

## CURRENT TRENDS IN FEEDING AND CARING FOR PREMATURE AND LOW BIRTH WEIGHT INFANTS

Laura Florescu, Oana Temneanu, Dana Mindru  
*„Gr. T. Popa“ University of Medicine and Pharmacy, Iasi*

### ABSTRACT

Low weight at birth is an important indicator of infant health due to the tight relationship between birth weight and infant mortality and morbidity. The diminishing of the mortality and morbidity rate requires information on the growth characteristics and caring requirements for this category of children. Regardless of the category they are in – prematures, Small for Gestational Age, delay in intrauterine growth – these children, due to their low weight at birth present a high risk to develop malnutrition, a reason why there should be known the energy requirements and the optimum nutrition principles, specific to them. Ensuring an early most favourable diet is the essential element in their care assistance.

**Keywords:** low birth weight, premature, small for gestational age, delay in intrauterine growth, malnutrition

We define an infant with low birth weight (Wb) any child smaller than 2,500 g. These children form a heterogenous group of new-born infants: premature infants, born on term but with smaller Wb for the gestational age (Small for Gestational Age-SGA), both premature as well as low Wb for the gestational age. The premature infant is the newborn with the gestational age (GA) smaller than 37 weeks, Wb smaller than 2,500 g and the birth height (Hb) under 47 cm. The newborn with intrauterine growth retardation (IUGR) is the infant with Wb under 10 percentile on the standards of intrauterine growth or smaller than 2 standard deviations (SD) than the corresponding weight.

It is estimated that approximately 15 million infants are born under the normal gestational age every year. This means more than one in 10 children. Approximately 1 million children die every year due to premature birth complications. Many survivors face a real life handicap, including learning disabilities and visual and hearing problems.(1)

In almost all the countries with fiable data, the premature birth rate is growing. Worldwide, premature birth is the main cause of death in new born and a second cause of death after pneumonia in

children under 5. The inequalities as regards the survival rate in these children differ from one country to another; in the underdeveloped countries, half of the new born infants with gestational age under 32 weeks die because of the improper care conditions and nutrition. More than three thirds of the premature children can be saved, maintaining the balance between costs and efficient care, for example antenatal steroids (administered to pregnant women presenting risks of premature birth, aiming to help lung development), using the "kangaroo mother care" method (the baby is carried by the mother close to her skin and the baby is breastfed frequently) and administering antibiotics to treat neonatal infections – even without the possibility to benefit from intensive neonatal care.(1)

Low birth weight is an important indicator for the infantile health due to the close relationship between birth weight and infant mortality. There are two categories of small birth weight: those who are born as consequence of reduced fetal growth and those who are born before the term. (2) New-borns (n.b) with small Wb present a higher risk to have a precarious health or to die, they need a longer hospitalization period after birth and are more suscep-

Corresponding author:

Oana Temneanu, „Gr. T. Popa“ University of Medicine and Pharmacy, 16 Universitatii Street, Iasi  
E-mail: ralucatemneanu@yahoo.com

tible to develop significant disabilities.(3) Depending on the gestational age and the birth weight there are three prematurity degrees (Table 1).

**TABLE 1.** Degrees of prematurity – International Classification of Diseases (ICD)

	Gestational age	Birth weight
<b>LBW</b> (low birth weight)	GA < 37 weeks	2,499 g – 1,500 g
<b>VLBW</b> (very low birth weight)	GA < 32 weeks	1,499 g – 1,000 g
<b>ELBW</b> (extremely low birth weight)	GA < 28 weeks	< 1,000 g

The causes for premature birth are numerous: most of them are spontaneous, but some can be due to pre-term birth, spontaneous birth or cesarian section. Prematurity is influenced by several social and economical factors such as unchecked pregnancy, low level of education of the mother, low income and precarious life conditions, drug addiction, smoking and alcohol consumption. To all these we add the maternal pathology, respectively conditions prior to the pregnancy (system diseases, TB infections, heart defects); diseases during the pregnancy (arterial hypertension, diabetes, pneumonia, urinary tract infections and vagina infections); diseases of the female genital apparatus (fibroma, uterus abnormalities); twin pregnancy (frequently met after in vitro fertilization); short period between pregnancies and lack of adequate sexual hygiene; in spite of all these, sometimes no clear cause is identified. There is also a genetic influence.(4) Women, especially teenagers should be included in family planning programs, and also be monitored before and during the pregnancy. A better understanding of the causes and mechanisms will trigger advances in finding solutions to prevent premature birth.

More than 60% of births are in Africa and South Asia, but premature birth is really a global issue. In the countries with lower incomes, in average, 12% of the babies are born too early, in comparison to 9% in the countries with bigger incomes. In all the countries, poor families present a higher risk. "These babies are born too early, but they do not come to this world to die", says Dr. Joy Lawn, MD of Save the Children International.(5) According to the data provided by "Save the Children" Romania, approximately 20,000 children are prematurely born in Romania. The figure is based on the statistics made by the Romanian Association of Neonatology and it is different from that of the National Institute of Statistics.

According to a statement made by "Save the Children", even though the infant mortality rate in

Romania has dropped significantly during 1990-2010, in percentage as well as in numbers, 8,471 deaths in 1990, 2,250 in 2009 respectively 2,078 in 2010 (the figures show that the level in 2010 is more than two thirds lower than in 1990), Romania remains on top in the European Union, with an infant mortality rate of 9,8 in 1,000 babies born alive in 2010, according to the National Institute of Statistics. (6)

In 2011, the infant mortality rate registered in Romania (according to the National Institute of Statistics) was again the highest in Europe, meaning 9,4 in 1,000 babies born alive, the main cause being premature birth. One third of these deaths can be prevented by supporting programs for pregnant women and babies, as well as improving the quality of care assistance for the patients with imminent pre-term birth and equipping the hospitals and maternity departments. In Romania, more than 20,000 children are born premature and with low birth weight, prematurity being one of the main causes of neonatal mortality on national level. The official data of the National Institute of Statistics show that in 2009, out of the 222,388 new born infants, 17,383 had less than 2,500 grams and 10,635 children had a gestational age smaller than 36 weeks. (7)

A study made by Save the Children Romania, part of the program "Every Child Matters" undertaken during 2010-2015, on a sample of 200 respondents from the counties of Iași, Vaslui, Botoșani, Neamț, Suceava, 37% of the mothers state they did not go to any gynecological check during the pregnancy and approximately 36% of the mothers gave birth to the first born before the age of 18. The average age of the mother at birth is 18, significantly lower than the average of the total population. (8)

Diminishing the mortality and morbidity rate requires knowledge on the growing demands and care-assistance characteristics for this category of children and they start even from the birth ward:

- Take measures against breathing deficiency: lateral decubitus positioning; unblocking the oropharynx, then the nose using a rubber tube; vacuum the gastric contents in intestinal stasis to ease the movements of the diaphragm; supply heated humidified discontinuous flow of oxygen, 2 – 4 l/min, using the cephalic technique, nose cannula, CPAP (Continuous Positive Airway Pressure), tracheal intubation;
- Take measures against the thermoregulation deficit: 26°C temperature in the birth ward;

taking the newborn in sterile napkins, on a table with radiating heat, 26-28°C temperature in wards; premature infants with Wb < 1,800 g will stay in neonatal incubators: for Wb = 1.000 g → t = 34°C; for each 250 g more, the temperature decreases by 1°C; for each 250 g less, it increases by 1°C.

- Take measures against acidosis: oxygen + glucose serum 5% + serum bicarbonate for the mother in labour and then to the premature newborn, during the first days, depending on the Astrup parameter values.
- Take measures against intracranial hemorrhage risks: soft manoeuvres, avoiding the Trendelenburg position (the risk to intracranial hemorrhage increases); administer capillarotrophic agents (C and E vitamine); administer vitamine K during the first days (Phytomenadione).
- Prevent infections: small wards with their own reduced circuit; strictly forbidden access for people outside the family; limit the contact between the sick newborn babies and the healthy ones; continuous and current decontamination of the wards, beds, incubators; the humidifier liquid and oxygenator will be changed daily; prevent the contamination of the air in the wards; the medical staff will be periodically checked; the hands will be washed before each contact with the newborn; the cloths, dishes and instruments will be sterilized before each use; there will be taken all the measures to prevent the contamination of the milk.(9)

Criteria to leave the hospital for the newborn:

- he receives the full nutrition ratio (breastfed or bottle);
- he presents a constant growth and has reached 2,500 g;
- His temperature is stable outside the incubator;
- Has not suffered from recent apnea or bradycardia.

Regardless of the category they belong to – prematures, SGA, IUGR – these infants, due to small Wb have a risk to malnutrition. In order to properly assess their development there should be used graphs/growth curves typical to the age (age in weeks, since their birthday, out of which the number of weeks the newborn was prematurely born is taken out). High incidence of malnutrition in these children requires information on the energy and nutritional maximum needs, in their particular case. Ensuring an optimum nutritional intake is the key element in their care.

The digestive system should adapt in the short postnatal period so as to meet the nutritional and metabolic needs of the extrauterine life. In intra-uterine life, the intestine is somehow adapted to this function by the daily passage of amniotic liquid which contains immunoglobulins, enzymes, growth agents, hormones, absorbing a certain quantity of proteins through the digestive mucous membrane. The gastrointestinal tract is completely developed in 20 weeks of gestation; part of the gastrointestinal functions begin to take effect after birth, regardless of the gestation age (for example, gastrointestinal permeability), while others seem to be programmed to function starting from post-conceptional ages (such as the suckling – deglutition coordination which appears between 33 and 36 weeks). Even if the premature baby presents anatomical and functional immaturity of the digestive tract which might require parental nutrition in the first stage, it is recommended to start early and increase gradually the enteral nutrition by special techniques so as to ensure the calory intake and the metabolic and hydroelectrolytic equilibrium of this category of vulnerable infants.(10)

The “composition” of the premature body grown in extrauterine environment should be similar to that of the baby grown in utero. On term, the body of the newborn contains 75% water (40% extracellular and 35% intracellular) and he loses 5-10% of the Wb in the first week of life; at 23 weeks GA, the body of the premature contains 90% water, (60% extracellular), he might lose 10-15% of the Wb in the first week of life. SGA premature babies have more water in their body composition than the AGA premature infants, 90% versus 84%, in the period 25-30 weeks GA.(11)

A premature infant has increased metabolic needs (Table 2), inadequate nutritional reserves, organic and functional immaturity, associated multiple pathology, all these having negative effects on the proteic, energetic, mineral and vitamin needs, as well as on the capacity to absorb and digest them.(12)

**TABLE 2.** Energy needs and the principle of maximum nutrients for low Wb (13):

Energy needs	110-135 kcal/kg/day	
proteins	4-4,5 g/kg/day (G < 1,000 g) 3,5-4 g/kg/day (G = 1,000-1,800 g)	
lipids	4,8-6,6 g/kg/day	linoleic acid 350-1,400 mg/100 kcal
		linolenic acid 50 mg/100 kcal
		medium – chain triglycerides – up to 40% of the total quantity of lipids
carbohydrates	11,6-13,2 g/kg/day	

It is initially recommended to ensure the necessary of energy and proteins by parenteral nutrition to which we can add from the first 24 hours of life the enteral one (trophic feeding) if the clinical condition allows it. Total parenteral nutrition means supplying the necessary nutrients for the metabolic processes and growth through a catheter in the vein, aiming to provide the necessary energetic requirements and prevent catabolism and also reach a positive nitrogen balance.

#### Proteins:

- from the first 12-24 hours of life, to avoid catabolism
- minimum 1,2 g proteins/kg/day, according to the losses
- maximum 4 g proteins/kg/day to ensure a decreasing rhythm similar to the intrauterine one
- minimum intake of 30 kcal/kg/day to maintain proteic homeostasis.

#### Lipids:

- parenteral administration since the first 24 hours of life to provide the essential fat acids
- it is temporized in case infections are associated and/or hyperbilirubinemia
- minimum intake of 0,5 g/kg/day
- depending on tolerance: 1-4 g/kg/day (2,5 g/kg/day)
- lipids emulsions of 20%, administered slowly.

#### Carbohydrates:

- the minimum intake of glucose should supply the metabolic basic needs and the energy required for proteic synthesis
- a rhythm of 9 mg/kg/min is the minimum requirement of glucose for the energy needed by the brain and the proteic synthesis. (14,15)

Prolonged parenteral nutrition increases the risk of colestasis and hypertriglyceridemia. (16) That is why it is necessary to assess periodically the hepatic function and the triglycerides. All the solutions of parenteral neonatal nutrition include trace elements (Zn, Cu, Mn, Cr, Se), but actually there is suggested an additional quantity of Mo and Co, especially in the children who receive longer parenteral nutrition.(17) Parenteral nutrition is more expensive, it requires technical skills, it has side effects, it also requires specially trained staff to set up and maintain the venous lines, there is needed special equipment in the neonatology department (such as luminal medical beam to prepare solutions, radiologic scan unit to check the position of the catheters, perfusion pumps, laboratory). (18)

It is recommended to start the enteral nutrition as soon as possible after birth (24-48 hours of life),

in order to prevent intestinal atrophy – "trophic" nutrition (2,5-20 ml/kg/day, with an average of 10 ml/kg/day). This quantity will be increased gradually, since the 8<sup>th</sup> day -11<sup>th</sup> day of life (depending on the digestive tolerance) by 10-20 ml/kg/day, up to the complete oral ratio (135-200 ml/kg/day).(13,19)

Among the advantages of the enteral nutrition we count the physiological stimulation and maintaining the intestinal mucous membrane, increase the width of the intestinal mucous membrane and stimulate the development of intestinal villi, decrease permeability of the mucous membrane to foreign antigens, increase the quantity of peptides and intestinal hormones, decrease complications due to parenteral feeding, reduced cost. Early enteral feeding allowed the reduction of the necessary days to reach complete nutrition, the signs of digestive intolerance, hospitalisation period, osteopenia in the premature infants, the risk of cholestasis associated to parenteral nutrition.(20)

The balanced intake of maximum nutrients is highly important in early enteral feeding. The studies have shown the existence of a correlation between the increased intake of carbohydrates during the neonatal period, increased weight gain and decreased tolerance to glucose in children with Wb < 1,000 g. Hence, this category of infants presents an increased risk of metabolic syndrome. (21)

Enteral feeding uses human milk enriched with fortifiers for Wb < 1,500 g, and in the case of an inadequate milk secretion/contraindications for breastfeeding, there will be used special milk formulas for premature infants. The ideal food for enteral feeding is human milk. There are numerous advantages for feeding premature infants with human milk and they are widely known: antropometric growth and proper development, (22) optimal absorption of nutrients (especially fats, zinc and iron), decreased osmolarity, proper adjustment of the thermal, glycemic equilibrium saturation of the hemoglobin in the oxygen and partial pressure of oxygen, less variation in the heart and breathing frequency and less episodes of apnea and bradycardia, it stimulates the increase and postnatal intestinal differentiation due to the presence of several growth factors (EGF – Epidermal Growth Factor, NGF – *nerve growth factor*, TGF- $\alpha$  – transforming growth factor  $\alpha$  and TGF- $\beta$  – transforming growth factor  $\beta$ , insulin, relaxin, insulin-like GF – insulin-like growth factor), protection against oxidative stress by increased content of superoxide dismutase and glutathione-peroxidase and by the optimal quantity of vitamins, A and E, with role of antioxidants, (23,24) protection against infections (25)



and ulcero-necrotic enterocolitis (UNE) due to increased quantity of secretory IgA, (26) lower incidence of acute diarrhea induced by Rotavirus, *E. coli*, *Shigella*, *Salmonella*, *C. difficile*, *G. lamblia*, *Campylobacter*; (27) lower incidence of urinary infections and meningitis, protection of premature infants with family history of atopy against allergies, low incidence of retinopathy of prematurity (ROP) (28) and improved sight at 2-6 months corrected age, superior neurologic development, more important as the period of breastfeeding is longer, the risk to heart diseases in adolescence and maturity is lower, the risk to diabetes type 2 is also lowered and the number of hospitalizations is smaller. (29)

- Digestion and absorption of maximum nutrients:
- Digestion and absorption of milk proteins is the same as that of newborns.
- Digestion and absorption of milk lipids is efficient due to the lipases present in this milk.

Digestion and absorption of carbohydrates is satisfactory. The premature baby can use lactose from the human milk, although it presents a transitional deficit of lactase during the first week of life.

In case the human milk is not produced (agalactia/hypogalactia/associated maternal pathology), natural feeding should be administered if there are specialized milk banks to collect and dispense this milk. (30,31,32,33,34)

Human milk can be collected and administered immediately, it can be kept in the fridge at 4°C for 48 hours, or it can be kept frozen at -20°C for 3 months. Freezing the human milk leads to the loss of 40% of the quantity of Vitamin C, 40% of the quantity of lysozyme, 30% of the quantity of lactoferrin, 40% of the quantity of secretory IgA decrease by 25% the lipase activity. It is recommended that the doctor indicates freezing the human milk, not boiling or pasteurize it. During the thermal treatment of the milk, there are more nutrients than by freezing it. Pasteurization leads to the reduction of IgA and lysozyme percentage, nitrogen retention, lipids absorption and lipase destruction, decrease in the concentration of water-soluble vitamins and anti-infection factors. (10)

“Premature“ milk contains more proteins, calcium and phosphor than “mature“ milk, but it does not cover the necessary of calories, proteins, vitamins and minerals in these children, a reason why it is recommended to increase the quantity of fortifiers. (35)

They will be used for the children with GA < 34 weeks those with Wb < 1,500 g, the moment when

the oral ratio is complete until the baby reaches 2,000 g. By fortifying human milk we obtain: improvement of weight gain, improvement of protein status, the seric values of calcium, phosphor, alkaline phosphatase are brought to normal, bone minerals are increased.

The potential disadvantages in the use of fortifiers could be the increase of osmolarity, a reason why it is not recommended for the children suspicious of UNE, the risk of bacterial contamination. (36)

The special milk formulas for premature and low weight babies are the best substitute for human milk; they are used until the baby reaches 2,500 g, they have a bigger intake of calories (80 kcal/100 ml) and an increased quantity of proteins (2,25-3,10 g/100 kcal), whey predominant (the whey/casein ratio is 70/30), they have an increased absorption rate. The quantity of lactose is lower than that in the standard formulas, according to the diminished activity of lactase in these infants. The lipids are represented by a mixture of medium-chain triglycerides and vegetable oils, rich in long chain polyunsaturated fatty acids – LC-PUFA. The vitamins, oligoelements and minerals are needed in a greater quantity to cover the increased needs of these children. (37)

When the babies weigh 2,500 g, there are recommended the transitional formulas, Nutrient-enriched post-discharge formulas – NEPDF); (38) they contain a greater quantity of proteins, calcium, phosphor, vitamins and minerals in comparison to the standard formulas, they have a greater caloric value (70 kcal/100 ml vs 68 kcal/100 ml), they contribute to an improved growing rhythm and bone mineralization in comparison to the standard formulas. If Wb = 1,000-2,000 g, there will be used transitional formulas up to 9 months of corrected age, later the standard formulas will be used, should increased values of calcium and phosphor be noticed or excessive weight gain; when Wb > 2,000 g there are recommended the standard formulas enriched with iron, up to 1 year of corrected age.

Regardless of the type of feeding (natural or artificial), in the context of an accelerated postnatal growth during the first year of life (catch-up growth) it is necessary to supplement the diet with vitamins until the catch-up growth is reached and the child receives an equilibrated diet, including solid food. Vitamin D: 800-1,000 UI/day, during the first months, considering the increased recurrence of pregnant women lacking vitamins. (39, 40)

In order to ensure a proper bone mineralization and supply an adequate intake of calcium (120-140

mg/kg/day) and phosphor (60-90 mg/kg/day), it is recommended to increase the dosage of vitamin A, 700-1500 UI/kg/day until the baby weighs 2,000 g (there are practically used multivitamin solutions). Vitamin K is administered in intramuscular injection, at birth, in a dosage of 1mg for the infants of  $Wb \geq 1,000$  g and 0,3 mg/kg for those with  $Wb < 1,000$  g. (41)

The prophylactic administration of iron supplements as oral solutions (ferrous fumarate or ferrous gluconate), 2-3 mg/kg/day, starting with the age of 2-6 weeks (LBW and VLBW) and 2-4 weeks (ELBW), at least up to the age of 6-12 months.(42, 43) The dosage of iron will not be bigger than 5 mg/kg/day due to the risk of premature retinopathy. Iron will be administered carefully to those who have been through numerous transfusions.

Premature infants who receive parenteral feeding with high content of folic acid do not risk any deficit of folic acid during the first two months; the premature infants with enteral feeding since their birth with human milk (with or without fortifiers) or formulas for premature infants with low content of folic acid might have an increased risk of deficit of folic acid, especially when the mothers smoke and/or do not benefit from folic acid supplements during the pregnancy. (44)

The studies undertaken so far have highlighted the benefits of improving the standard formulas with symbiotics (pre and probiotics). The formulas enriched with probiotics (bifidobacteria, lactobacillus) have a significant effect in preventing acute and infectious community diarrhea, especially rotavirus diarrhea and significantly reduce the duration of the condition. (45,46,47)

Also, the formulas enriched with probiotics have proven the modulation of the immune reaction and reduced incidence of allergies in prema-

ture babies predisposed to atopia, the decrease being significant from the statistical point of view as regards the incidence of atopic dermatitis.(48)

Feeding methods:

- continuous gavage feeding or intermittent (GA < 34 weeks)
- using a bottle/spoon/breastfeeding (GA > 34 weeks), as at this age there is a good coordination between the deglutition, suckling and breathing mechanisms.

Continuous gavage feeding means using a tube to administer the whole quantity of milk for 24 hours, distributed in 4-8 syringes; it is used for ELBW newborn infants (limited gastric volume). It is indicated in case the intermittent gavage feeding is not tolerated, or in case of severe respiratory distress, gastroesophageal reflux, persistent gastric residuum.

Intermittent gavage feeding means 8-10 meals in a day, depending on the weight, GA, the clinical condition; the milk can be administered in free flow (the recommended method) or using a piston. (49,50)

The aim of correct and proper nutrition of the premature infant is to ensure an optimum development, from the weight-height as well as neurological point of view. There is no universal recipe for feeding the premature infant, it all depends on the GA, Wb and pathology. Regardless of the type, method and rhythm of feeding, there should be ensured a similar rhythm to that of a normal last term of pregnancy.

In conclusion, we consider it is necessary to continue studying the nutritional needs of the infant with low birth weight, considering the impact in the long run of the feeding errors made during the first months of life.

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