



practice

Cow & Gate's practical support
for Healthcare Professionals

Module 4 Preterm nutrition



In Practice Nutritional Learning Modules

...because **healthy babies are happy babies**



Preterm nutrition distance learning pack

Did you know? Around 7% of babies are born preterm in England and Wales (NHS)¹

Key definitions

Preterm babies are classed as those born before 37 weeks gestation. Most mortality and morbidity affects "very preterm" infants (born before 32 weeks) and especially "extremely preterm" infants (born before 28 weeks).

Infants may also be defined by birth weight²:

- Low birth weight (LBW) $\leq 2500\text{g}$
- Very low birth weight (VLBW) $\leq 1500\text{g}$
- Extremely low birth weight (ELBW) $\leq 1000\text{g}$

Improvements in neonatal care over the past few decades mean that a greater number of preterm infants are surviving in the UK; this is particularly the case for extremely low birth weight infants³.

Around 7% of babies are born preterm in England and Wales, which equates to about 41,000 births¹. The UK currently has one of the highest rates of low birth weight babies in Western Europe – 5% of which are low birth weight, and 1% extremely low birth weight.

Age definitions

There is often confusion when it comes to defining the age of preterm infants consistently to assess growth and development. Consequently, the American Academy of Pediatrics, AAP issued a policy statement recommending standard terminology as follows⁴ (figure 1):

- Gestational age – time elapsed between the first day of the last menstrual period and the day of delivery (units = completed weeks).
- Chronological age – time elapsed since birth (days, weeks, months, years)
- Postmenstrual age – gestational age + chronological age (weeks)
- Corrected age – chronological age reduced by the number of weeks born before 40 weeks of gestation (weeks, months)

This is illustrated in figure 1 below.

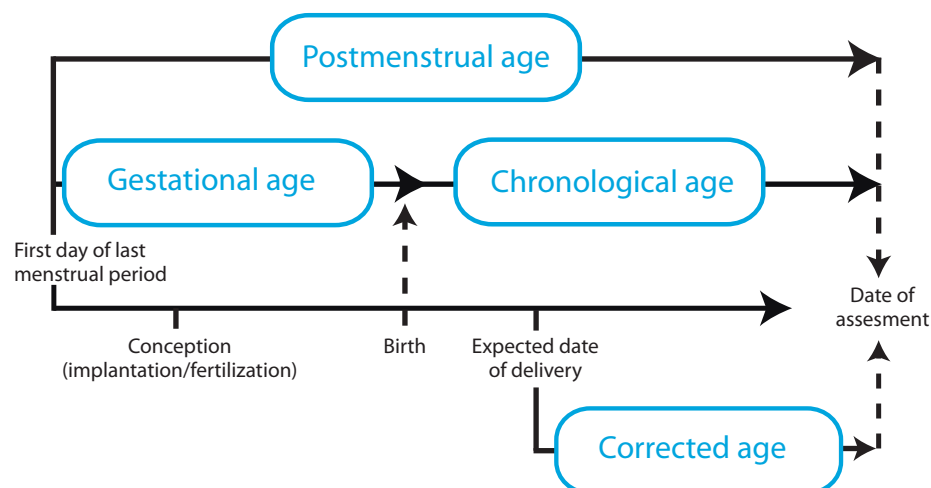


Figure 1 – Age terminology during perinatal period¹⁴



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Causes of prematurity

There are many reasons why a baby may be born preterm, including:

- High maternal blood pressure and pre-eclampsia
- Acute infections, stress or anxiety and other psychological factors
- Hard physical work
- Multiple births



Immature physiology

A preterm baby will have an immature physiology that is not yet adapted for extra-uterine survival, which often requires specialised nutrition from birth⁵. For example, their immature organ systems can result in some or all of the following problems:

- Inability to adjust to environmental temperatures, causing rapid overheating or heat loss. For this reason preterm infants are placed in incubators and often given hats to prevent heat loss
- Immature respiratory function – major cause of infant mortality and morbidity, ELBW infants often require a ventilator
- Greater susceptibility to infection compared to a full term infant
- Inadequate liver function may give rise to jaundice
- Poor kidney function, easily disturbed acid-base balance and increased risk of fluid retention
- Immaturity of gastrointestinal tract:
 - Impaired sucking, swallowing (<34 weeks) – may have frequent regurgitation and often fed via gastric tube
 - Immature peristalsis, low gastric volume – affects tolerance and volume of feed
 - Reduced enzyme activity – impaired digestion/absorption of nutrients
- Thus, full enteral nutrition is not always possible from birth and parenteral nutrition may be needed in the first few days or weeks of life



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As a consequence of their immaturity, preterm infants may suffer from a variety of nutrition related problems. The developing fetus undergoes a very rapid accumulation of nutrients during the last trimester of pregnancy. Therefore, a preterm infant will miss out on much of this crucial process. Table 1 shows the difference in the body stores of an infant born at 28 weeks gestation compared to a full term infant born at 37-40 weeks gestation.

Gestational Age (weeks)	28	37-40
Body weight (g)	1000	3500
Fat (g)	10	530
Protein (g)	85	390
Water (g/kg body weight)	850	686
Sodium (mg)	4.1	12.4
Iron (mg)	65	229
Calcium (g)	6.3	33.6

Table 1 – Differences in body stores by gestational age

What are the nutritional implications?

Considerations	Implications
High growth rates	Increased requirements for energy, protein, vitamins and minerals for new tissue growth
Low body reserves	Increased requirements for energy, protein, fatty acids (including LCs), nucleotides, vitamins and minerals
Immature physiology e.g. <ul style="list-style-type: none"> • Digestive enzymes • Gastro-intestinal tract 	Nutrients must be available in an easily absorbed form

Complications

Due to their immaturity preterm infants are at increased risk of:

- Bronchopulmonary dysplasia (Chronic lung disease)
- Respiratory distress syndrome
- Hypoglycaemia
- Hypothermia
- Hyperbilirubinaemia (jaundice)
- Infections
- Necrotising enterocolitis

Necrotising Enterocolitis (NEC)

NEC is an inflammatory condition of the gastro-intestinal tract with an incidence of around 5 to 10% in LBW infants and a mortality rate of over 20%⁶. The lower the gestational age and birthweight, the greater the incidence. Survival rates are improving with increasing availability of specialist baby units and medical advances.

The pathophysiology of NEC is poorly understood and there are a variety of factors that are thought to be involved, such as inadequate oxygen supply to gut, immature gut function, immune defences and circulatory regulation, and abnormal bacterial colonisation.⁷

Symptoms: feeding intolerance, abdominal distension, delayed gastric emptying, leading to discontinuation of breathing, collapse and shock

Treatment: bowel rest (TPN), bowel decompression, antibiotics and, if necessary, surgical intervention.

Prevention: feeding the mother's breastmilk and conservative feeding are thought to reduce the risk of NEC, but there is debate over whether donor milk has the same protective effect⁷. Trophic feeds may be useful as they encourage gut maturation and appear to result in improved growth, feeding tolerance and reduced sepsis and period of hospitalisation⁷. Prebiotic oligosaccharides and probiotics are also being investigated as potential strategies, as they encourage the colonisation of beneficial gut flora⁷⁻¹⁰.



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Nutritional needs of preterm infants

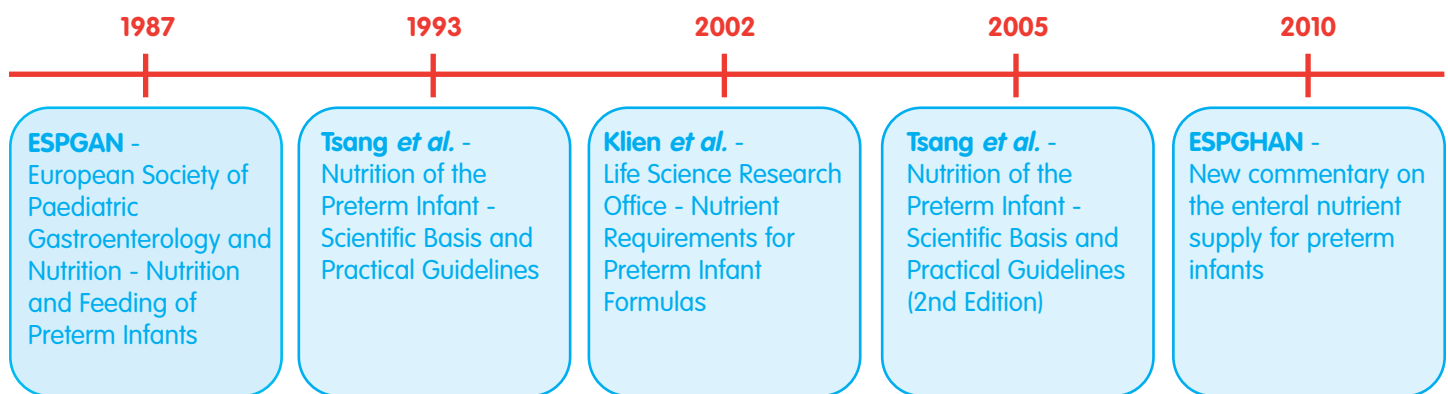
Preterm nutritional management aims

The aim of the nutritional management of preterm infants in hospital is to attempt to mimic the growth rate that would have occurred in the last trimester in utero, had the baby not been born prematurely. The AAP conclude that "levels of provided nutrients and energy should permit growth levels similar to intrauterine growth rates"⁴.

E.g. 28 weeks 1000g → 40 weeks 3500g

Longer term, the aim is to allow the maximum attainment of their potential growth and development. Although many preterm infants go on to lead normal lives they often remain growth restricted in comparison to their term peers¹¹⁻¹³. Research has shown that those who fail to achieve their growth potential during the first few weeks after birth have less favourable outcomes, particularly with respect to neurodevelopment¹⁴⁻¹⁶.

Preterm nutritional guidelines



There are three current key sets of recommendations on the nutrition of preterm infants and there is much overlap in their conclusions:

- Klein *et al* 2002¹⁷ – a report prepared for the US Food and Drug Administration (FDA) by the Life Sciences Research Office (LRSO)
- Tsang *et al* 2005⁵ – a book written and edited by experts in the field of preterm nutrition, often referred to as the Tsang Guidelines
- Agostoni *et al* 2010¹⁸ – ESPGHAN have just released new guidelines on preterm nutrition which are consistent with, but not identical to, Tsang and Klein

N.B. these are all guidelines and not legislation.

Did you know?

In comparison to a term infant that doubles in birth weight in 5 months, a preterm infant achieves this in just 1-2 months¹⁸

Key nutrients requirements

1. Energy: Preterm infants have high requirements for energy as they have a high growth rate with a target weight gain of 16-20g/kg/day. Increased requirements are also due to:

- a high basal metabolic rate
- poor temperature regulation and a large surface area in comparison to their size
- increased likelihood of suffering from disease and other stressors
- lowered absorptive capacity because of an immature digestive system

Recommendations are based on mimicking intrauterine growth and nutrient retention, whilst taking into account differences in nutrient supply and metabolism and the extrauterine environment. The aim is to achieve catch up growth without excessive fat deposition¹⁸. Individual energy requirements will be extremely variable, depending on:

- Post-conceptual age
- Accumulated nutrient deficits
- Body composition
- Resting energy expenditure



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Energy recommendations (kcal/kg/day)

Tsang <i>et al</i> 2005:	Klein <i>et al</i> 2002:	ESPGHAN 2010:
ELBW: 130-150	110-135	110-135
VLBW: 110-130		

2. Protein: The relationship between protein and energy intake is important as they are reciprocally limiting; if energy is too low then protein will be used for energy which is not desirable for nitrogen balance, so increasing energy intake helps to spare protein. However, if there is excess energy and low protein then this can cause fat deposition¹⁷.

In terms of total protein and amino acid composition, the requirements are based on the quantity and quality needed for tissue growth comparable to that achieved in utero¹⁷. Currently there is a lack of data on the optimal intake of amino acids and long-term effects of different levels of protein, but it's recognised that a deficit in protein can negatively affect growth¹⁸.

Protein recommendations (g/100kcal)

Tsang <i>et al</i> 2005:	Klein <i>et al</i> 2002:	ESPGHAN 2010:
ELBW: 2.5-3.4	2.5-3.6	<1kg BW: 3.6-4.1
VLBW: 2.6-3.8		1-1.8kg BW: 3.2-3.6

3. Fat: Most fat stores in an infant are laid down in the last trimester of pregnancy, so preterm infants miss out on this accumulation. They also have impaired digestion and absorption of fats as a result of reduced bile acids and pancreatic lipase production. Consequently, they require a highly digestible fat blend that is low in long-chain saturates which are poorly absorbed. Fats are important as an energy source and also to provide essential polyunsaturated fatty acids and fat-soluble vitamins. Consequently, fat intake affects both growth and body composition¹⁸.

Long-chain polyunsaturated fatty acids (LCPs), which are important in brain, eye and nervous system development, are also rapidly accumulated in the last trimester of pregnancy. Preterm infants do not have the enzymes required for the conversion of essential fatty acids (linoleic and alpha-linolenic acid) into LCPs (the conversion in humans is extremely poor at <1% even when the enzymes are present¹⁹). So it is important for preformed LCPs to be included in the diets of preterm infants, either through breastmilk or a preterm formula supplemented with LCPs.

Fat recommendations (g/kg/day)

Tsang <i>et al</i> 2005:	Klein <i>et al</i> 2002:	ESPGHAN 2010:
ELBW: 6.2-8.4	4.4-5.7	4.8-6.6
VLBW: 5.3-7.2		

4. Calcium and phosphorus: Preterm infants are more prone to hypocalcaemia and osteopenia (rickets of prematurity) as mineral accretion peaks in the last trimester of pregnancy, which they will miss out on, and they have a high requirement for bone growth²⁰. Both the amount and ratio of calcium and phosphorus are important for bone mineralisation⁵. Current recommendations on the ratio of calcium to phosphorus for preterm formula are between 1.5 and 2:1^{17,18}.

Calcium: phosphorus recommendations (by mass)

Tsang <i>et al</i> 2005:	Klein <i>et al</i> 2002:	ESPGHAN 2010:
1.7-2.1	1.7-2.1	~1.5-2.1

5. Iron: Iron is important for the production of red blood cells, DNA replication, brain and muscle development, and gastrointestinal function so there is a clear requirement for growth^{5,21}. However, it is also toxic at high levels as the body does not have an excretory mechanism and can cause infection and poor growth¹⁸. In comparison to a term infant that doubles in birth weight in 5 months, a preterm infant achieves this in just 1-2 months¹⁸. Therefore, a preterm infant will have higher iron requirements than a term infant but low iron stores in comparison to their needs (although they are similar on a per kg basis to term infants). Additionally, a preterm infant is undergoing significant stressors, like phlebotomy⁵.

There is some controversy about when to start iron supplementation, either in preterm formula, fortified breastmilk or as separate iron supplements; Tsang *et al*⁵ suggest starting at 2 weeks in enterally fed infants, ESPGHAN¹⁸ at 2 - 6 weeks and Jones & King²⁰ at 4-6 weeks.

Iron recommendations (mg/kg/day)

Tsang <i>et al</i> 2005:	Klein <i>et al</i> 2002:	ESPGHAN 2010:
2-4	2-3	2-3



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Feeding options – in hospital

Unlike term infants, preterm babies have very small reserves of fat or glycogen at birth so they are extremely vulnerable to even short periods of nutrient deprivation. Therefore, feeding should be established as soon as possible, when the infant's clinical condition is considered stable, usually between 12 and 24 hours after delivery. It's worth bearing in mind that initiation of feeding varies in practice.

Generally some enteral feed should be given within the first few days, even if it is only 1-2ml, as maturation of the gastrointestinal tract can be accelerated by early feeding. Minimal enteral feeding, or trophic feeding, is sometimes used to prime the gut of the smallest and sickest infants, while most of their nutrition is derived from parenteral nutrition²⁰.

Early initiation of feeding aids gut maturation and leads to earlier tolerance of full enteral feeding²⁰. Preterm infants may be tube-fed with expressed breastmilk and the milk supply maintained by manual expression until the infant is strong enough to breastfeed. Well infants

over 34 weeks gestational age are usually capable of breast or bottle feeding⁶.

Breastmilk

Breastmilk is the food of choice for preterm infants because of its nutritional and non-nutritional properties; offering support for the immune system, enzymes, growth factors and hormones. Studies have shown that breastfeeding helps protect preterm infants against infections and it has also been shown to reduce the risk of NEC in preterm infants²².

Compared with formula fed preterm infants, those fed breastmilk have quicker gastric emptying and pass stools more frequently. Additionally, they often tolerate full enteral feeds sooner and require less parenteral nutrition²⁰. See figure 2 for the advantages of breastfeeding.



Figure 2 – The advantages of breastfeeding preterm infants

The breastmilk of preterm mothers has a different composition to that of mature milk, particularly during the first 2 weeks of lactation, after which it gradually transitions to become more like term milk. The energy content of the two is very similar, but preterm breastmilk contains more protein and sodium, and altered levels of some minerals (see table 2, following page).



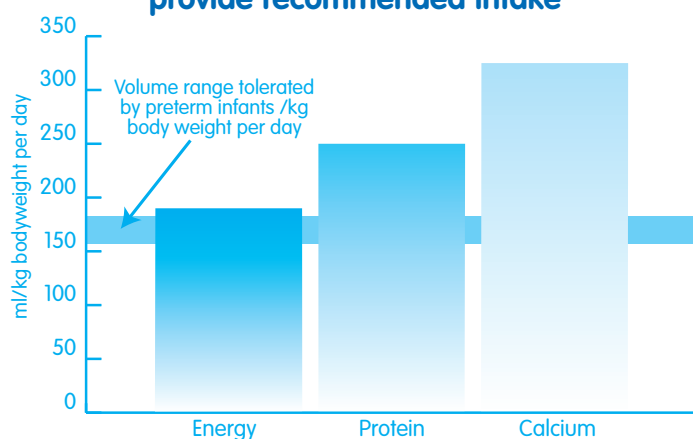
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Table 2 – Nutritional composition of preterm compared with mature breastmilk

Values per 100ml	Units	Preterm breastmilk ²³	Mature breastmilk ²⁴
Energy	kJ	293	289
		70	69
Protein	g	1.8	1.3
Carbohydrate	g	7	7.2
Fat	g	4	4.1
Sodium	mg	30	15
Calcium	g	22	34
Phosphorus	mg	14	15
Calcium: Phosphorus	mg	1.6:1	2.3:1
Iron	mg	0.09	0.07

However, unfortified breastmilk alone may not be sufficient to support intrauterine growth rates and nutrient storage due to the volume tolerated and/or the quality of the breastmilk (figure 3). This can lead to nutrient deficiencies and poor growth, particularly in infants <1500g^{20,22}. Consequently, breastmilk fortifiers, such as Cow & Gate Nutriprem Breastmilk Fortifier, may be used. This enables the benefits of breastmilk to be preserved, whilst nutrient supply and growth are optimised²⁰.

Volume of mature preterm milk required to provide recommended intake



Nutrients supplied by unfortified human milk insufficient for preterm babies. Consequences include poor growth during and beyond hospital stay.

Figure 3 – Preterm infants may not be able to tolerate sufficient quantities of preterm breastmilk to meet their nutritional needs

Figure 3 shows the volume of milk required to provide the recommended intakes of some nutrients for preterm babies. For example, to get enough protein, preterm babies would need a minimum of 250ml/kg/day of breastmilk, and even more for other nutrients like calcium. In practice this is an unrealistic target. Preterm infants (especially those with an extremely low birthweight) do not easily tolerate volumes above 180ml/kg/day and tend to only take in about 150-160ml/kg/day. Many preterm infants also don't actually tolerate full enteral feeds of this amount for several weeks after birth. Therefore, if they are fed unsupplemented breastmilk only, many preterm infants may not get enough nutrients to support adequate growth and development.

Breastmilk fortifier

Breastmilk fortifier (BMF) contains:

- energy (in form of carbohydrate),
- protein
- vitamins and minerals

There is a broad consensus that breastmilk is beneficial for preterm infants. However, as discussed, it does have a number of limitations. BMF increases the energy and nutritional content of breastmilk to meet the increased needs of preterm infants.

Studies have shown that preterm infants fed unsupplemented breastmilk have a slower growth rate⁵. The micronutrient supplementation of breastmilk has been shown to lead to improvements in growth, including increases in weight, length and head circumference as well as improvements in nutritional status and this has been confirmed by a Cochrane Review^{25,26}.

Tsang *et al*⁵ acknowledge that breastmilk supplementation is associated with improvements in growth and nutritional status and therefore recommend its use in preterm infants, especially those that are VLBW. ESPGHAN advocate the use of breastmilk for preterm infants provided it is fortified where necessary to meet requirements¹⁸. They also point out that parents and healthcare professionals need to be aware that breastmilk composition may vary during lactation, within the day and even during one expression and that storage and treatment following expression may also influence composition.

Consequently, it is common practice to supplement breastmilk, especially in very low birth weight and extremely low birth weight infants.



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Table 3 – Comparison of breastmilk fortifiers available in the UK

Per 100mls	Cow & Gate Nutriprem breastmilk fortifier (2 sachets)	SMA breastmilk fortifier (2 sachets)
Energy (kcal)	15	14.6
Protein (g)	0.8	1
Protein Whey : Casein	60:40	100% Whey
Protein source	Whey and casein hydrolysates	Whey
Carbohydrate (g)	3	2.4
Carbohydrate source	Maltodextrin	Maltodextrin
Fat (g)	Nil	0.16
Calcium (mg)	65	90
Phosphorus (mg)	46	46
Minerals	Na, K, Cl, Ca, P, Mg, Zn, Cu, I, Mn	Na, K, Cl, Ca, P, Mg, Zn, Mn
Vitamins	A, D, E, K, C, B ₁ , B ₂ , Niacin, B ₆ , B ₁₂ Pantothenic acid, Biotin, Folic Acid	A, D, E, K, C, B ₁ , B ₂ , Niacin, B ₆ , B ₁₂ Pantothenic acid, Biotin, Folic Acid
Presentation	2.15g sachet	2g sachet
Usage per 100ml	2 sachets	2 sachets
Shelf life	2 years	3 years

Preterm formulas

If a preterm infant is not fed breastmilk for whatever reason or requires top up feeds, then preterm formulas provide a suitable alternative. The use of standard infant formulas is not appropriate as they would provide a suboptimal range of nutrients, particularly protein, sodium, calcium, phosphorus and several micronutrients and consequently would be deleterious to growth and development (see figure 4)⁵. Preterm infants require a formula with a high nutrient density, due to their small gastric volume, and containing all the necessary nutrients in an easily digestible form, because of their immature physiology⁵.

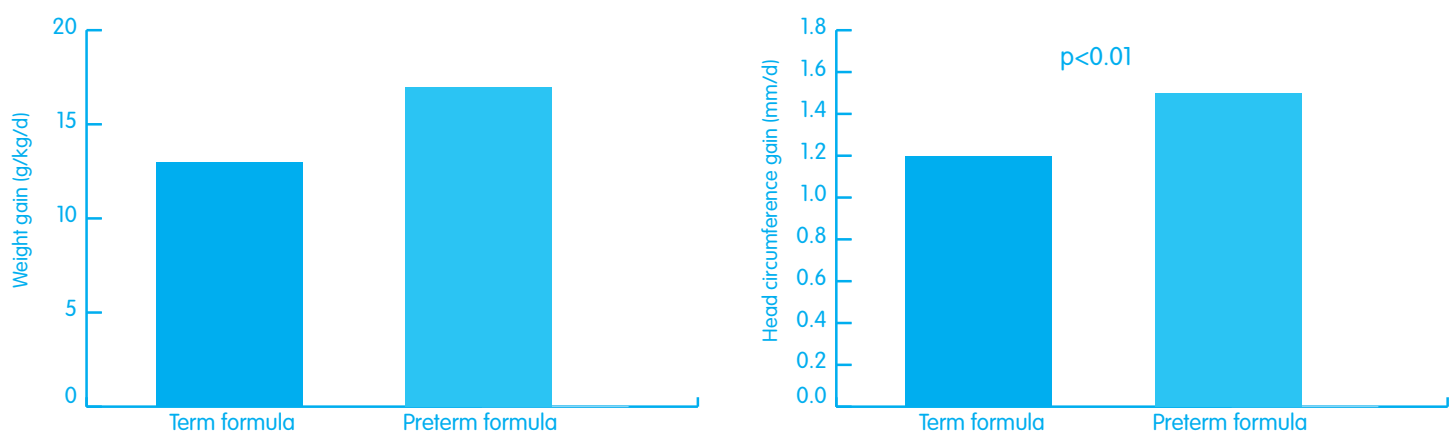


Figure 4 – Comparison of growth and development measures with preterm versus term formula fed to preterm infants²⁷

The preterm nutritional guidelines discussed earlier form the basis of recommendations for the composition of preterm formulas, although they are not legal requirements.



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Table 4 – Comparison of preterm formulas available in the UK

Per 100mls	Cow & Gate Nutriprem 1 (per 100ml)	Aptamil Preterm (per 100ml)	SMA Gold Prem (per 100ml)
Energy (kcal)	80	80	82
Protein (g)	2.5	2.5	2.2
Protein:Energy (g/100kcal)	3.1	3.1	2.7
LCPs - AA DHA	✓ ✓	✓ ✓	✓ ✓
Prebiotic oligosaccharides	✓	✓	✗
Nucleotides	✓	✓	✗
Calcium (mg)	120	120	101
Phosphorus (mg)	66	66	61
Calcium:Phosphorus	1.8:1	1.8:1	1.7:1
Iron (mg)	1.4	1.4	1.4
Iodine (µg)	25	25	10
Selenium (µg)	1.9	1.9	1.7
Osmolality (mOsmol/kg water)	360	360	272

There is increasing interest in the use of prebiotic oligosaccharides (OS) and probiotics in the nutritional management of preterm infants. Clinical studies have shown that a specific mixture of prebiotic OS (90% galacto-oligosaccharide and 10% fructo-oligosaccharides) in preterm infants:

- Stimulate growth of beneficial bifidobacteria²⁸
- Reduce intestinal pathogens²⁹
- Improve stool frequency and consistency (similar to breastmilk fed infants)^{28,30}
- Improve gastric emptying time³¹
- Improve gastrointestinal transit time³⁰
- Improve enteral tolerance in extremely preterm infants³²

A recent systematic review concluded that prebiotic supplemented formula increased stool bifidobacteria and lactobacilli counts in preterm infants without any adverse effect on weight gain³³.

Systematic reviews on probiotic supplementation have suggested that they reduce the risk of NEC in preterm infants, but the long-term safety of probiotic use requires further assessment^{9,10}.

Feeding options - after hospital discharge

Catch up growth versus accelerated and faltering growth

Catch-up growth: involves the linear bone growth, muscle growth and fat accumulation that are required in preterm infants to enable them to reach a satisfactory growth trajectory (one that mimics in-utero growth).

Accelerated growth: is where an excess of energy causes the excess storage of adipose tissue, rather than linear growth, and this is undesirable.

Faltering growth: is the growth failure in term infants that leads to a significant drop in weight, causing infants to move down and cross a centile. There are specific faltering growth products available, such as Nutricia Infatrini and SMA High Energy, but these are not appropriate for catch-up growth in preterm infants.

Catch up growth in preterm infants

Did you know?

Children who are born preterm tend to have poorer growth throughout their early years, and continuing into school age, compared with their term counterparts³⁴

The window for catch-up growth in low birth weight preterm infants seems to be narrow and if catch-up growth does not occur in early life then the chances that it will occur later are limited³⁵. At discharge, preterm infants often have not reached term and are still low birth weight (<2500g). In addition, nutritional deficits at birth may still be present despite optimal hospital care³⁶. Thus, these infants often have higher energy and nutrient requirements per kilo body weight than healthy term infants. Ongoing nutritional support of preterm and low birth weight infants after discharge is important to ensure adequate growth and development and to minimise adverse health consequences in the long term.

Breastmilk

Breastmilk is the preferred source of nutrition for all infants, and mothers should therefore be encouraged and supported to continue to breastfeed once their baby has been discharged from hospital (along with the use of additional supplements as advised).

Post-discharge formulas

If a baby is not being breastfed, or formula is required to supplement breastfeeds, then specific nutrient enriched post-discharge formulas (e.g. Cow & Gate Nutriprem 2) are available on prescription and these normally replace preterm formulas after the infant has attained a weight of 1.8-2kg and their growth rate is normal. These formulas are tailored to meet the high nutritional requirements of preterm infants after hospital discharge. Compared to term formulas they contain more energy, protein and micronutrients to help support adequate development and catch-up growth in preterm infants.

Studies have shown that preterm infants fed a nutrient-enriched formula post-discharge have improved growth (weight, length and head circumference) and improved bone mass compared to infants fed standard term



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formula³⁷⁻⁴². Boys and lower birth weight infants seem to benefit the most from the use of post-discharge formula. A study by Cooke *et al* investigated the effect of feeding a nutrient-enriched formula, compared to a standard term formula, from hospital discharge to 6 months corrected age on growth in preterm infants with a birth weight less than 1750g³⁸⁻⁴⁰. At 18 months corrected age, boys fed the nutrient-enriched formula post-discharge were heavier, longer and had a larger head circumference ($p < 0.0001$) than those fed a standard term formula⁴⁰. Body composition measures using DEXA taken at 12 months corrected age indicated weight gain was due to an increase in lean body mass and bone mass and was not purely the result of additional fat mass³⁹.

As a result of the body of research, and given the importance of nutrition in early life, a number of expert groups recommend the use of a nutrient enriched formula after hospital discharge in formula fed preterm infants.

- The European Society of Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN)³⁵ recommend the use of a post-discharge formula in preterm infants until at least 42 weeks post-conception or possibly until 52 weeks (3 months corrected age) in infants with suboptimal weight for age.

Table 5 – Comparison of post-discharge formulas available in the UK

Per 100mls	Post-discharge formulas	
	Cow & Gate Nutriprem 2	SMA Gold Prem 2
Energy (kcal)	75	73
Protein (g)	2	1.9
Protein:Energy (g/100kcal)	2.7	2.6
Total Fat (g)	4.1	3.9
LCPs - AA DHA	✓ ✓	✓ ✓
Prebiotic oligosaccharides	✓	✗
Nucleotides	✓	✓
Calcium (mg)	94	73
Phosphorus (mg)	50	42
Calcium:Phosphorus	1.9:1	1.7:1
Iron (mg)	1.2	1.2
Iodine (µg)	20	10
Selenium (µg)	1.7	1.5
Osmolality (mOsmol/kg water*)	340	250
Available in ready to feed format?*	✓	✗

* Experts recommend avoidance of feeds over 460mOsmol/kg water for preterm infants^{30,43}

** In line with expert recommendations that liquid formats should be used for preterm infants to minimise the risk of infections⁴⁴

- Tsang *et al*⁵ recommend that a post-discharge formula should be used during the first year of life. Post-discharge formulas available in the UK (e.g. Cow & Gate Nutriprem 2, SMA Gold Prem 2) can be prescribed for catch-up growth in preterm infants up to 6 months corrected age if required. Continued weight and length monitoring of infants in the community is important to meet individual nutritional needs and to avoid either under or over nutrition.

Weaning the preterm infant

Weaning is: "the process of expanding the diet to include foods and drinks other than breast milk or infant formula"⁴⁵

The main objectives of weaning are:

- **To fill the developing nutritional gap** between the intakes of energy and nutrients provided by milk and the increasing nutritional requirements
- **To promote the development of neuromuscular functions**, e.g. bolus formation, chewing and swallowing of solid foods
- **To increase acceptance of new tastes** and accustom an infant to a variety of tastes/foods to help ensure a varied and balanced diet in later life

When?

The Department of Health recommends that solid food is introduced at 6 months of age⁴⁶. ESPGHAN also recommends that around 6 months is "a desirable goal" and that complementary foods should not be offered before 17 weeks of age and not delayed beyond 26 weeks⁴⁷. However, these recommendations are for healthy babies and so the decision to wean may be different for a preterm infant, where it may be preferable to either delay or bring forward weaning depending on the circumstances. Before 4 months an infant's renal and gastrointestinal functions are not sufficiently developed to be able to cope with solid foods⁴⁵, so it's important not to wean too early.

As discussed previously, preterm infants have extra nutritional needs because of the nourishment that they've missed in the last stage of pregnancy. Consequently, they may also need some extra care later on and weaning may be a slower process. It is recommended that weaning starts between 5-7 months from birth (chronological/uncorrected age), but every baby is an individual and develops at different rates, so it is important to look out for signs to show they are ready to start solids⁴⁸.



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Signs for a mum to look for:

- baby demands milk more frequently or appears hungry after a milk feed
- baby is waking for feeds during the night
- baby starts sucking fists
- baby shows an interest in foods, e.g. picking up and tasting finger foods

Weaning too early could result in poor growth as breastmilk or formula intake will reduce, but leaving it too late may compromise the development of chewing and jaw muscles⁴⁸. The process of weaning is the same as for a term infant (look out for our new weaning distance learning pack arriving in 2010).

The timing and the types of foods that are appropriate for infants during the different stages of weaning are determined by the development of a number of different physiological functions, such as the development of neuromuscular, renal and digestive system function and gut defences^{45,49}.

More information

- Bliss – the premature baby charity offers a number of resources

www.bliss.org.uk
Parent support helpline 0500 618140

- Twins and Multiple Birth Association
www.tamba.org.uk 0800 138 0509

- Wharton BA, Committee on Nutrition of the Preterm Infant, ESPGHAN. Nutrition and Feeding in the Preterm Infant. Oxford: Blackwell Scientific Publications, 1987.
- Food Standards Agency. McCance & Widdowson's The Composition of Foods, Sixth summary edition. Cambridge: The Royal Society of Chemistry, 2002.
- Nicholl RM, Gamsu HR. Changes in growth and metabolism in very low birthweight infants fed with fortified breast milk. *Acta Paediatr* 1999;88:1056-61.
- Kuschel CA, Harding JE. Multicomponent fortified human milk for promoting growth in preterm infants (Cochrane Review). In: The Cochrane Library, Issue 2, 2004. Chichester: John Wiley and Sons, Ltd.
- Lucas A, Morley R, Cole TJ *et al*. Early diet in preterm babies and developmental status at 18 months. *Lancet* 1990;335(8704):1477-81.
- Boehm G, Lidestri M, Casetta P *et al*. Supplementation of an oligosaccharide mixture to a bovine milk formula increases counts of faecal bifidobacteria in preterm infants. *Arch Dis Child* 2002;86:F178-81.
- Knol J, Boehm G, Lidestri M *et al*. Increase of faecal bifidobacteria due to dietary oligosaccharides induces a reduction of clinically relevant pathogen germs in the faeces of formula-fed preterm infants. *Acta Paediatr* 2005; 94 (Suppl 449): 31-3.
- Mihatsch WA, Hoegel J, Pohlandt F. Prebiotic oligosaccharides reduce stool viscosity and accelerate gastrointestinal transport in preterm infants. *Acta Paediatr* 2006;95(7):843-8.
- Indrio F, Riezzo G, Raimondi F. Prebiotics improve gastric motility and gastric electrical activity in preterm newborns. *J Pediatr Gastroenterol Nutr* 2009;49:1-4.
- Modi N, Kulinskaya E, Uthaya S. A double-blind, randomised, controlled trial of the effect of prebiotic bifidogenic oligosaccharides on enteral tolerance in preterm infants. *Arch Dis Child* 2008;93(5):A58.
- Srinivasajoi R, Rao S, Patole S. Prebiotic supplementation of formula in preterm neonates: A systematic review and meta-analysis of randomised controlled trials. *Clin Nutr* 2009;28:237-42.
- Cooke RW, Fouldler-Hughes L. Growth impairment in the very preterm and cognitive and motor performance at 7 years. *Arch Dis Child*. 2003;88:482-7.
- ESPGHAN Committee on Nutrition, Aggett PJ *et al*. Feeding preterm infants after hospital discharge: a commentary by the ESPGHAN Committee on Nutrition. *J Pediatr Gastroenterol Nutr* 2006;42(5):596-603.
- Embleton ND, Pang N, Cook RJ. Postnatal nutrition and growth retardation: an inevitable consequence of current recommendations in preterm infants? *Pediatrics* 2001;107:270-73.
- Carver JD, Wu PYK, Hall RT *et al*. Growth of preterm infants fed nutrient-enriched or term formula after hospital discharge. *Pediatrics* 2001;107:683-9.
- Cooke RJ, Griffin U, McCormick K *et al*. Feeding preterm infants after hospital discharge: effect of dietary manipulation on nutrient intake and growth. *Pediatr Res* 1998;43:355-60.
- Cooke RJ, McCormick K, Griffin U *et al*. Feeding preterm infants after hospital discharge: effect on diet and body composition. *Pediatr Res* 1999;46:461-4.
- Cooke RJ, Embleton N, Griffin U *et al*. Feeding preterm infants after hospital discharge: growth and development at 18 months of age. *Pediatr Res* 2001;49:719-22.
- Lucas A, Fewtrell MS, Morley R *et al*. Randomised trial of nutrient-enriched formula versus standard formula for postdischarge preterm infants. *Pediatrics* 2001;108:703-11.
- Picard JC, Decullier E, Plan O *et al*. Growth and bone mineralisation in preterm infants fed preterm formula or standard term formula after discharge. *J Pediatr* 2008;153:616-21.
- Barnes A, Mauer AM, Holliday MA *et al*. American Academy of Pediatrics. Commentary on breast-feeding and infant formulas, including proposed standards for formulas. *Pediatrics* 1976; 57: 278-85
- FAO/WHO Joint FAO/WHO workshop on Enterobacter Sakazakii and other micro-organisms in powdered infant formula. Geneva: WHO, 2004. <http://www.who.int/foodsafety/publications/micro/summary.pdf>.
- Department of Health. Weaning and the Weaning Diet. Report on Health and Social Subjects: 45. London: HMSO, 1994.
- Department of Health. Infant Feeding Recommendations. 2003. Available at: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4097197 [accessed May 2009]
- ESPGHAN Committee on Nutrition. Complementary feeding: a commentary by the ESPGHAN Committee on Nutrition. *J Pediatr Gastroenterol Nutr* 2008; 46: 99-110.
- Bliss. Weaning Your Premature Baby, 5th ed. London: Bliss, 2008.
- Fleischer Michaelson K, Weaver L, Branca F, Robertson A. Feeding and nutrition of infants and young children. Guidelines for the WHO European region, with emphasis on the former Soviet countries. WHO Regional Publications European Series No. 87. Copenhagen: World Health Organisation, 2003.

References

- NHS. NHS Maternity Statistics, England 2005-06. London: The Information Centre, 2007. Available at: <http://www.ic.nhs.uk/statistics-and-data-collections/hospital-care/maternity/nhs-maternity-statistics-2005-06> [Accessed December 2009]
- Bliss. Definitions, facts and figures (online). www.bliss.org.uk July 2007.
- Rigo J, Senterre J. Nutritional needs of premature infants: current issues. *J Pediatr* 2006;149:S80-88.
- American Academy of Pediatrics Committee on Fetus and Newborn. Policy Statement: Age terminology during the perinatal period. *Pediatrics* 2004; 114(5):1362-4.
- Tsang RC, Uauy R, Koletzko B, Zlotkin SH (eds). Nutrition of the Pre-term Infant. Scientific Basis and Practical Guidelines (2nd edition). Cincinnati: Digital Educational Publishing, Inc., 2005.
- McGuire W, Henderson G, Fowlie PW. Feeding the preterm infant. *BMJ* 2004;329:1227-30.
- Lin PW, Stall BJ. Necrotising enterocolitis. *Lancet* 2006;368:1271-83.
- Schanler RJ. Probiotics and necrotising enterocolitis in premature infants. *Arch Dis Child* 2006; 91:F395-7.
- AlFaleh K, Anabrees J, Bassler D. Probiotics reduce the risk of necrotising enterocolitis in preterm infants: a meta-analysis. *Neonatology* 2010;97:93-9.
- Deshpande G, Rao S, Patole S. Probiotics for prevention of necrotising enterocolitis in preterm neonates with very low birthweight: a systematic review of randomised controlled trials. *Lancet* 2007;369:1614-20.
- Clark RH, Thomas P, Peabody J. Extruterine growth restriction remains a serious problem in prematurely born neonates. *Pediatrics* 2003;111:986-90.
- Ehrenkranz RA, Younes N, Lemons JA *et al*. Longitudinal growth of hospitalized very low birth weight infants. *Pediatrics* 1999;104:280-9.
- Hack M, Schluchter M, Cartar L *et al*. Growth of very low birth weight infants to age 20 years. *Pediatrics* 2003;112:e30-8.
- Franz AR, Pohlandt F, Bode H *et al*. Intrauterine, early neonatal and post-discharge growth and neurodevelopmental outcome at 5.4 years in extremely preterm infants after intensive neonatal nutritional support. *Pediatrics* 2009;123:e101-9.
- Isaacs EB, Gadian DG, Sabatini S *et al*. The effect of early human diet on caudate volumes and IQ. *Pediatr Res* 2008;63(3):308-14.
- Isaacs EB, Morley R, Lucas A. Early diet and general cognitive outcome at adolescence in children born at or below 30 weeks gestation. *J Pediatr* 2009; 155:229-234.
- Klein CJ (ed). Nutrient requirements for preterm infant formulas. *J Nutr* 2002;132:1395S-577S.
- Agostoni C, Buonocore G, Carnielli VP *et al*. Enteral nutrient supply for preterm infants: commentary from the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition Committee on Nutrition. *J Pediatr Gastroenterol Nutr* 2010;50(1):85-91.
- Innis SM. Omega-3 fatty acids and neural development to 2 years of age: do we know enough for dietary recommendations? *J Pediatr Gastroenterol Nutr* 2009;48:S16-24.
- Jones E, King C (eds). Feeding and Nutrition in the Preterm Infant. Edinburgh: Elsevier, 2005.
- British Nutrition Foundation. Iron: Nutritional and Physiological Significance. London: Chapman & Hall, 1995.
- Schanler RJ. The use of human milk for premature infants. *Pediatr Clin North Am* 2001;48(1):207-19.



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