develop typical convulsions of tetany of the newborn.

2. Digestibility: Buffer Content and Curd Tension

Buffer Content: The buffer content of cow's milk is three times that of human milk. This affects digestibility. Marriot¹²⁸ in the 1920s, advanced an explanation for the difference in the digestibility of human versus cow's milk based upon the degree of acidity of the stomach contents after ingestion of either milk. For human milk, Marriot found the average pH of the gastric contents to be 3.6 as compared with an average pH of 5.3, when equivalent amounts of undiluted sweet cow's milk were fed. This degree of acidity, Marriot maintained, did not inhibit bacterial growth, was not sufficient for peptic digestion, did not favour gastric motility, and, upon passage of the stomach contents through the pylorus, failed to stimulate the production of "secretion", which in turn stimulated the flow of bile and pancreatic juice. Thus, he reasoned that by adding sufficient acid to cow's milk to neutralize its buffer content, cow's milk could be made as digestible as human milk. Acidification also precipitated a fine casein curd.

Curd Tension: Human milk yields fine soft flocculent curds in the stomach, a physical state which permits full utilization with minimal intestinal losses. Cow's milk produces large, tough curds, which Brennemann¹⁸ described as being peculiar solid, and contended that the physical state of the casein curd was the all-important factor in accounting for the difference in digestibility between human and cow's milk. This appears to

be the prevailing view today. Following this observation, it became routine to process the infant's formula by one of the methods effective in reducing curd tension. These are:- homogenization, evaporation, boiling, drying and acidification. However, pasteurization alone has little or no effect upon curd tension.

E. Breast-feeding and Breast Cancer

Various writers^{15,93,99,113,122,166,210} have called attention to the high incidence of breast cancer which accompanies the failure of normal lactation whether spontaneous or induced.

Lactation is a normal physiologic sequel to parturition. If the breasts carry out their normal function, cancer is much less likely to develop. Some believe that the likelihood of cancer of the breast may be five times as great in the non-lactating woman as for the woman who normally lactates and involutes the breasts by pursuing the nursing period from four to six months.

Several studies confirm the positive correlation between cancer of the breast and marital factors. Single women and infertile married women run the greater risk, whereas a younger age at marriage, pregnancy and nursing offer more protection.¹¹⁸

Hormonal or other artificial suppression of the originally normal lactation of women may result in incomplete involution of the breast and pathologic changes. A number of cases of carcinoma of the breast in young women have been seen within a relatively short period after receiving estrogen therapy for inhibition of lactation.

For years past, it has been a well-known fact that the wet nurses of China are virtually free of breast cancer while the well-to-do mothers who turn the baby over to the wet nurse after birth have a high incidence of breast cancer.

In a review of 2 636 cases of breast cancer McDonald¹³¹ found satisfactory information about lactation in only 101 of the cases, whereas in 42 per cent the breasts failed to lactate. Thus, he concluded, "It is entirely possible that the steady increase in carcinoma of the breast

in 'civilized women' is in large measure due to complete or partial failure of lactation".

A review of mortality statistics in cancer¹¹⁶ of the breast received from 19 countries, which covered a period of 33 years, showed that in the United States breast cancer has increased 50 per cent in the period studied, and 100 per cent in some European countries. In Finland, Italy, Chile and Japan, however, not only is the incidence rate very low with respect to the female population, but there has been very little increase in frequency in these countries.¹¹⁶

After a review of the literature concerned with the presumed relationship between nursing and mammary cancer Day³⁷ states, "Whatever the underlying causes, the evidence supports the thesis that breast cancer is least frequent in those women whose breasts have had the physiologic stimulation associated with pregnancy, followed by a period of normal lactation".

Haagensen⁷⁷ says "There is very good indirect statistical evidence, mostly from the Scandinavian countries that breast cancer is much more frequent in women who never marry and therefore never nurse children. The data also show that breast cancer is least common in women who have the most children. Since most Scandinavian women nurse their children, one might infer indirectly that nursing protects the breasts against the disease. In a number of other countries a low breast cancer incidence is associated with early marriage, high birth rate and breast-feeding".

F. Breast-Feeding and Child Spacing

There is a widespread belief among mothers in developing countries that breast-feeding serves as a natural contraceptive device or "baby-spacer". Jelliffe,¹⁰⁸ in an extensive survey, reported that prolonged breast-feeding (1 1/2 - 2 or even 3 years) is used by mothers to avert the risk of a new pregnancy in North Africa (Egypt specifically), India (New Delhi), Ceylon, Syria, and other countries. Similar observations have been reported from Iraq by Gounelle and Demarchi,⁶⁷ from Lebanon by Harfouche,⁸² and from Malaya by Millis.¹³⁷ The WHO Expert Committee on Maternal and Child Health²²²

calls attention to the fact that in many societies the maintenance of lactation for relatively long periods is of great value for the protection of the young child and may also be of value as a custom assisting the spacing of babies.

The traditional belief that the risk of conception is low among nursing mothers is supported by studies showing that ovulation may be suppressed during lactation²¹⁹ (breast-feeding). The woman who does not menstruate while nursing, does not ovulate, and when she starts menstruating, she may have an anovulatory cycle. During lactation-menstruation, the suppression of the ovulatory cycle is incomplete, but during lactation-amenorrhea, the inhibition is complete. Udesky²⁰⁶ in a study of ovulation in nursing mothers made the following conclusions:- 1) when there is no menstruation during breast-feeding the suppression of ovulation is almost complete; 2) when ovulation does occur, it invariably heralds the approach of menstruation unless pregnancy intervenes; 3) during lactation-menstruation, suppression is gradually lifted so that in 14 per cent of the cases, ovulation occurs in the first cycle, and in 28 per cent it occurs after 3 or more periods. The mother who nurses her baby will likely have her babies about two years apart. There are nine months of pregnancy, six months of nursing without menstrual periods, three months of periods without ovulation and perhaps six months more in which to start over again and become pregnant.

Douglas⁴⁰ found that in the first nine months after childbirth only half of the nursing mothers he studied (some of whom were only partly nursing) became pregnant as the mothers whose babies were bottle-fed. But, after weaning, as many of the nursing mothers became pregnant as the non-nursing mothers. Gioiosa,⁵⁹ in a study of 500 mothers in New Mexico, found that only 46 of them had become pregnant while nursing their infants. Of these, all but 6 became pregnant during the last few months of breast-feeding, or when the process of weaning was taking place. Only 9.2 per cent became pregnant while even partially breast-feeding. In 1961, the

La Leche league¹²⁰ (United States) conducted a National Survey to determine among other things, whether the process of breast-feeding, was in fact, helping mothers to space their babies naturally. The results showed that 80.8 per cent had an interval of 10 24 months, and that the time interval between births is shorter when the mother initiates other milks and infant solid foods while she is breast-feeding. Richardson¹⁷³ in his book - The Nursing Mother - states that the sucking of the nursing infant holds back ovulation. "The decrease in frequency of feedings and the cessation of nursing result in the re-establishment of ovarian function, the reappearance of menstruation and ultimately, ovulation. Complete breast-feeding in the early months of life is a fairly effective method of suppressing ovarian function and conception

The oral contraceptive pill (progesterone and estrogen derivatives) is contraindicated in lactation as well as in pregnancy. The reasons for contraindication in lactation are twofold: 1) harm to the nursing infant, and 2) suppression of lactation.

Detectable amounts of active ingredients in oral contraceptives have been identified in milk of mothers receiving these drugs.⁵⁰ Despite the small quantities of the steroids appearing in breast milk, mammary enlargement may occur in nursing infants. Thus far, a documented case of an infant male who developed gynecomastia at the age of five weeks has been reported. Furthermore, the administration of oral contraceptive hormones to newborn experimental animals at crucial periods can affect sex differentiation and behaviour and result in sterility, at a later stage in life.³⁵ Masculinization of the female fetus³⁶ has been observed in a few patients receiving progestational agents during pregnancy.

The hormones used in the contraceptive pills produce a marked inhibition of lactation. Confirmation of this is seen in the reports of investigators who have found that the progestogen-estrogen combination is most effective in artificially suppressing lactation.

V DISADVANTAGES

In general, it may be stated that human milk has no disadvantages. However, there are certain conditions that pose practical problems for physicians and other health workers attending to breast-fed infants, and may lead to unnecessary weaning. Consequently it is deemed appropriate to consider them briefly.

A. Drugs

Some drugs taken by the mother may pass into the milk. The literature on this subject was reviewed by Illingworth¹⁰² in 1953. He then concluded that, "Although numerous drugs are excreted in breast milk in small amounts, the number of drugs excreted in sufficient quantity to affect the baby is extremely small"... and "... No medicine can be given to the mother for the purpose of treating the child via the breast milk, because the concentration of the drugs in the breast milk is not sufficiently high and constant". A summary of the drugs excreted in human milk and their effects on nursing infants is shown below.

1. Drugs excreted in small amounts, without harm to the baby:- iodine, morphine, hyoscine (prescribed for motion sickness), mandelic acid, sodium salicylate, radioactive sodium, hexamine, quinine, caffeine (after drinking coffee or tea), nicotine (moderate smoking, 10-15 cigarettes daily or less), alcohol (in small or moderate amounts), barbiturates (thiopentone, phenobarbitone and phenytoin given to epileptic mothers) and the anthracene group of purgatives (calomel, phenolphthalein).

2. Drugs excreted in large amounts, without harm to the baby:- sulphonamides (free sulphonilamide) are excreted in milk in quantities approximating that in the blood, penicillin.

3. Drugs excreted with toxic or harmful effects on the baby:- Bromides (drowsiness and rash), daily dose received by the mother 40-90 grains.

Thiouracil may be found in a higher concentration in milk than in blood or urine (observed range of 9-12 mg per cent for milk as compared

to 1-3 mg per cent in blood)

Ergot gives symptoms of ergotism in 90 per cent of babies.

Purgatives of the emodin group (the active principle of cascara, senna, rhubarb, aloes). The evidence for senna is only clinical.

Alcohol (in very large amount). A case of drunkenness in an 8-day-old baby has been reported. The mother had taken a whole bottle of Port in 24 hours.

Nicotine-over 20 cigarettes per day (controversial evidence).

B. Foods Taken by the Mother Which May Affect The Baby Through Breast Milk.

Mothers commonly ascribe all types of symptoms in their baby to substances included in their diet, and they are often warned not to eat pickles, highly spiced food, and unripe fruit. However, this area has not been very well explored, and there is little scientific evidence to support these beliefs and practices.

Illingworth¹⁰² made a special study of this matter asking every mother if any particular foodstuff taken by her seemed to cause colic in the infant. Only 9 out of 57 mothers thought that the colic was related to food substances they had taken. The foods blamed were.- tomatoes, grapefruit, rhubarb, onions, turnips, peas, fresh fruit, beans, sprouts and banana.

In a study of Lebanese mothers in the low-income group 28 4 per cent expressed the belief that maternal diet could exert a harmful effect on breast milk. The foods that were considered especially harmful are: spices and spiced foods, sour grapes and lemon, bitter and salty foods; fish; greasy and fried foods, some vegetables such as cabbage, green beans, onions, garlic, spinach, cucumbers, radishes and lettuce. "Onions make the milk dirty, and cause diarrhea, like garlic they spoil the taste of the milk and the baby notices it " One mother said, "I know of an infant who nursed until he was four years, and would scold his mother every time she ate onions, because he feels it".

Cereals and pulses were considered heavy to digest by most mothers.

"They distend, and the gas which they produce passes with the milk to cause colic".⁸²

The belief associated with the division of foods into - 'hot and cold' - and the harmful effects, especially of "hot" foods, on lactating women and breast-fed infants was widely held by Lebanese mothers. It also appears that the belief is widespread in West Bengal and other parts of India, Iran and Peru as reported by Jelliffe,¹⁰⁹ Ghadimi⁵⁷ and Wellin.²¹⁸

There is evidence that protein substances sometimes pass through the breast-milk, and may therefore cause responses in a sensitive child.

Carotenemia (yellow staining of skin) has been observed. In one case the mother consumed 2-3 lbs of raw carrots per week. The condition was relieved after withdrawal of human milk.¹⁰²

C. Cancer Factor

Certain strains of mice have a high incidence of mammary carcinoma, which develops only in mice who have been suckled by their mothers (very little milk being necessary for the transmission of the factor responsible). While if the infant mice are entirely suckled by a dam of a different strain, they rarely develop mammary cancer.¹³ The importance of this factor in women is uncertain. Gross et al^{68,69} reported that with the electron microscope they found suggestive particles in the breast milk of women with a family history of cancer, but cancer of the breast occurs in women who have not been breast-fed. Thus, "The presence of this factor does not affect our ideas of the advantages of breast-feeding, more especially as the factor is transmitted in intercourse".¹²⁴

VI INCIDENCE OF BREAST-FEEDING AND TIME TREND

Wide differences in the incidence of breast-feeding in different parts of the world are now evident, however, the time trend indicates a continuing decline.^{109,111,132}

National surveys conducted by Bain⁵ in 1946 and by Meyer¹³⁶ in 1956 indicate that the neonatal breast-feeding rate in the United States fell by almost half during just ten years. In 1967, Hill⁸⁹ estimated an incidence of 25 per cent.

In the course of twenty years in Bristol England,¹⁷⁶ the number of three-month-old breast-fed infants dropped from 77 to 33 per cent. Another report from England¹⁸⁰ showed that 43 per cent of 13 687 mothers who gave birth to babies in one week in March, 1946, were fully breast-feeding their babies at two months of age, but there were wide geographical variations (ranging from 85% at Lewisham to 24% in Southport). Douglas⁴⁰ described a sample of 4 669 babies, and found that 62.5 per cent were breast-fed at 1 month and 31 per cent at 6 months.

In an obstetric clinic in France,¹⁷⁸ the proportion of babies getting no breast milk increased from 31 to 51 per cent in just five years. In Sweden, for the two districts (the town of Kiruna and the rural districts of Tore and Ranea), which Mellander and Vahlquist¹³⁵ selected for their research in the 1950s, the incidence for plain breast-feeding varied between 45 and 55 per cent at 2 months, between 28 and 40 per cent at 4 months; and between 20 and 30 per cent at six months.

In the post World War II era, the declining trend in the developing countries became evident in urban and peri-urban sectors of the population. However, breast-feeding has not appreciably decreased in rural communities since no such social, or economic situation exists to favor artificial feeding, nor is processed or safe milk available at a reasonable cost.

In China, Yung-en Kao²²⁸ said that 95 per cent of 26 674 babies were fully breast-fed. A study of an urban community (Calcutta) reported by Chaudhuri²⁴ in 1964, showed that 57 per cent of infants below one year

were breast-fed, and in 54 per cent of the cases breast-feeding was continued beyond one year of age. Other observers^{11,62} from Calcutta reported that 46 per cent of infants below six months are breast-fed.

Welbourn²¹⁷ (working among the children of a relatively advanced and well educated African tribe - the Baganda - living near Kampala, Uganda) compared the clinic records of 223 infants in 1950, and 285 in 1955, found that infants completely weaned from the breast before the age of three months remained about the same, at 3 and 4 per cent respectively. However, the use of supplementary bottle-feeds before the age of six months increased from 14 to 30 per cent. The average duration was 12.7 months in those not receiving supplemental feeds, and 6.6 months in those being fed from a bottle as well. In 41 cases, the supplement was probably unnecessary and the mothers did not ask for feeding advice at the clinic.

A sample of 379 Lebanese⁸¹ mothers in the low-income group, who resided in the urban and peri-urban sectors of Beirut city, 96.8 per cent breast-fed their infants at the age of one month (78.7% completely and 18.1% partially); 85 per cent at three months (47.8% completely and 37.2% partially), 67.9 per cent at six months (9.9% completely and 58.0% partially), 37.2 per cent at the age of one year (0.6% completely and 36.6% partially), and only 9.5 per cent continued to breast-feed partially through the eighteenth month of age.

Whereas mothers in the upper-income groups in developing countries have, on the whole, satisfactorily managed to artificially feed their infants, the low-income groups have met with numerous failures; since the latter comprise the largest sector of the population a declining incidence of breast-feeding, with the associated health, economic, and social hazards should constitute a source of concern for health workers, nutritionists, and parents throughout the developing countries. Factors responsible for the decline, especially those relating to unnecessary weaning and early supplementation, should be better understood and prevented

from further penetration into the peri-urban and rural sectors of the developing countries. In this regard Jelliffe says,¹¹² "Unfortunately, one of the most deleterious exports from the Western world in recent decades has been the trend away from breast-feeding toward artificial feeding with cow's milk, usually employing a bottle...even a brief consideration of tropical circumstances for the majority of the population concerned clearly indicates the impracticability and overwhelming difficulty of bottle-feeding for economic, hygienic, and education reasons... Also, from the long-term point of view, there will be a depletion of the limited resources of protein of high quality...certainly manufacturers should be persuaded by explanation or legislation to modify their well-meaning, but ultimately extremely harmful advertisements."

The prevention of the decline in breast-feeding in regions where the pattern is at present satisfactory was also emphasized by other workers. In reference to rural India, this basic need is summarized by Gopalan as follows:⁶² "The satisfactory situation with regard to lactation must be considered a valuable asset to be preserved, protected and augmented." Chaudhuri says,²³ "In developing countries, it is imperative to encourage mothers to breast-feed the babies at least six months... Breast-feeding is a necessity both for nutritional and economic reasons in low-income groups". In 1965, the WHO Expert Committee on Nutrition in Pregnancy and Lactation said,²²⁴ "Unfortunately there seems to be a trend towards shortening of the duration of lactation and more extensive use of breast milk substitutes in the developing countries. This trend should not be encouraged".

VII FACTORS IN THE DECLINING INCIDENCE OF BREAST-FEEDING

Factors related to the continuing decline in the incidence of breast-feeding are multiple and closely interrelated. Wide variations in the incidence of breast-feeding between and within countries in different parts of the world could not be due to maternal inadequacy alone, other factors must also be responsible for such variations. McGeorge¹³² asserts that the

rapid decline in breast-feeding as it is occurring in many parts of the world almost certainly is closely ~~related~~ to psychologic changes triggered by changes in group interaction and influenced by economic and historical trends. Newton and Newton,¹⁵⁵ in supporting this view say, "This decrease is so rapid that hereditary factors could not be operative and major physiologic changes in function would be unlikely in the absence of radical stress such as starvation or epidemic disease. Human emotion and behavior, however, may change rapidly in keeping with the rapid changes observed in rates of breast-feeding." The wide variety of interrelated psychologic factors held responsible for lactation failure were roughly grouped by the authors as follows:- individual emotions and attitudes; group-derived emotions and attitudes; and psycho-physiologic ~~medicating mechanisms~~. These include the "milk-ejection reflex", sucking stimulation; and other types of sensory contact between mother and baby.

Although the factors related to lactation failure are not all clearly understood, on the whole, they are a by product of modernization, economic and social development, changes in family life, women's emancipation and gainful employment outside the house, changes in attitudes and value system, the availability of tinned baby food and commercial pressure, medical services and the simplicity of bottle-feeding in industrialized cultures. In most instances, those factors operate jointly, and as Jellife¹¹¹ states, "Both lactation failure - either real or alleged - and bottle-feeding are probably the result of 'complex interlocking social pressures', which deserve further investigation on a world basis, especially in areas where breast milk is still the principle source of protein, both on a personal and a community basis".

1. Economic Development and Industrialization

The trigger mechanism for the decline in breast-feeding may be in attitude changes within family life that accompany industrialization and the money economy. Economic development, high standard of living, improved income and affluence are associated with a lowered incidence of breast-feeding.

In developing countries, upper-income groups are usually the first to adopt artificial feeding. In the Western world, historical cycles in the decline of breast-feeding were related to great wealth and luxury. The age of Imperial Rome, Athens in the time of Pericles, the era of Louis XIV in Paris,¹⁸⁵ early eighteenth century England and Colonial America¹⁷ were characterized by the rejection of breast-feeding by large numbers of women who used wet nursing or artificial feeding in the form of nap to sustain infants. However, in what Toynbee calls "times of trouble" breast-feeding has been popular.¹⁰⁹

2. Availability of Artificial Milk, Commercial Pressure, And Simplicity of Bottle-Feeding

Around the turn of the century, there was little or no science in infant feeding. Mortality and morbidity rates among bottle-fed infants in Western countries were extremely high as is the case at present in low-income groups of the developing countries. Summers were dreaded because of diarrhea and dehydration, and breast-feeding was at a high premium. The chance for survival of the breast-fed infant was clearly recognized, and every effort was made to promote nursing at the breast.⁸⁹ Wet nursing was almost a profession in those days and many of the prospective wet nurses were not too much concerned about their marital status so long as they could qualify for what was considered one of the more desirable forms of employment in that era. With the advancement of scientific knowledge four important changes were introduced which radically modified concepts regarding artificial feeding of infants and lowered the prestige of human milk. The changes include:⁸⁹ 1) bacteriological control of infant food supply; 2) processing of cow's milk to reduce curd tension to minimum levels by homogenization, evaporation, acidification, boiling, and drying, 3) adequate vitamin administration, 4) and detailed chemical analyses of milk with special reference to protein fractions and amino acid content. All these have helped to simplify the mechanism of infant feeding and formula preparation, to minimize the ill-effects of artificial feeding, and to manufacture a wide variety of tinned

milk products and baby food. In the wake of the progress achieved and the dilemma of choice which confronts the paediatrician, Brennemann aptly states,¹⁸ "...We have emerged from a chaos of complexity to a chaos of simplicity. We no longer evolve formulas with the help of algebraic equations, we are actually confronted in a given case by the question of which simple method of feeding to choose from among a wide variety, any one of which will in all probability be quite satisfactory". The implications of simplicity and availability of a wide variety of artificial milks on breast-feeding in the United States, was recently described by Hill⁸⁹ as follows: - "Breast-feeding has declined lamentably in incidence, wet nursing has become extinct, and formula feeding has become so simple and safe that even the services of a physician are no longer essential to ensure success... Commercially prepared formulas have become increasingly popular with housewives, presumably because of their ease of preparation... It is becoming increasingly difficult to defend the thesis that breast-feeding has important advantages over bottle-feeding". Thus, it, "no longer seems worth the bother". Commercial pressure and advertisement have markedly enhanced the widespread of artificial food products both in the developed and developing countries. Meyer¹³⁶ states that as of October 15, 1959, there were available over 200 different brands of evaporated milk, some 78 different infant foods and 26 separate carbohydrate modifiers. Many milk brands were freely distributed to newborn nurseries to ensure their use before the establishment of lactation and effective breast-feeding. Over 30 different brands of milk and 18 different varieties of special baby foods were enumerated by Lebanese mothers in low-income groups.⁸¹ All of them were imported, some were received free of charge from one source or the other, and others were bought despite the low purchasing power of the families. Newton and Newton¹⁵⁵ state that now in the United States, there is a "strong taboo" on showing photographs of babies nursing from the breast, whereas photographs of bottle-fed babies are "totally acceptable".

The "snob appeal" which seems to be associated with the use of tinned milk products in developing countries and its implications on breast-feeding was emphasized by Jelliffe^{108,111} and Welbourn.²¹⁷ The latter also points out that the availability of nursing bottles in a community in which they had not previously been available can be a "very dangerous development". Chaudhuri asserts that abandoning of breast-feeding in India may be, at least in part, due to the availability of other means of infant feeding.

3. Medical Factors

The availability of medical services and Western trained health workers have had a tremendous impact on the declining incidence of breast-feeding, especially in developing countries, where society is in transition and young mothers live in conjugal families with limited access to their own mothers and to elderly female relatives with experience in breast-feeding.

That the medical profession and medical services have been, at least partly, responsible for a lowered incidence in breast-feeding finds support in the work of numerous observers. Illingworth¹⁰³ asserts that, "Wide variations in the incidence of breast-feeding can hardly be explained by the oft-repeated suggestion that women are now unable to produce sufficient milk to feed their babies... It is almost certainly the case that differences are due to differences in the management of lactation. Unless doctors, nurses and mothers are convinced of the value of breast-feeding, babies will be fed on cow's milk".

On the whole, medical education³⁸ at both the undergraduate and graduate levels emphasizes the importance of artificial feeding, and takes little interest in breast-feeding. Prenatal care deficient in health education, hospital routines and regulations in new born nurseries and the post-partum period and a rapid turn-over of maternity cases, all tend to discourage breast-feeding. In this regard Hill⁸⁹ says, "... Unfortunately among the rank and file of physicians who deal with newborn infants there is a

deplorable lack of interest in the mode of feeding". He also adds, "Foremost...in the causes for the progressive decline in the incidence of breast-feeding...is a lack of hospital personnel really interested in promoting breast-feeding. In many centers (U.S.A.) breast-feeding is largely restricted to those women who are psychologically and physiologically constituted for nursing... The many others who start out so hopefully abandon the task after a few days or weeks, usually because some minor difficulty is encountered which could have been anticipated and prevented. Most primiparae, perhaps four out of five, with a little encouragement express a desire to breast-feed, only to be defeated in the few days or weeks under the system of neonatal care which prevails in a majority of American Hospitals...The current custom of discharging mothers from the hospital on the 5th post-partum day; rarely have the problems of breast-feeding been resolved by this time... The all too frequent result, often on professional advice, is to abandon the breast in favor of the bottle".⁸⁸ The latter observation was also supported by Meyer,¹³⁶ who obtained data by questionnaire from 1 904 hospitals reflecting the percentage of infants in their newborn nurseries, who were artificially or breast-fed, at the time of discharge. He found that 84 per cent of the infants left the hospital at the age of 5 days or less, and suggested that there may be a relationship between early discharge of the mother and infant and the failure to breast-feed.

Fraser,⁵² points out the, "Problem of conflicting advice" in infant feeding, given by several counsellors, each unaware of exactly what the other has said, that they hardly speak with one voice to the young and vulnerable mother. A contradictory feeding advice often causes the mother worry and confusion, lessens her confidence in her advisers and may, indeed, be harmful to the infant if it leads to frequent changes in feeding methods.

A frequent way in which the baby comes to reject breast-feeding is by being taught other techniques of sucking at the newborn nursery that are not appropriate to the breast. It has now become well established that

supplementary bottle-feeding interferes with the milk supply.¹⁵⁵

Medical arrangement techniques often induce inefficient sucking by the baby, which interferes with the stimulation of lactation and proper emptying of the breast. It has been observed that there is a high relation between the ability to nurse effectively and the amount of barbiturate medication given to the mother during labor. Significant differences between babies of the heavily and the lightly medicated mothers continue through the fourth day. Not until the fifth and sixth days are the babies of heavily medicated mothers as alert and effective in nursing situations as those of less heavily medicated. It was also found that newborn infants whose mothers had received a single dose of obstetric sedation during labor sucked at significantly lower rates and pressures, and consumed less nutrient than those born to mothers who had received no obstetric sedation. Drug effects persisted at a significant level throughout the four-day period that the infants remained in the newborn nursery.¹⁵⁵

In medical practice where physicians were highly motivated to promote breast-feeding, their positive attitudes favorably influenced the incidence of breast-feeding.^{115,212,213} In 1921 Sedgwick and Fleischner¹⁸⁹ conducted a campaign in Minneapolis in which they enlisted a group of physicians, "who were convinced of the overwhelming superiority of breast-feeding, who believed it was attainable for the vast majority of infants, and who were familiar with the working technique for making breast-feeding possible." The main points in the technique were the manual expression of milk after feeds, in order to ensure proper emptying of the breast, and the giving of complementary feeds until the supply of the mother's milk was adequate, the amount taken being decided by the baby. They had sufficient nurses trained in the technique, who visited mothers immediately after a birth was notified. The result was that 96 per cent of 2 847 were fully breast-feeding their babies at the end of the second month, and 84 per cent of 2 355 women at the end of the sixth month; 1 000 consecutive babies were discharged from maternity units fully breast-fed. Similar experiences were subsequently

carried out with equal success in Nassau county, and elsewhere,^{170,171}
Waller²¹³ reported that 83 per cent of 100 primiparae seen by him were
fully breast-feeding their babies at the age of 6 months as a result of
proper lactating management and advice, which those mothers had received.

4. Maternal Factors

Maternal factors are the most important single group of factors in
the declining incidence of breast-feeding, because of their direct bearing
on the lactation process, milk adequacy, maternal attitudes and breast-
feeding performance. Some of the conditions known to modify these factors
are considered below.

a. Age and Parity

Milk secretion is to some extent dependent on the age and parity of
the mother and on the state of her general health. Older mothers, especially
primiparae, tend to have less milk; primiparae in general tend to have less
milk and to have a later onset of full lactation. Only serious illness
appears to affect the supply of milk, primiparae being more adversely affect-
ed than multiparae. However, minor ailments, including anemia have no
special effect.⁴⁴

b. Ante-Natal Preparation For Breast-Feeding

The quality of ante-natal care is one factor that appears clearly to
affect the success or failure of breast-feeding,⁴⁴ but whether this is
achieved by the advice given on nutrition, by the attention given to deformati-
ties of the nipples, or by the inculcation of an attitude is uncertain.

In a large investigation of 12 991 women in Great Britain,¹⁸⁰ ante-
natal care was the factor which stood out as important in contributing to
the success of breast-feeding. Differences of social class or of parity,
and whether the mother was working or not, were much less important.

During the prenatal, it is necessary to advise the mother on diet and
to see that the nipples and breasts are adapted for feeding and to convey
an attitude to the mother. The breast and nipples should be examined at an
early stage and always before the sixth month is reached, for the ante-natal

period gives an opportunity to ensure two essentials for easy feeding by the child: adequate nipples and unobstructed ducts. There is increased liability to engorgement of the breast in the early puerperium and special attention should be directed before delivery to the various measures aimed at preventing it.

Patency of the ducts is ensured by expression of the viscid colostrum and epithelial debris during the later weeks of pregnancy. This is best learnt and done by the mother herself, so that she can do it several times daily. Waller²¹² advises compression of the breast between the two hands from the outlying parts down to the areola ten or a dozen times to express the milk from the glandular tissue and along the outlying ducts, a very firm stroking of the breast which is followed by expression from the lactiferous sinuses lying beneath the areola.

During the first few weeks after the baby is born, the mother should express milk after each feed.⁴⁴ It is advisable to learn the techniques of manual expression during the ante-natal period rather than in the first days after delivery. Blaikley¹⁶ and co-workers have shown that manual expression before delivery is chiefly important as a preparation of the expression of milk after each feed in the lying-in period. If milk is scanty complete emptying promotes production, and if milk is produced in excess of the infant's needs expression after feeds will prevent over-filling of the breasts

c. Mother-Baby Separation; Schedules and The First Feed

The time nursing begins after birth is thought to play a considerable role in the initiation and maintenance of lactation. In birds, as well as in mammals, it has been demonstrated that behavior is affected by events in the first few days of life. If a lamb is removed from the other sheep for the first ten days, it never develops the instinct to follow the flock. In relating this instinctive behavior to human infants, MacKeith¹²⁴ makes the following comment, "... Perhaps in the development of efficient feeding by the human baby, and in the establishment of the mother's efficient milk

secretion and ejection the first few days of life are a critical period." Archavsky³ observes that the sucking reflex is at its height twenty to thirty minutes after birth. If the infant is not fed, then the reflex diminishes rapidly and reappears forty hours later. On the other hand if the infant is fed half an hour after birth and every three hours thereafter, he takes the breast well and the early physiologic loss of weight is prevented

The common practice among rural women is to begin nursing as soon after delivery as the mother is able to handle the baby, who is kept close to her where she can see, hear and touch him. Although the milk-ejection reflex and sucking stimulation depend primarily on sensory stimulation of the nipple, other sensory contact, especially visual, auditory, tactile and olfactory may be important.¹⁵⁵ Research in mammals⁸⁷ indicates that tactile stimulation may be important. In goats, licking and nuzzling as well as vocalization is described as a prelude to getting the neonate in a favorable position for nursing. If the mother is separated from the neonate and put back in the herd, even for a few minutes, this instinctive process is stopped.

In a study of mothers of premature babies, Hartmann⁸⁵ and co-workers gained the impression that the desire to nurse fades if the mothers do not have their babies as soon as possible to see and feel, to keep up their interest in nursing. When Duke Hospital changed from routine separation of mother and baby to routine rooming-in, McBryde¹³⁰ observed that the breast-feeding rate was significantly increased.

Cultures with negative attitudes toward breast-feeding follow restricted, short breast-feeding schedules. Whereas, in cultures with positive attitudes, sucking is permissive and the course of breast-feeding is prolonged.^{81,82} In societies where breast-feeding is enjoyable enough to continue its full course, mother-baby separation is not easily tolerated. Cots and cradles are not welcomed.⁸² The baby remains from birth until about the second year of life almost constantly in close physical contact with the mother who will feed him at irregular intervals, usually determined by the onset of crying or by the pattern of sleep.

Illingworth¹⁰⁰ has suggested that most of the common difficulties in infant feeding were "man made". Based on the assumption that the higher incidence of successful lactators in primitive communities than in more civilized population groups could have been due to an elastic feeding schedule, Illingworth and Stone¹⁰¹ have shown in a controlled experiment the favorable effect of demand feeding on the establishment and maintenance of lactation in the early post-partum period. The favorable effect of self-demand feeding on lactation in the neonatal period was also demonstrated by Olmsted and Jackson.¹⁶²

Many modern hospitals now practice separation of mothers and babies at birth, except for brief feeding times, and when the baby and mother return home, the ideal is a separate room, where the baby is left alone most of the time. Mothers who breast-feed are often separated from their infants when they are hospitalized for severe illness. Thus, the milk dries up and the infant often leaves the hospital on bottle-feeds.

Gainful employment outside the home promotes mother-baby separation and attitudes of indifference toward breast-feeding. Jelliffe¹⁰⁹ emphasizes the need for tropical women to go out to work all day as a cause of increasingly early weaning in urban and sophisticated rural groups. The low-income farmers, however, carry the infant to the field as they reap the harvest. Close contact is maintained during work and the problem of mother-baby separation does not arise. In regard to the distance between mother and infant created by modernized ways of life and its implication on lactation and sensory contact. Newton and Newton¹⁵⁵ say, "Western cultures raise many barriers against sensory contact between mother and baby. Modern Western styles of female dress make breast-baby contact difficult. Families no longer sleep all together in 1 room. Narrow beds built for 1 person only are fashionable, and the baby, especially, is expected to sleep alone".

d. Female Status

Breast-feeding performance, including milk adequacy and the reaction of the infant to the breast-feeding situation, may be related to the woman's role

in life, as determined by her cultural locale, subcultural grouping, education, and social class. The untroubled confidence of the mother in her lactating ability and her cultural outlook on motherhood and sucking have been emphasized by Mathews¹²⁹ as a basis for successful breast-feeding. Several studies indicate a relation between breast-feeding behavior and motherly interest. Newton¹⁵³ has emphasized the point that women's joy and acceptance of the female biologic role in life may be an important factor in their psychosexual behavior, which includes lactation. It has also been reported that multiparae who planned to breast-feed significantly more frequently stated their satisfaction in the women's role in life than those who did not plan to breast-feed.¹⁵⁵ Newson and Newson¹⁴⁷ found indications of a positive relation between enjoyment of breast-feeding and duration of breast-feeding. Feelings of aversion for the breast-feeding act appear to be related to dislike of nudity and sexuality. Salber¹⁸⁷ and associates, working with American mothers who had never attempted to nurse stated, "The idea of nursing repelled them. They were excessively embarrassed at the idea or too 'modest' to nurse".

In cultures where motherhood is still regarded as a vocation, mothers continue to be good lactators. Breast-feeding, like reproduction, is regarded a natural function and what it entails in the way of love and sacrifice is a sign of maternal adequacy. Lactation management and breast-feeding as an act and way of life are acquired in the home. The pattern has a familiar transmission; girls usually identify with their mothers, and after marriage they try to comply with the wishes of their in-laws and husbands.^{81,82}

The impact of urbanization and an industrial money-economy, with the breaking up of the extended family unit has had far reaching effects on the role of women and the value placed on women's unique biologic contribution. Children are no longer associated with rise in social status. Among the young generation of mothers, it is becoming fashionable not to breast-feed, and young primiparae are more influenced by the attitudes of their friends rather than by family group attitudes. In big cities, especially among the educated

and upper-income groups, it has become quite common to find young primiparae, who were reared in families where the mothers and, even, the grandmothers did not breast-feed.

e. Verbalized Attitudes

Breast-feeding performance is also closely related to what the mother says about her attitudes toward breast-feeding. It has been demonstrated that frigid women with negative verbalized attitudes towards breast-feeding, feed less successfully than those with positive attitudes.¹⁵⁵ Of a highly motivated group of Lebanese mothers,⁸² who indicated an almost universal acceptance of breast-feeding (97.6 per cent had planned to breast-feed in the prenatal period, and 96.8 per cent of them breast-fed their infants at the age of one month), 87.6 per cent stated that their community did not look favorably upon a mother who does not breast-feed her infant, as compared with 10.3 per cent who stated that the community was indifferent, and 1.3 per cent who said that the community considered it favorable not to breast-feed. Mothers falling into the first category, regarded breast milk as "God's special gift to the infant... It is the best food and there is nothing like it... Nursing is a duty, a mother who does not nurse denies her baby's right". She is described as being "stingy", "lazy", "negligent", "lacks affection like a step-mother", and has "interests outside the house". "No lactation, no affection". However, the deviants who did not breast-feed (2.4 per cent of the total), expressed liberal views and indifference toward group-derived feelings and attitudes. Some said, "Every one is free to do what she wants. -Breast-feeding is a personal matter, mothers who do not nurse should not be blamed... Cow's milk and mother's milk give the same nourishment, artificial milk is available and easy to use".

f. Past Experience

The behavior of mothers of older children with successful past attempts to breast-feed have confidence in their milk adequacy and are more successful lactators than mothers who made no attempt. Previous attempts to breast-feed may also determine attitudes. Robinson,¹⁷⁵ in a study of 3 266 infants,

gained the impression that multiparae who failed in previous lactations were likely to take the infants off the breast when they returned to household duties. They failed and "were quite sure they would fail again".

Some life experiences of the mother appear to be related to breast-feeding success, especially labor and breast-feeding experiences associated with the breast-feeding mother's own infancy. Recent research with other mammals (monkey, rat, and goat mothers) suggests that the mother-baby contact in the mother's own infancy is also related to the ability to breast-feed in adulthood. Thus, partial mother separation in infancy is of significance

g. Religion and Common Beliefs

Religious teaching may have a significant impact on the incidence of breast-feeding. The Holy Quran provides the followers of Islam with special instructions regarding the duration of sucking, weaning, and rearing of infants. The content of this teaching is best conveyed by the following ayyat¹: "And we have enjoined on man the doing of good to his parents. His mother bears him with trouble and she brings him forth in pain. And the bearing of him and the weaning of him is thirty months" (Surat Al-Ahqaf: The Sand Hills:15), "And mothers shall suckle their children for two whole years, for him who desires to complete the time of suckling" (Surat Al-Bekara, the Cow:233). Muslim mothers, who strictly observe the fast of Ramadan, though highly motivated by the religious teaching, may sometimes be forced to abandon breast-feeding for health reasons. However, the Lenten regime observed by some Christian communities is mild and easily tolerated by lactating mothers and rarely affects the duration of breast-feeding.

VIII WEANING

Weaning is an essential part of infant feeding.²⁵ It should be done gradually when the infant would have doubled his birth weight, by the age of 4 to 6 months. There are two major reasons for weaning, even if there is sufficient breast milk : 1) breast milk is not an adequate diet after the age of about 4 - 6 months; 2) if weaning is not started by the age of 6 months, introduction of solid food becomes difficult at a later age.

Weaning should be avoided during the summer months or if the infant is sick. If an attempt is made to introduce new foods when the baby is ill, or in summer, considerable difficulty will be met with, and weaning may lead to severe gastro-intestinal disturbances and dehydration.

In most cultures where breast-feeding is the traditional pattern of feeding, weaning is heralded by a special ceremony marking the initiation of the infant into a new phase of his physical and social development. In India the ceremony is called "Anna Prasana",²⁵ and in the Arab countries "Snenieh" (or the appearance of teeth). Thus, rice with milk is offered to family members and friends, celebrating the eruption of the first deciduous tooth at about the age of 6 months, when the baby begins to share the family food. In Islamic culture, the art of weaning is incorporated with religious teaching.¹

The process of weaning is done by replacing gradually breast-feeding by liquids and milk, semi-solid and solid food administered with spoon from cup or plate. Since breast-feeding is usually permissive and does not follow any scheduled pattern, the baby continues to be suckled on crying, especially during the night. Complete weaning may be achieved by the age of 14 - 18 months or more.^{81,108}

The pre-weaning, weaning, and post weaning periods are known to be hazardous. Mothers where breast-feeding is widely practiced have always dreaded the stage of weaning, and fully recognized its implications on health and life. Much folklore is centered around this experience, although little formal health teaching about it is available in the

developing countries. Unfortunately, health personnel, who take little interest in breast-feeding, do not bother to know more about the weaning process.

Weaning is a period of physical and psychologic stress for the infant and, in recent years, has become identified with the overwhelming problem of protein-calorie malnutrition and other nutritional deficiency states. The term "to wean" (Anglo-Saxon *wenian*), means "to accustom a child or other young animal to the loss of mother's milk, to detach or alienate the affection of; to reconcile to a severance, as to wean one from a life of ease!"* According to this definition, the term has a dual meaning : - to accustom an infant to the loss of mother's milk (as in the case of gradual weaning); or to detach him from mother's milk (as in the case of abrupt weaning). In addition to the physical aspect - to accustom the child to the loss of mother's milk through the use of other dietary substitutes - the definition also makes provisions for detachment from maternal affection which is an integral part of the weaning process. Weaning from affection, like weaning from mother's milk, may be gradual and reconciliatory, or it may be abrupt, alienating or severing the infant from his maternal secure base with accompanying emotional disturbances. In the natural process, different ranges of these two types of weaning, with their concomitant physical and psychologic implications, commonly occur as a result of variations in the cultural setting.^{32,33,81}

The physical implications of abrupt weaning during the neonatal period and early infancy may be much more serious than the physical implications of abrupt weaning in late infancy.⁸⁴ This is particularly true if the purchasing power of the family prohibits an adequate supply of milk for the infant who is completely dependent on it as a basic

* Webster's New Collegiate Dictionary. Springfield, Mass. G. & C. Merriam Co. Publishers, 1958.

dietary element, or when sanitary conditions and maternal care are in such a poor state to make bottle-feeding a hazardous experience.

The psychologic implications of abrupt weaning in late infancy, however, are known to be much more serious than those of early infancy, due to the infant's stronger degree of attachment to his mother as a base of security.

The success of the weaning process entails two basic factors. 1) what foods to be given, and 2) how should these goods be given. Therefore, there is the what and how. Most of the pitfalls lie in the latter. This can only be ameliorated through health education; adapted feeding advice; and **improvements** in personal hygiene, sanitary and housing conditions. The availability of milk and food alone is not sufficient for successful weaning. With new foods and feeding bottles, traditional weaning practices may even become worse. The dangers of introducing new tinned foods and feeding bottles to developing communities has been emphasized by Welbourn^{215,216,217} and Jelliffe.¹⁰⁹

Although the traditional patterns of weaning are far from perfect, some new elements have been introduced through affluence and health services which, in some instances, have aggravated this situation. Of these, early supplementations with solid foods, unnecessary reasons for weaning, and over-supplementations with vitamins will be considered.

A. Solid Food and Early Supplementation

In most of the developing countries solid food may be started between 6 - 12 months, and in some instances, the infant may be kept on breast-milk alone without any additional food until he is completely weaned from the breast. Before the importation of special baby foods, mothers made use of suitable soft family food to supplement breast milk. In recent years, however, two major changes have occurred : - 1) a shift in the age of onset of solid food, a practice introduced by Western trained physicians and health workers, and 2) unsupervised early feeding of solids, due to the availability of a wide variety of imported special baby foods.

These changes have had advantages as well as disadvantages.

The advantages emanate, largely, from the growing awareness among mothers to the need for breast milk supplementation during the first year of life, and the observation of hygienic measures in administering supplementary food. These, in fact, may be considered an improvement of the traditional pattern, although they are limited to mothers who have access to health services.

The disadvantages are many and varied. The first, is the disruption of the traditional pattern by adding two steps to the process of weaning: namely weaning from special baby food to the regular family diet, and weaning from the bottle to the cup. The second, is pressure on the economy of low-income families who are attracted by tinned baby foods, and often buy them at the expense of essential items, already deficient in the family diet. The third, may be summarized as a "complex of disadvantages", largely caused by confusion among health workers and mothers as to the proper age at which solid food should be started, and by unsupervised early feeding of solids, especially among low-income groups.

Early age-unsupervised-supplementary-feeding reflects pressures and influences originating in the West, the unchallenged acceptance of foods, poor adaptation of feeding practices, lack of appreciation of modernized mothers and health workers for the traditional pattern and poor utilization of scientific knowledge for its improvement. Thus, a consideration of the current situation in the West is of value.

In the West there is controversy about the proper age for beginning solid food supplementation, and the time trend indicates a progressive change from no solid food supplementation during the first year of life to its introduction in the first days of life.⁸⁹ In the 1920s infants were not given solid food until they were nearly a year of age. By the mid 1930s Brenneman¹⁸ suggested that six months was about the proper age to introduce solid foods. In the 1940s Chester Stewart¹⁹⁹ reported that

he fed sardines, creamed tuna fish, salmon, shrimp, crushed peas and carrots to month-old infants, and in the 1950s Sackett¹⁸³ began solid foods on the second or third day of life on a six-hour schedule.

Perhaps with the exception of Stewart's feeding scheme, all other schemes were introduced to the developing countries by Western trained physicians. Thus, giving rise to confusion and disrupting the traditional pattern without much advantage.

In the opinion of Hill,⁸⁹ early introduction of solid foods into the infant's diet "is the result of empiricism and competition, not of sound nutritional principles. It is attended by certain dangers which are not compensated for by any discernible advantages". Gyorgy asserts that there is no reasonable scientific - medical support for early mixed feeding of infants. The appearance of the first teeth at the age of 5 or 6 months is a clear indication that the infant is not dependent on mastication before the end of the first half-year of life. May, also declares that the practice of early introduction of solid foods, especially cereals, into the infant's diet is a result of a desire to do something novel and to employ products which have been made readily available, rather than to translate any considerable body of scientific information concerning the usefulness of the practice.

In addition to supervised early feeding of solid food, the incidence of unsupervised supplementation has been observed by Epps and Jolly⁴³ to be on the increase in the United States as is the case in developing countries. The practice was strongly influenced by the ready availability of commercially prepared solids for infants and by maternal competitiveness, and appeared to be independent of race, birth weight, sibling order, maternal age, or the educational level of the mothers.

The too early use of solid infant foods started as early as the first month of life, or before, has contributed at least four major problems ;

1) the lessening demand on mother's milk with an increasing decline in the incidence of breast-feeding; 2) feeding problems; 3) worsening of the infant's nutritional status (e.g. overfeeding or underfeeding), 4) food allergy.

1. The Lessening Demand on Mother's Milk and Its Implications

The early introduction of solids is a fad which does not benefit the infant and may decrease his mother's ability to lactate. It has been shown many times that the oftener the breast is emptied, the more the milk is produced.¹⁵⁵ The practice is, therefore, likely to deprive the infant from his mother's milk at an age when he needs it most, and the efficacy of lactation as a baby-spacer is reduced. These two implications have a greater bearing on infants and mothers in the developing than in the developed countries.

2. Feeding Problems

Young infants have a poorly developed tongue reflex and therefore, cannot push the food to the back of the mouth easily. Experiments have shown that the giving of solids too early can cause feeding problems. Rowan-Legg¹⁷⁹ stresses that food should never be introduced by age but only when the baby is still hungry after the breast (or formula) is given. Such a time may be when he is 3 months old or not until he is 6 to 8 months old. Beal,⁹ in a study conducted over a ten-year period (1946 - 1955), observed that since the end of 1948, an increasing number of mothers have reported difficulty in the feeding of solid foods during the early months. The most common picture is one of eagerness on the part of the infant for the breast or bottle, but resistance to feeding of other foods with crying, or fussing, or spitting out, until a time, usually between 4 and 6 months of age, when the child begins to accept willingly solid food.

3. Worsening of the Nutritional State

A survey conducted in 1954, showed that out of 2,000 American paediatricians (who participated in the survey), 88 per cent routinely began

the feeding of solid foods before three months, and 66 per cent before eight weeks of age. In its comments regarding the results of this survey, the Committee on Nutrition²⁸ (American Academy of Pediatrics) states, "Lackin~~g~~ **is** proof that the feeding of solid foods at ages earlier than 5 - 6 months ~~is~~ nutritionally or psychologically beneficial. The feeding of solids at the expense of milk could result in worsening the nutritional state of the infant rather than bettering it. Consideration should be given to the possibility that it is the adult who is emotionally satisfied rather than the baby."

In recent years several authors have stressed the disadvantages of over-feeding. Youmans²²⁷ deplored "super-nutrition, and maintained that it might lead to definite shortening of the average life-time span. He suggested that the trend towards growing children bigger and faster may be linked to the increased incidence of degenerative diseases later in life.

In the developing countries worsening of the nutritional state through early supplementation may be of two kinds, and is often aggravated by unsupervised early supplementation, due to shortage of health services and/or ignorance of mothers.

Among the sophisticated upper-income groups of city dwellers, the picture of infant overnutrition is drawing closer to the Western pattern. Whereas, undernutrition and diarrhea due to feeding malpractice and the unhygienic conditions under which solid foods are administered, is the lot of infants in low-income groups, especially in shanty-towns of big cities and urban sectors. Most of these mothers are illiterate. Thus, they are unable to read or follow instructions. The errors committed in preparation, administration, and unwise choice of tinned solid food, constitute a serious source of concern for health workers throughout the developing countries.

4. Food Allergy

Although the scientific evidence to correlate early supplementation of solid food with allergies is not well established,¹³⁵ most allergists and many pediatricians are of the opinion that the recent trend towards starting infants on solid foods, while they are still quite young, may be responsible for some of the current rise in the incidence of major allergic diseases among children in the developed countries, especially the United States. "The earlier solid foods are introduced the more likely a child is to become sensitized to them. Fruthaler⁵⁴ maintained that early feeding of different solid foods surely will increase an infant's chances of becoming allergic to some of them. Gyorgy and Richardson¹⁷³ point out that starting solids early is unnecessary, serves no good purpose, and in some cases is even a risk, since it increases the danger of allergies... The fact that food products are the leading allergens in infancy... favors, even if only indirectly, the introduction of late or at least not too early supplemental feeding in infancy."

B. Unnecessary Causes for Weaning : Errors of Diagnosis and Treatment

1. Suitability of Milk - By far the commonest mistakes are the diagnosis of insufficiency of milk without carrying out test feeds or properly weighing up the history, and the diagnosis that symptoms such as vomiting, diarrhea or crying are due to the breast milk not suiting the baby. Illingworth¹⁰³ says, "Any diagnosis that breast milk does not suit a baby is always wrong. Exceptions to this rule are so rare that I have never yet seen one."

2. Menstruation - Many babies are deliberately taken off the breast because menstruation has recommenced. The reason for this action is the idea that the breast milk of a menstruating woman is "poisonous" for the baby. "There is no foundation for this belief."

3. Pregnancy - Most mothers in developing countries wean their infants from the breast at about the end of the first trimester of pregnancy, because they are of the opinion that breast milk becomes poisonous to the nursing infant. It is described as "haleeb ghal or ghair". This practice is probably justified, although nursing can continue during the first two months without much inconvenience to either mother or infant.

4. Breast Abscess - it is justifiable to take a baby off the breast in which there is a breast abscess, because of the possibility that the abscess will drain into the duct.

5. Allergy - Among the allergising food-stuffs of animal origin milk is considered to be the second in order of frequency (egg albumin being the first). This consideration, however, has been based on clinical observation and the disappearance of allergic manifestations after the withdrawal of milk, rather than on a clearly defined immunological abnormality in the suspected cases. Thus, milk allergy is still subject to controversy and, in particular, human-milk allergy lacks documentation, and as Mellander and Vahlquist observe in this regard, "Facts are as scarce on this problem as opinions are numerous".¹³⁵

Manifestations ascribed to milk allergy include respiratory, gastrointestinal, dermal, anaphylactic and other reactions.⁶¹ Loveless,¹²³ using a masked ingestion-test reported an incidence of 1.5 percent. Collins-Williams²⁷ reported a range of 0.1-30 per cent in pediatric practice, but in his own series (3,000 cases), he observed an incidence of 0.3 per cent. Stanfield¹⁹⁶ attributes these differences to the great variations in the criteria used for the diagnosis, and for the different samples of populations of allergic cases in the different series.

Most of the reported cases have been attributed to cow's, or goat's, or mare's milk, but allergy to human milk is believed to be very uncommon,¹⁹⁴ and some workers doubt its existence.

According to Parish¹⁶⁵ et al. Cot-death in infancy may be due to an anaphylactic type of reaction consequent to inhalation of cow's milk protein

regurgitated from stomach during sleep. Grulee and Sanford,⁷⁰ in a large series, declared the incidence of eczema to be seven times higher in the artificially-fed than in the breast-fed.

6. Physiologic Jaundice - Physiologic jaundice or normal hyperbilirubinemia is common in the neonatal period and occurs in about 30-75 per cent of newborns. Clinically, it is defined as hyperbilirubinemia of not more than 12 mg. of bilirubin per 100 ml. of blood in the absence of a hemolytic disease, in which visible jaundice appears after 36 hours of life and disappears by the tenth day.¹⁶¹ Physiologic jaundice carries with it no harmful effect, does not require treatment, and does not constitute a contraindication to breast-feeding.

7. Breast Milk Jaundice and Pregnanediol - Recently, Arias⁴ & Gartner observed nursing mothers occasionally have infants with prolonged jaundice which cannot be explained by any known cause of jaundice in infants. Approximately two-thirds of the infants nursed by these mothers developed prolonged jaundice, while none of their bottle-fed infants became jaundiced. Jaundice began during the middle of the first week of life and lasted from three weeks to two months. If the mothers stopped nursing their infants, for three or four days, jaundice disappeared in three to seven days. In this instance, resumption of breast feeding is believed not to result in the jaundice becoming severe again, and breast feeding may be continued without any anxiety.

All jaundiced infants were entirely well and developed normally. No brain damage has been observed as in Rh disease, probably because this type of jaundice begins later and is not severe. However, the fact that the syndrome was termed "breast-milk jaundice", it aroused great deal of confusion among nursing mothers, and was "badly misunderstood by physicians", who found in it a new justification for discouraging breast feeding.

Examination of the milk from four of the observed mothers revealed pregnanediol (pregnane-3 alpha, 20 beta-diol), a steroid hormone previously found in cattle but considered not to occur in humans. In vitro, the steroid has an inhibitory effect on bilirubin^{conjugation} and its ingestion by babies is believed to interfere with a specific liver enzyme necessary for the yellow pigment to be excreted into the bile. In all cases, the mothers are entirely well and show no signs indicating that they make this material. "The frequency of this phenomenon is unknown, but the disorder is undoubtedly rare".

⁴Arias contends, "Because of the rarity of breast milk jaundice and its thoroughly benign nature, we do not feel the existence of this syndrome should be used in any way to discourage the breast feeding of infants".

8. Hemolytic Jaundice - Hemolytic jaundice due to blood incompatibilities (Rh & ABO), usually appears within 24 hours of delivery and may result in Kernicterus and severe brain damage.

Rh negative mothers who possess anti-Rh agglutinin in their blood also have these agglutinin in their breast milk. This was at one time considered a contraindication to breast feeding, until it was demonstrated that no effect (anemia, jaundice, or edema) takes place when breast milk containing anti-Rh agglutinin or high titer human serum was fed to Rh positive infants.²¹ The antibodies in the milk diminish rapidly in the first 48 hours and may then, if present, fail to be absorbed from the gastro intestinal tract. Thus, Rh incompatibility is no more considered a contraindication to breast feeding, and many infants have been nursed successfully without harm to either child or mother, even after exchange transfusions when the infant's serum has been stabilized. In this regard Moulinier¹⁴⁰ came out with the following conclusions :

1 - Incomplete antibodies undergo a partial or total denaturation in the newborn's stomach, the degree depending on the gastric acidity.

2 - Those immune antibodies that are not destroyed by the gastric juice can enter the infant's circulation.

3 - The antibodies that enter the circulation clinically have no noxious effect.

4 - Breast feeding in infants with hemolytic disease can be continued under observation.

C. Over-supplementation with Vitamins and Other Nutrients

1. Vitamins - The availability of vitamin preparations and, in some instances, free distribution by physicians and other health workers, and their unsupervised use by mothers, have created a rather serious situation in most developed and developing countries.

The toxic effects of ingesting large amounts of vitamin A during relatively short periods have ^{been} well documented.^{90,139,157} The occurrence of such cases point to the importance of professional advice and individualized teaching to mothers.

Excessive quantities of vitamin D (of the order of 1,000 to 3,000 Units/Kg/day) are toxic and may lead to hypercalcemia. A few infants receiving 5-10 times the recommended allowance (300 to 400 Units daily) in association with a liberal intake of calcium suffer this syndrome, and amelioration often follows a reduction in vitamin D and calcium intake. Although hypersensitivity to the vitamin may be the responsible factor in some infants with hypercalcemia, in others it undoubtedly represents true intoxication due to excess zeal of an ill-advised mother.^{2,145}

The needs of breast-fed infants for vitamin supplementation differ from those of artificially-fed infants. If the mother is well nourished, all the necessary vitamins are available in breast milk in adequate amounts, to meet the needs of the infant for at least the first 5 to 6 months of life, with the exception of vitamin D, which may be easily obtained by exposing the infant to sunlight. If the baby is swaddled and conditions do not permit exposure to sunlight, a dosage of 400 IU for breast-fed infants is recommended,¹⁴⁵ and should be started as early as the first 1 or 2 months.

The use of other vitamins before the age of 6 months had to be individualized in accordance with the nutritional state of the mother and infant. After 6 months the following dosages are recommended.

Vitamin A - 420 micrograms per day or about 65 micrograms per Kg per day.²²⁶

Vitamin C - 30 - 80 mg per day,^{144,145} and may be easily provided by orange and tomato juice.

2. Minerals - With the exception of iron, it must be presumed that the mineral requirements of the infant are met by breast-feeding.

Iron is an essential nutrient in the human. It is a constituent of hemoglobin and myoglobin and of oxidative enzymes and a co-factor for the action of other enzymes. The absorption rate is generally increased when a demand for iron exists as in growth, pregnancy, or as a result of bleeding. In the normal adult with normal iron stores, usually less than 10 per cent of food iron is absorbed, whereas in infants and young children 10 per cent or more is usually absorbed.^{79,188}

The newborn infant is apparently unable to utilize additional iron over and above that furnished by reduction of its hemoglobin mass shortly after birth and by maternal milk.^{191,192} The need for iron to support growth becomes apparent at approximately three months of age. The total iron requirement during the period 3 -12 months approximates 0.8 mg/day, and the recommended allowance is 8 mg per day or 1.0 mg per kg of body weight.¹⁵⁶ After the age of one year 8-12 mg per day is considered adequate.¹⁴⁵

Iron deficiency anemia is very common among infants (breast-fed and artificially-fed) and children in the post-weaning period. Thus, a satisfactory iron intake either through diet or supplementation should be provided.^{22,105}

3. Calories and Protein - The need for meeting the calorie requirements of the growing infants in the weaning, and post-weaning

period cannot be over emphasized, and this should come from the normal constituents of the family diet and from cow's milk. The same applies for protein of good biologic value. Calories, if adequately met, spare body proteins. Protein shortage in developing countries can be partly met by promoting breast-feeding and prolonging its duration in as much as possible. Health, economic, social and cultural factors in the developing countries - all speak in support of the importance of human milk and breast-feeding.

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