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Which milk for the sick preterm infant?

S.T. Kempley*, A.K. Sinha, M.R. Thomas

Neonatal Intensive Care Unit, Barts and the London NHS Trust, Royal London Hospital, Whitechapel, London E1 1BB, UK

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Summary Understanding the nutritional needs of the sick preterm infant will ensure that nutritionally adequate milks are used, but to minimise complications an understanding of the interaction between milk composition and neonatal gastrointestinal physiology is required. Unmodified preterm breast milk is probably the safest milk, but might require supplementation with fortifiers to meet nutritional needs. Fortification affects the osmolarity, protein and mineral content of breast milk in ways that can have adverse effects on intestinal function. Although preterm formulas meet the nutritional requirements of sick preterm infants, formula milk is associated with an increased risk of necrotising enterocolitis. Hydrolysate and elemental formulas have a role in treating established malabsorption, dysmotility or obstruction, but they are nutritionally inadequate for the sick preterm baby and have features which make them unsuitable for the prevention of gastrointestinal disease. In some circumstances, the use of minimal or partial enteral nutrition can help to maintain nutrition in the particularly sick infant, in which case the nutritional content of the milk will be less critical.

Practice points

- The baby's own mother's expressed breast milk has many advantages for the sick preterm infant
- Breast milk may be nutritionally inadequate, but it can be fortified to improve its nutritional content. Fortifiers have a number of effects which may reduce the safety of the milk
- Preterm formulas are more likely to meet nutritional requirements than any other milk, but formula milk may carry an increased risk of necrotising enterocolitis (NEC)
- Although hydrolysates and elemental formulas may be used to treat malabsorbtion following NEC, they are nutritionally unsuitable and have little role in the sick preterm baby before gastrointestinal problems have developed.

*Corresponding author.
E-mail address: steve.kempley@bartsandthelondon.nhs.uk (S.T. Kempley).

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Introduction

Advances in the intensive care of preterm infants have decreased morbidity and mortality, but appropriate nutritional intake remains critical in ensuring optimal growth and developmental outcome. Although parenteral nutrition might be necessary for some preterm infants, their long-term nutritional needs are best met enterally.

The nutrient intake of preterm infants can be limited by gastrointestinal immaturity and co-existing medical conditions. When devising feeding plans for sick infants, clinicians must balance the safety of various feeding options while aiming to meet nutrient requirements. In such infants, baseline calorific requirements might be elevated but the need to maximise nutritional intake should be balanced against the effects of such enteral nutrition on gastrointestinal physiology.

In the sections below we aim to document:

- the nutritional requirements of the sick preterm
- the extent to which various milks can meet these needs
- the physiological limits imposed by immaturity and neonatal illness
- strategies for minimising risk when devising feeding strategies
- the way in which type of milk could vary according to the aims of feeding.

Nutritional requirements in preterm infants

For term infants, mother's milk is the 'gold standard' for nutrient requirements. However, it is not the reference standard for preterm infants, who are at greater risk of inadequate growth and nutrient deficiencies.

Energy

Preterm infants have very high total energy requirements in order to achieve growth similar to the third trimester of gestation (in utero gain 12–16 g/kg/day). Energy demands vary widely, depending on conditions and diseases affecting the infant. Energy expenditure by preterm infants can be grouped into the resting metabolic rate (47–52 kcal/kg/day), the rate during activity (3–4 kcal/kg/day), loss of energy through excretion (11–18 kcal/kg/day) and the energy cost of weight gain (3–4 kcal/g of weight gained).[1] Required energy intake depends on the goal for weight gain. It is between 50 and 60 kcal/kg/day for a parenterally fed infant in a thermoneutral environment who is not growing, but it is 130–140 kcal/kg/day for an infant showing 'catch-up' growth. Infants fed parenterally have lower total energy needs because of lower energy losses in stools and, possibly, more efficient use of energy. The recommended energy intake for infants on formula feeds has been increasing in recent years: 98–128 kcal/kg/day (ESPGAN 1991),[2] 105–135 kcal/kg/day (Canadian Paediatric Society (CPS) Nutrition Committee 1995),[3] 105–130 kcal/kg/day (American Academy on Pediatrics (AAP) Committee on Nutrition 1998)[4] and 110–135 kcal/kg/day (LSRO 2002).[5]

Protein

The goal for protein intake is to provide adequate quality and quantity for optimal nitrogen retention without metabolic stress, such as uraemia or distorted blood amino-acid profiles. Minimum protein intake for preterm infants is 3.4 g/kg/day based on studies of fetal nitrogen accretion rates, evaluation of physiological and biochemical variables and growth and neurodevelopmental data.[5] Protein intake of 4.3 g/kg/day has no adverse effects but intakes of 5 g/kg/day or more are undesirable. Many studies indicate that term breast milk as the sole source of nutrition leads to inadequate weight gain.[6,7] Although the protein content of preterm breast milk is higher, it is probably inadequate to support growth rates equivalent to those of the fetus, especially for infants of less than 1000 g.[8]

Protein:energy ratio

If energy intake is inadequate, protein is used as an energy source. If there is surplus energy with limited protein intake, the excess energy is used for fat deposition.[1] An increase in the protein energy ratio generally leads to the deposition of more of the ingested calories as lean body mass. The recommended protein:energy ratio in preterm formula should be 2.5–3.6 g/100kcal.[5]

Lipids

Fat is the major source of dietary energy for preterm infants, constituting 40–60% of energy in human milk and infant formulas. The fat requirement for preterm infants is determined by their energy requirement, intake of protein and carbohydrate, and the volume that they can be fed. Essential fatty acids (omega-6 and omega-3) are