Nutrition of the preterm infants

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Abstract

Objective: to review the recent medical literature on nutrition of preterm infants, focusing on practical aspects that are relevant to pediatricians and neonatologists.

Sources: an extensive review of the related literature using Medline, Cochrane Database of Systematic Reviews and Best Evidence was performed.

Summary of the findings: there is compelling evidence that early nutritional practices may affect short-term growth and developmental outcome in preterm infants. In addition, these practices have a determinant role in adult health. We still have to learn a lot about the safety and effectiveness of nutrient administration in preterm infants; about techniques targeted at assessing the effect of different nutritional strategies; and about the long term effects of these regimens on developmental outcome, growth and disease.

Conclusions: despite recent advances in neonatal nutrition, basic and clinical research is still necessary so that the nutritional needs of preterm infants can be better defined and adequately provided.


Introduction

The birth of preterm children represents a nutritional emergency. Theoretical calculations have shown that these children present nutritional reserves that last only a few days,1 and the smaller the preterm newborn, the smaller the reserve. Children with gestational ages less than 24 weeks can have as low as one day of calorie reserves.2 Infants below 1000 g birth weight, even with parenteral nutrition started on the first day, can lose as much as 10% of their weight and regain weight at a mean postnatal age of 11 days.3

Nutritional handling of preterm babies is very controversial, especially due to the lack of randomized, controlled studies.4 Information is even more scarce in the case of sick preterm babies. The wide variety of proposed nutritional schemes found in the literature is a clear demonstration of the lack of solid understanding on the nutrition of these children.

It is easy to recognize the immediate consequences of nutritional deficiency in preterms. Moreover, there is evidence indicating that early nutritional deficiency can also have long-term and extremely negative effects on development. For example, malnutrition during the development of the brain results in a smaller number of brain cells and in behavioral, learning, and memory...
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such as epidermal growth factor, which is possibly secreted hypoplasia. The swallowed fluids contain trophic factors esophageal atresia without distal fistula leads to gastric shown that, for example, the absence of swallowing in preterms. The poor production of pancreatic lipase is carbohydrates occurs even in extremely low birth weight 11  Studies with test meals showed that digestion of fat, proteins, and starch is faster when milk is administered.19  Approximately half the children with less than 28 weeks evacuate within 3 days. 20

The measurements of indirect calorimetry show that baseline energy requirements in premature babies vary from 60 to 75 kcal/kg/day.21 Another important source of energy expenditure in preterms is growth; in other words, by the amniotic membrane.14 The co-ordination of sucking, swallowing and breathing improves after 32-34 weeks of gestation.15

The lower esophageal sphincter is a relatively inefficient anti-reflux barrier in preterm babies. With 27-28 weeks gestation this sphincter can resist 4 mmHg pressures, whereas in term babies it can resist 18 mmHg.16 This pressure is slightly reduced by the oro gastric tube and strongly reduced by caffeine.17 This frequently results in gastroesophageal reflux and all of its symptomatology (vomit, esophagitis, recurrent apnea, pulmonary aspiration, deterioration of pulmonary dysplasia, growth difficulties). In the case of preterm newborns presenting these symptoms, it is always important to consider the possibility of reflux.17

Gastric emptying is slow in premature babies, which can affect their ability to tolerate milk.18 Emptying is faster and intragastric pressure increases with gestational age. The time to emptying half the volume with human milk is between 20 and 40 minutes; emptying is slower with formula, with greater osmolarity, and greater calorific density.10

Mature motility of the small intestine, with migrating motor complexes in fasting state and coordinated response in fed state, cannot be observed before 32 to 34 weeks’ gestation. It is known, however, that the maturing of motility and the tolerance to feedings are improved with previous exposure to enteral nutrition.19 This understanding has led to the practice of feeding minute volumes of enteral feeds in order to stimulate maturing of the intestine, which was called trophic feeding.

Whole gut transit time is slower in preterm than term newborns. The transit time is of 1 to 5 days, and it is even faster when milk is administered.19 Approximately half the children with less than 28 weeks evacuate within 3 days.20

Nutritional needs of the preterm

The nutritional needs of premature newborns are very peculiar, vary according to gestational ages, and are not well-understood.

Development of the intestinal tract

The intestinal tract is one of the first structures that can be identified in the embryo. The growth in length occurs especially during the last trimester of gestation. But it continues, though at a much slower pace, up to 3 to 4 years of life.9

Biochemical maturity occurs very early in life. In the stomach, for example, the proton pump can be identified at 13 weeks, and the intrinsic factor and pepsin are secreted only a few weeks later.10 This allows for gastric pH to drop to 4 in extremely low birth weight newborns.11 Studies with test meals showed that digestion of fat, proteins, and carbohydrates occurs even in extremely low birth weight preterms. The poor production of pancreatic lipase is compensated by other lipases.12

The mobility of the tract is also identifiable early in development. The fetus begins to swallow after 16 weeks of gestation. Swallowed volumes increase progressively causing fluctuations in gastric volume with a periodicity of 45 minutes at the end of the third trimester.13 Others have shown that, for example, the absence of swallowing in esophageal atresia without distal fistula leads to gastric hypoplasia. The swallowed fluids contain trophic factors such as epidermal growth factor, which is possibly secreted

Energy requirements

The matter of evaluating the energy requirements of premature babies is obstructed by deciding on the appropriate methodology. In addition to indirect calorimetry, other methods such as direct calorimetry, double labeled water, monitoring cardiac frequency, and infusion of labeled bicarbonate also present serious limitations in their application with premature newborns.

The measurements of indirect calorimetry show that baseline energy requirements in premature babies vary from 60 to 75 kcal/kg/day.21 Another important source of energy expenditure in preterms is growth; in other words,
an increased need for synthesis and new tissue. In addition to that there is the increased heat loss and evaporation due to fine skin and greater surface/mass relation. Conditions such as those of respiratory difficulty and sepsis and certain medication - including caffeine, insulin, and dexamethasone - also seem to increase energy expenditure. The metabolic requirements of ventilated, preterm babies was reported 25% higher in relation to controls. In this sense, in the case of sick and extremely low weight preterm babies, the calculation indicating 110 to 150 kcal/kg/day for preterms may be insufficient; it is necessary to try to apply higher standards.

Frequently, the amount of energy delivered to preterms is much lower than 120 kcal/kg/day. Inability to achieve adequate intake is caused by, among others, restriction of fluid intake, intolerance to infusion of glucose solutions, and recurring limitation of lipid intake due to complications related to respiratory function, hyperbilirubinemia, and sepsis. It is also common to delay the start and increase the time to achieve total enteral nutrition. In addition to these complications, there are those related to technical problems such as infusion of non-nutritional fluids with the medication.

Glucose

Glucose is the main energy source for the fetus and for the newborn in early life. Glucose is stored in the form of glycogen. The storage of glucose is limited in preterm babies because the fetus does not begin to produce glycogen until the third trimester. Consequently, premature babies have a small energy reserve. Babies weighing 1,000 g at birth have only 2% fat and less than 0.5% glycogen, in comparison to a term baby who has 15% fat and 1.2% glycogen. A preterm newborn with 24 weeks of gestation would have energy for less than 1 day of life. Thus, preterms require a significant and continuous source of glucose in their metabolism.

Term newborns require approximately 3 to 4 mg/kg/min (or less) glucose in order to prevent hypoglycemia. Preterm newborns, in turn, frequently require higher dosages. However, the actual glucose, or carbohydrate, requirements of these babies are probably much lower than what is usually administered to them. Often, more than 12 to 14 mg/kg/min is offered as part of the parenteral or enteral nutrition of the preterm. The measurement of glucose requirements for preterm patients, even right after birth, indicates values between 6 to 10 mg/kg/min. These levels are slightly higher than those of term newborns, partially because of the preterms’ greater brain/body relation and because of their greater energy requirements.

The production of glucose by glucogenolysis and gluconeogenesis starts right after delivery, even in the case of preterm babies. The production and utilization levels are of approximately 6 to 8 mg/kg/min. Infusion of glucose above these levels will only add fatty tissue and increase production of carbon dioxide. It is not known whether these consequences have a clinical meaning or if they can cause other results.

In medical practice, infusion of large quantities of glucose is limited by the low tolerance of these children during the first days of life; at which point they are at risk for developing hyperglycemia, whose incidence varies from 20 to 85%. The minimum levels of glucose tolerance for premature babies are still not well understood; recent evidence, however, indicates values between 45 and 55 mg/dl. It is not known whether these levels can bring benefits to children.

A common practice is of starting glucose infusion at 4 to 6 mg/kg/min (6 to 9 g/kg/day) in premature newborns. This dosage is usually well-tolerated. In the following days, the dosage is increased to levels of 10 to 12 mg/kg/min (15 to 18 g/kg/day) always monitoring for hyperglycemia. Glucose infusion higher than 16 to 18 g/kg/day can lead to an increase in plasma CO₂.

Amino acid and protein requirements

The largest incorporation of protein in life occurs before 32 weeks of gestation. Newborns with less than 1,000 grams who receive only glucose can lose approximately 1.2 g/kg/day of endogenous proteins. The administration of amino acids, even with low energy intake, saves endogenous protein because it increases protein synthesis and, thus, reduces the difference between proteolysis and protein synthesis. Generally, 1.5 to 2 g/kg/day are required in order to avoid catabolism. However, parenteral administration of low quantities of amino acids, such as 1.0 to 1.5 g/kg/day and 30 kcal/kg/day changes the protein balance from negative to zero or slightly positive. These values can be considered the lower limits for parenteral infusion of proteins. Many studies have shown that infusion of proteins can be started as early as the first day of life. A greater intake of calories reduces proteolysis; and a greater intake of both protein and calories leads to anabolism. In terms of upper limits for protein intake, in order to achieve intruterine levels of protein aggregation, it is estimated that premature babies weighing between 700 and 1,000 g require 3.85 g/kg/day. These values are probably slightly higher for newborns smaller than 700 g. Despite the presented evidence, many premature newborns are not administered the required amino acids and energy for many days after birth; this will ensure a permanent catabolic state. Still, further studies need to be carried out to confirm and evaluate the limits for protein intake in the first days of life.

Even with adequate administration of protein, many other factors are involved in, and can limit the use of protein. A very important factor is the limited intake of any essential amino acid. Among the important amino acids, there are tyrosine, cystein, taurine, histidine, glycine, glutamine, and arginine. For adequate protein balance, it is
also necessary that non-essential amino acids be available in sufficient amounts. If not, the essential amino acids will be used in the production of non-essential amino acids, consequently reducing protein synthesis. Thus, both quantity and quality of amino acids are important for promoting adequate growth. Human milk provides an appropriate composition of amino acids. In formulas, in turn, the quality of amino acids may be compromised; moreover, especially in parenteral mixtures, the proportion of amino acids may not be appropriate. As a result, the patient will be at higher risk for protein imbalance during the first days of life, during which time enteral nutrition is limited, and parenteral solutions are administered as the only source of protein and increased gradually. In this sense, for example, essential amino acids such as glutamine, cystine, cystein, and tyrosine are not present in the currently available amino acid mixtures. Glutamine, cystine, and cystein are unstable in solution. These amino acids could be administered daily outside the mixture. Tyrosine, in turn, is insoluble. The required dosage of these amino acids is also unknown. Even if the required dosage was known, there would still be serious strategy problems that would need to be solved. For example, if phenylalanine intake were increased, on the one hand it would be possible to increase tyrosine availability, but on the other hand, this could result in hyperphenylalaninemia and its potential deleterious effects on brain development. Substances such as tyrosine peptides (for example, glycyl-tyrosine) present a potential use as soluble tyrosine, but still have not been evaluated in their use with newborns.

Others have clearly shown, however, that the increase in energy intake in preterm babies with the same protein intake increased protein aggregation up to 100 to 120 kcal/kg/day. This correlation, however, is curvilinear; in other words, most of the gain following increase in calories occurs with the intake of 50 to 60 kcal/kg/day. Conversely, if protein intake is increased, there is an increase in protein aggregation in all energy ranges above 50 kcal/kg/day. The minimum amount of energy required to metabolize protein, during the first days of extrauterine life of premature babies, is still unknown.

Theoretical calculations based on relatively stable, mechanically-ventilated children during the first days of life indicated the need for at least 50 kcal/kg/day of energy intake for an amino acid intake of 2 g/kg/day; and of 60 kcal/kg/day for an amino acid intake of 3 g/kg/day. These calculations support the clinical finding that most children present positive protein balance receiving 50 to 60 kcal/kg/day. This amount of energy intake can be delivered with 10 mg/kg/min of glucose.

In case of a lack of protein intake, glucose is a more effective energy substratum than the lipid for the prevention of protein breakdown. When amino acids are delivered, it is known that both glucose and lipids will spare protein catabolism; but the optimal glucose/lipid relation for premature newborns is still unknown.

### Lipids

Fat is fundamental for brain development. It is required in myelination and growth of neurons, in the development of retina, and it is part of the key substances of the cellular membrane. Premature newborns are particularly vulnerable to the lack of fluids, since intrauterine delivery of fluids does not occur until the third trimester.

The determination of lipid requirements is restricted to the requirements of essential fatty acids. For example, 1 to 4% of energy intake in the form of linoleic acid (18:2w6) and approximately 1% of the total energy intake as alphalinolenic acid (18:3w3).

The minimum administration of lipids should be calculated based on preventing deficiency of essential fatty acids; it should also cover for the lack of calories in case it is not possible to obtain energy from other sources. It is imperative to avoid linoleic and linolenic acid deficiency considering that they play a critical role in brain development of premature newborns. These babies can develop deficiency of essential fatty acids in 72 hours unless they receive these acids from an exogenous source. This occurs especially in cases of low calorie intake, when lipids are oxidized to generate energy. Essential fatty acid deficiency can be prevented with endovenous administration of lipids at 0.5 to 1.0 g/kg/day.

The American Academy of Pediatrics Committee on Nutrition recommends a maximum lipid infusion of 0.25 g/kg/day. A 24-hour infusion at this dosage would be equivalent to the intake of 6 g/kg/day. The usual recommendation is to increase administration of lipids progressively up to a maximum 3 g/kg/day.

The maximum, tolerable serum triglyceride concentration should be below 150 mg/dl to 200 mg/dl. Clearing of the serum of administered lipids depends on lipase activity on the capillary endothelium and extrahepatic tissues, on hepatic lipase on the endothelium of hepatic capillaries, and on lecithin cholesterol acyltransferase. The lower the gestational age, the lower the activity of these enzymes; moreover, the activity of these enzymes is especially low in newborns with less than 26 weeks’ gestation. The activity also depends on the speed of lipid infusion. In this sense, maximum clearing is achieved if the infusion is carried out within 24 hours. The clearing of equivalent amounts of triglycerides is slower if infused using emulsions of 10 to 20%. Ten percent emulsions have not been used due to the effect of phospholipids, which are found in relatively higher amounts in the 10% emulsions.

The intake of high quantities of lipids is necessary to administer adequate amounts of energy for normal growth of the baby. Despite the fact that lipids are responsible for approximately 50% of non-protein energy in both human milk and formulas (both contain linoleic and linolenic acid), normal limitations of enteral nutrition cause these sources of essential fatty acids to be used scarcely.
Parenteral lipid emulsions can also deliver calories and essential fatty acids. However, the use of these emulsions in premature newborns is frequently delayed and limited due to complications of intolerance to lipids, either due to reduction in clearing (increase in serum triglyceride concentration) or in use (increase in serum free fatty acid concentration). Both situations are more common in premature patients and children with intrauterine growth retardation, in which cases there could be adverse effects.

The most common complications are difficulties with oxygenation, deterioration of lung function due to alteration in the ventilation/perfusion relation, increase in risk for pulmonary disease (especially bronchopulmonary dysplasia), damage to the immune function, and increase in serum concentration of free bilirubin.43

Many studies have examined the effects of lipid emulsions on the incidence and severity of respiratory morbidity. Some have not reported any effects, whereas others have shown damaging effects.44 A study with 11 premature children with respiratory difficulties showed an increase in pulmonary resistance with the increase in lipid infusion from 1.5 g to 3.0 g/kg/day.42 These data indicate that it is important to proceed with caution when administering lipids to children with pulmonary hypertension.

The effects of lipids on the immune function are also not well understood, since there is no evidence of deleterious effect in vivo (only cases in vitro were studied).43 The toxicity of bilirubin is attributed to the increase in non-esterified fatty acids in plasma. It is based on the potential that fatty acids have of displacing bilirubin from albumin and, thus, increasing free bilirubin in plasma. As a result, there is a risk for bilirubin encephalopathy. However, the displacement of bilirubin from albumin is minimal in relation to that of fatty acids/albumin (less than 4.1); in this case even greater proportions are highly possible. In addition, clinical studies have demonstrated that infusions of up to 3 g/kg/day do not increase plasmatic levels of free fatty acids and free bilirubin.44

The currently available lipid emulsions contain a large proportion of linoleic and linolenic acid. The lack of linoleic acid intake causes biochemical signs of deficiency to appear within 72 hours.45 However, deficiency can be avoided with the administration of amounts as low as 0.5 g/kg/day of parenteral emulsion. These solutions do not contain arachidonic (AA 20:4ω6) or docosahexanoic (DHA 22:6ω3) acid. This fact has raised concerns regarding adequate development of the central nervous system of these children. In this sense, plasmatic, liver, lung, and kidney levels of arachidonic and docosahexanoic acid drop during lipid infusion. Nonetheless, the short-term effects on cerebral lipids are very small.45 The long-term effects of low arachidonic and docosahexanoic acid intake on the development of the brain are still unknown. Further studies should be carried out, however, in order to evaluate these effects considering that these acids are very important for brain development and growth, especially during such an early stage in life.

It is important to remember that there are possible adverse effects with the use of parenteral lipid emulsions, which are secondary to inadequate fatty acid composition.46 Unfortunately there is no consensus on the most adequate composition of these emulsions. That is not a positive fact since the intake of fat is an important determinant of lipidic composition of the membrane, of a variety of functions associated to the membrane, to the metabolism of ecosanoids, and, possibly, to the development of the central nervous system. Other complications such as lipid peroxidation and formation of free radicals, attributed to the increase in incorporation of polyunsaturated fatty acids (arachidonic and linolenic acid, for example) into the lipids of tissues, can also occur and should be further evaluated.28

Minerals

Sodium requirements of premature newborns vary from 1 to 7 mEq/kg/day. This means that frequently the amount of sodium delivered in human milk or formulas is inadequate; in this sense, there have been reports of hyponatremia.47 The intake of 200 to 250 mg/kg/day of calcium and of 110 to 125 mg/kg/day of phosphorus allows for bone mineralization in premature newborns that appears to approximate the intrauterine bone mineralization rate.48 The rate of accumulation of magnesium in the fetus, during the last trimester of gestation, is of 3.5 mg/kg/day.49 Oral supplementation of iron at 2 mg/kg/day is recommended during the whole first year of life; this supplementation should start before the second month of life. Very low weight newborns will probably require higher doses of iron; clinical and laboratory follow-up of these patients should indicate the requirement of doses between 3 and 4 mg/kg/day. The administration of 90 micrograms of copper per 100 kcal of diet should suffice the requirements of preterm newborns.49 Avoiding the symptomatology of deficiency, which includes anemia, leukopenia, osteoporosis, reduction of skin and hair pigmentation, dermatitis, diarrhea, hepatosplenomegaly, anemia, hypotonia, and psychomotor retardation. Likewise, the administration of Zn, Se, Co, and Mn are also necessary, especially in the case of children with less than 32 weeks of life.50 The importance of I, Mn, Mo, Cr, F, and Co has also been recognized; the lack of these minerals, however, is not an important problem. In turn, Va, Bo, Ar, Si, Pb, and Ni can be important, but their requirements have not been established. The requirements of Zn are being studied and seem to be greater in premature than in term newborns; however, in both cases newborns fed their mother’s milk did not seem to require supplemental zinc.51 Administration of supplemental zinc to the mother during gestation apparently reduces the incidence of premature births.52
Suggestions for parenteral feeding of preterm newborns

As we have presented in this review, there are many unknown aspects related to the feeding of preterm newborns. Thus, not all feeding strategies are based exclusively on evidence, especially considering that many times there are none. This has resulted in a wide variability of strategies in the literature. The following scheme has presented positive results53:

1. Start infusion of fluids at 60 to 70 ml/kg/day on the first day; increase to approximately 15 to 20 ml/kg/day based on weight loss and increase in plasmatic sodium. The use of incubator at maximum humidity and of skin protection with a layer of fat reduces fluid requirements. Achieve maximum volume between 160 to 180 ml/kg/day. Avoid weight loss greater than 10% and significant alterations in plasmatic sodium.

2. Start amino acid administration on day 1 at 1 g/kg/day; increase progressively (from 0.5 to 1 g/kg/day) to a maximum 3 g/kg/day or 4 g/kg/day for preterms with less than 700 g.

3. Start endovenous lipid infusion on day 2 with 1 g/kg/day and increase progressively (0.5 to 1.0 g/kg/day) to a maximum 3 g/kg/day; check for normal triglyceride concentrations (less than 150 to 200 mg/dl).

4. Start with total calorie administration of 27 kcal/kg/day (6 g/kg/day of glucose and 1 g/kg/day of amino acids) controlled by levels of glycemia. Administer an increase of approximately 10 kcal/kg/day until a maximum 100 kcal/kg/day.

5. Start with volumes from 10 to 20 ml/kg/day of human milk on day 1 (preferably the mother’s milk) at every two to three hours, observing the child’s tolerance. Administer daily increases of approximately 20 ml/kg/day with concomitant reduction of parenteral infusion.

6. Administer Na and K when the plasmatic levels start to fall. Start calcium administration on the first day.

Enteral feeding

There are no precise information on the more appropriate time to administer milk for sick preterm newborns. Most authors suggest that the child should be in stable or predictable condition.54

Premature newborns with 34 weeks’ gestation or more generally present efficient suction reflex and good coordination of suction and swallowing. If there are no contraindications, oral feeding should start right after delivery. The child can be breastfed and in the case of any impediment human milk can be administered using a cup or tube. Feeding should be started with volumes of less than 24 to 30 ml/kg/day and increased at this same proportion; fast increase in volumes can increase the risk for enterocolitis. At our services we usually administer 20 ml/kg/day, always according to the tolerance of the baby, until the volume of 140 to 160 ml/kg/day is reached.

Most preterm newborns with less than 34 weeks’ gestation - due to their limitations of synchronizing suction, swallowing, and respiration - are fed through a nasogastric or orogastric tube. The nasogastric tube is easier to fixate, but it obstructs one nostril. The orogastric tube, in turn, is more difficult to maintain, but it does not obstruct the airways. We use the orogastric tube during the first days of treatment and switch to the nasogastric tube as soon as respiratory stability is attained. Others have reported no differences in results of continuous or bolus infusion.55 In case of any problems with one of these types of feeding, other options should be considered. The introduction of milk in the presence of arterial or venous catheter did not increase the incidence of necrotizing enterocolitis.54 During the infusion of milk, nonnutritive sucking was associated with shorter hospital stay.56

Enteral feeding of milk can be given even to smaller babies. In very small babies, parenteral feeding, which should start right at birth, is gradually replaced by enteral feeding. Even if the newborn does not tolerate intake of significant volumes of milk, the administration of milk should be maintained at a dosage between 10 to 20 ml/kg/day in order to take advantage of the trophic effects of minimum intake of milk. Among the advantages described for minimum enteral feeding there are enhanced gut motility, improved feeding tolerance, reduction of the incidence of sepsis, and induction of lactase activity.19 These advantages are not fully confirmed considering the metaanalysis of the available literature.57

As to what concerns milk, the current literature is almost unanimous in that the mother’s milk is the ideal feeding for preterm newborns.58 The literature of the past decade has presented a great amount of information regarding studies that follow up the long-term impact of human milk on intellectual acquisition and development of vision according to feeding method.59

The advantages of the use of human milk go beyond those of its nutritional constituents. The protection against gastrointestinal infections is very well documented. The protection against infections of the lower and upper respiratory tract and of the urinary tract is also impressive, and only recently it was well-documented.60 Epidemiological studies comparing children who were naturally breastfed with those who were artificially fed indicate an important reduction of the need for medical appointments, for use of antibiotics, and for hospitalization due to infectious diseases in breastfed children. This allowed for an important reduction of healthcare costs.61 In addition to the nutritional benefits and to the reduction on the incidence of infectious, immunologic, and chronic diseases, as well as of allergies and to the improvement in cognitive performance, there are also the benefits to the mother, which should not be undermined. These benefits include reduction of risk for ovarian cancer and for premenopausal breast cancer.63 Women also return to their prepregnancy status a lot more rapidly. Both the incidence of obesity and
osteoporosis are reduced. Lactation also stimulates calcium absorption and the production of calcitriol and parathyroid hormone.59

Another interesting point is the fact that policies of use of human milk in the feeding of premature newborns have brought mothers into the neonatal units. Mothers began to be stimulated to participate actively in the feeding of their babies, even when they were not being breastfed. This involvement of the mother can be a positive stimulation for lactation, which is extremely difficult in this type of population.64

During the follow-up of preterm babies, it is possible to observe that they are subject to early weaning. This type of patient presents many difficulties in relation to breastfeeding by the mother. Some of these difficulties are related to the prematurity itself and others to maintaining lactation and maternal care. Frequently, there is a long period of separation between the mother and the child, which can affect the mother’s ability to breastfeed.65 In Brazil, it was reported that 58.3% of the population of children born with less than 1,500 g were not breastfed and that the prevalence of breastfeeding was less than 20% in the third month of life.64 Thus, techniques aimed at promoting breastfeeding from the beginning of hospitalization of the baby are important, especially considering that the mother of a premature newborn is faced with limitations related to the condition in which the child was born.

Usually, breastfeeding is appropriate for premature babies with more than 1,500 g; whereas for smaller premature the density of proteins, sodium, calcium, and phosphorus is low. For smaller babies, the milk should be supplemented according to the higher requirements of the newborn. The calcium and phosphorus in human milk represent only 25% of the requirements for adequate bone growth of preterm patients. Consequently, it is necessary to add greater amounts of these minerals. The matter, however, is still defining the amount that should be added.66 Many currently available supplements have different compositions and all are composed of various nutrients.67,68 The ideal composition of these preparations is still to be defined. The literature already presents enough evidence showing the short-term benefits of these supplements. Usually, the supplement is added to human milk when the intake is of at least 100 ml/kg/day.

With the presence of mothers in neonatal units and with the stimulation of breastfeeding to preterm babies, it has been possible to look for ways of bringing mother and child closer together. One of the possibilities is of stimulating skin-to-skin holding and using the technique of the marsupial mother.

This method was developed in order to keep premature babies warm in neonatal units that did not have the appropriate equipment.69 The skin-to-skin contact between mother and baby showed improvement on development, growth, and well-being of the children. More recently, others have shown that skin-to-skin holding increases the maternal milk volume and duration of breastfeeding.70 A randomized comparison was carried out with infants clothed in diaper and held upright between mothers’ breasts; both mother and infant were covered with a blanket and with infants who were clothed, wrapped in blankets, and held cradled in mother’s arms. The skin-to-skin group presented better oxygenation during breastfeeding and longer duration of breastfeeding.71

Different authors have evaluated the effects of different ways of administering milk to newborns. Breastfed newborns presented different physiological profiles in relation to bottle-fed newborns. When breastfed, babies presented lower cardiac frequency, greater variability of the cardiac period, and elevated vagal tonus with more stable oxygenation patterns. These findings can be explained by the fact that newborns can better control the flow of milk when they are being breastfed in comparison to being bottle-fed. The release of a greater flow of milk by the bottle can cause a significant reduction in the ventilation per minute. Also, preterms use two different mechanisms to protect their airways when being fed; they alternate vigorous sucking with respiratory pauses and respiratory periods while stopping the flow of milk.72 Children present difficulties with this technique when using the bottle.

The use of a cup as a safe, artificial method of feeding preterm, low birth weight children has been described in the literature. It is recommended by the WHO for use with sick, low birth weight babies among other things indicated by the Iniciativa Hospital Amigo da Criança.73 In a recent study carried out in Brazil, the use of the cup did not result in evident benefits as compared to bottle-feeding in relation to increasing the incidence of breastfeeding.74 In children with pulmonary problems, monitoring pulse oxymetry during the breastfeeding act can help minimize episodes of hypoxia.74

There is still a lot to be said on the safety and efficacy of nutrients administered to premature babies, on the techniques for evaluation of different feeding strategies, and on the long-term effects of these regimens on development, growth, and onset of diseases.

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