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## 1 Recommendations

Parents and carers have the right to be involved in planning and making decisions about their baby's health and care, and to be given information and support to enable them to do this, as set out in the [NHS constitution](#) and summarised in [making decisions about your care](#).

[Making decisions using NICE guidelines](#) explains how we use words to show the strength (or certainty) of our recommendations, and has information about prescribing medicines (including off-label use), professional guidelines, standards and laws (including on consent and mental capacity), and safeguarding.

2

### 3 **1.1 Indications for, and timing of, neonatal parenteral nutrition**

#### 4 **Indications for neonatal parenteral nutrition**

5 1.1.1 For [preterm](#) babies born before 31<sup>+0</sup> weeks, start neonatal parenteral  
6 nutrition.

7 1.1.2 For preterm babies born at or after 31<sup>+0</sup> weeks, start parenteral nutrition if  
8 sufficient progress is not made with enteral feeding in the first 72 hours  
9 after birth.

10 1.1.3 Start parenteral nutrition for preterm and term babies who are unlikely to  
11 establish sufficient enteral feeding, for example, if they have:

- 12 • a congenital gut disorder
- 13 • a critical illness such as sepsis **or**
- 14 • a major cardiac disorder.

#### 15 **Indications for starting neonatal parenteral nutrition if enteral feeds are** 16 **stopped**

17 1.1.4 For preterm babies on enteral feeds, start parenteral nutrition if:

- 18 • enteral feeds are stopped for more than 24 hours **and**

- 1           • there is no prospect of making sufficient progress with enteral feeding  
2           within a further 48 hours (for example, because of suspected  
3           necrotising enterocolitis or a critical illness such as sepsis).

4   1.1.5   For term babies on enteral feeds, start parenteral nutrition if:

- 5           • enteral feeds are stopped for more than 48 hours **and**  
6           • there is no prospect of making sufficient progress with enteral feeding  
7           within a further 48 hours (for example, because of a critical illness such  
8           as sepsis, or a surgical gut disorder).

### 9   **Timing of starting neonatal parenteral nutrition**

10   1.1.6   When a baby meets the indications for parenteral nutrition, start it as soon  
11           as possible, and within 8 hours at the latest.

To find out why the committee made the recommendations on indications for, and timing of, neonatal parenteral nutrition, and how they might affect practice, see [rationale and impact](#).

## 12   **1.2       Administration of neonatal parenteral nutrition**

### 13   **Venous access**

14   1.2.1   Use a central venous catheter to give neonatal parenteral nutrition. Only  
15           use peripheral venous access to give neonatal parenteral nutrition if:

- 16           • it would avoid a delay in starting parenteral nutrition  
17           • short-term parenteral nutrition is anticipated, for example, less than  
18           3 days  
19           • it would avoid interruptions in giving parenteral nutrition **or**  
20           • central venous access is impractical, for example, if there is poor  
21           venous access.

22   1.2.2   Only consider surgically inserting a central venous catheter if:

- 23           • non-surgical insertion is not possible **or**

- 1                   • long-term parenteral nutrition is anticipated, for example, in short bowel  
2                   syndrome.

To find out why the committee made the recommendations on venous access for neonatal parenteral nutrition and how they might affect practice, see [rationale and impact](#).

### 3 **Protection from light**

4 1.2.3       Protect the neonatal parenteral nutrition bag from light during  
5                   administration and storage.

6 1.2.4       Consider protecting the syringe and infusion set of both aqueous and lipid  
7                   parenteral nutrition solutions from light during administration.

To find out why the committee made the recommendations on protection from light and how they might affect practice, and why the committee decided not to make a recommendation about filtration, see [rationale and impact](#).

## 8 **1.3       *Energy needs of babies on neonatal parenteral nutrition***

9 1.3.1       For preterm and term babies who need total neonatal parenteral nutrition,  
10                   deliver energy as follows:

- 11                   • If starting parenteral nutrition in the first 4 days after birth:  
12                   – give a starting range of 40 to 60 kcal/kg/day  
13                   – gradually increase (for example, over 4 days) to a maintenance  
14                   range of 75 to 120 kcal/kg/day.  
15                   • If starting parenteral nutrition more than 4 days after birth:  
16                   – give a range of 75 to 120 kcal/kg/day.

17 1.3.2       For preterm and term babies who are on enteral feeds in addition to  
18                   neonatal parenteral nutrition, reduce the amount of energy that is given  
19                   parenterally as enteral feeds increase.

20 1.3.3       For term babies who are critically ill or have just had surgery, consider  
21                   giving parenteral energy at the lower end of the starting range in

1 recommendation 1.3.1, and gradually increase to the intended  
2 maintenance intake.

To find out why the committee made the recommendations on the energy needs of babies on neonatal parenteral nutrition and how they might affect practice, see [rationale and impact](#).

### 3 **1.4 Neonatal parenteral nutrition volume**

4 1.4.1 [Standardised neonatal parenteral nutrition \('standardised bags'\)](#) should be  
5 formulated in concentrated solutions to help ensure that the nutritive  
6 element of intravenous fluids is included within the total fluid allowance.

To find out why the committee made the recommendation on neonatal parenteral nutrition volume and how it might affect practice, see [rationale and impact](#).

### 7 **1.5 Constituents of neonatal parenteral nutrition**

#### 8 **Glucose**

9 1.5.1 For preterm and term babies, give glucose as follows:

- 10
- If starting parenteral nutrition in the first 4 days after birth:  
11 – give a starting range of 6 to 9 g/kg/day  
12 – gradually increase (for example, over 4 days) to a maintenance  
13 range of 9 to 16 g/kg/day.
  - If starting parenteral nutrition more than 4 days after birth:  
14 – give a range of 9 to 16 g/kg/day.  
15

To find out why the committee made the recommendation on glucose and how it might affect practice, see [rationale and impact](#).

#### 16 **Amino acids**

17 1.5.2 For preterm babies, give amino acids as follows:

- 18
- If starting parenteral nutrition in the first 4 days after birth:

- 1                   – give a starting range of 1.5 to 2 g/kg/day
- 2                   – gradually increase (for example, over 4 days) to a maintenance
- 3                   range of 3 to 4 g/kg/day.
- 4                   • If starting parenteral nutrition more than 4 days after birth:
- 5                   – give a range of 3 to 4 g/kg/day.

6   1.5.3       For term babies, give amino acids as follows:

- 7                   • If starting parenteral nutrition in the first 4 days after birth:
- 8                   – give a starting range of 1 to 2 g/kg/day
- 9                   – gradually increase (for example, over 4 days) to a maintenance
- 10                  range of 2.5 to 3 g/kg/day.
- 11                  • If starting parenteral nutrition more than 4 days after birth:
- 12                  – give a range of 2.5 to 3 g/kg/day.

To find out why the committee made the recommendations on amino acids and how they might affect practice, see [rationale and impact](#).

### 13   **Lipids and lipid emulsions**

14   1.5.4       For preterm and term babies, give lipids as follows:

- 15                  • If starting parenteral nutrition in the first 4 days after birth:
- 16                  – give a starting range of 1 to 2 g/kg/day
- 17                  – gradually increase (for example, in daily increments of 0.5 to
- 18                  1 g/kg/day) to a maintenance range of 3 to 4 g/kg/day.
- 19                  • If starting parenteral nutrition more than 4 days after birth:
- 20                  – give a range of 2.5 to 3 g/kg/day.

21   1.5.5       For preterm and term babies with parenteral nutrition-associated liver

22                  disease, consider giving fish oil-containing lipid emulsions.

To find out why the committee made the recommendations on lipids and lipid emulsions and how they might affect practice, see [rationale and impact](#).

1 **Ratios of non-nitrogen energy to nitrogen, and carbohydrates to lipids**

2 1.5.6 When giving neonatal parenteral nutrition to preterm or term babies:

- 3
- 4 • use the values for each individual component in  
recommendations 1.5.1 to 1.5.4
  - 5 • provide non-nitrogen energy as 60% to 75% carbohydrate and 25% to  
6 40% lipid
  - 7 • use a non-nitrogen energy to nitrogen ratio in a range of 20 to 30 kcal  
8 of non-nitrogen energy per gram of amino acids (this equates to 30 to  
9 40 kcal of total energy per gram of amino acid).

10 1.5.7 When altering the amount of neonatal parenteral nutrition, maintain the  
11 non-nitrogen energy to nitrogen ratio, and the carbohydrate to lipid ratio,  
12 to keep within the ranges of ratios specified in recommendation 1.5.6.

To find out why the committee made the recommendations on ratios of non-nitrogen to nitrogen energy and carbohydrates to lipids and how they might affect practice, and why the committee decided not to make recommendations about ratios of phosphate to amino acids, see [rationale and impact](#).

13 **Iron**

14 1.5.8 Do not give intravenous parenteral iron supplements to preterm or term  
15 babies on neonatal parenteral nutrition who are younger than 28 days.

16 1.5.9 For preterm babies on neonatal parenteral nutrition who are 28 days or  
17 older, monitor for iron deficiency and treat if necessary (see  
18 recommendation 1.7.11).

To find out why the committee made the recommendations on iron and how they might affect practice, see [rationale and impact](#).

19 **Acetate**

20 1.5.10 Only consider including acetate in parenteral nutrition if hyperchloraemia  
21 occurs despite other methods to reduce chloride intake.



To find out why the committee made the recommendation on acetate and how it might affect practice, see [rationale and impact](#).

1 **Calcium**

2 1.5.11 For preterm and term babies, give calcium as follows:

- 3
- 4 • If starting parenteral nutrition in the first 48 hours after birth:
    - 5 – give a starting range of 0.8 to 1 mmol/kg/day
    - 6 – increase to a maintenance range of 1.5 to 2 mmol/kg/day after 48 hours.
  - 7 • If starting parenteral nutrition more than 48 hours, give a range of 1.5 to
  - 8 2 mmol/kg/day.

9 **Phosphate**

10 1.5.12 For preterm and term babies, give phosphate as follows:

- 11
- 12 • If starting parenteral nutrition in the first 48 hours after birth:
    - 13 – give 1 mmol/kg/day
    - 14 – increase to a maintenance dosage of 2 mmol/kg/day after 48 hours.
  - 15 • If starting parenteral nutrition more than 48 hours, give 2 mmol/kg/day.
  - 16 • Give a higher dosage of phosphate if indicated by serum phosphate monitoring.

17 1.5.13 Be aware that preterm babies may be at increased risk of phosphate

18 deficit requiring additional phosphate supplementation.

19 **Ratio of calcium to phosphate**

20 1.5.14 Use a calcium to phosphate ratio of between 0.75:1 and 1:1 for both

21 preterm and term babies on neonatal parenteral nutrition.

To find out why the committee made the recommendations on calcium and phosphate and how they might affect practice, see [rationale and impact](#).

1 **Other constituents of neonatal parenteral nutrition – general principles**

2 ***Vitamins***

3 1.5.15 Give daily intravenous fat-soluble and water-soluble vitamins ideally from  
4 the outset, but as soon as possible after starting parenteral nutrition.

5 1.5.16 Give fat-soluble and water-soluble vitamins in the intravenous lipid  
6 emulsion to improve their stability.

7 ***Electrolytes***

8 1.5.17 Give sodium and potassium in parenteral nutrition to maintain standard  
9 daily requirements, adjusted as necessary for the individual baby.

10 1.5.18 Be aware that even if the parenteral nutrition solution contains sodium and  
11 potassium, additional supplements of these electrolytes can be given  
12 using a separate intravenous infusion.

13 ***Magnesium***

14 1.5.19 Give magnesium in parenteral nutrition ideally from the outset, but as  
15 soon as possible after starting parenteral nutrition.

16 ***Trace elements***

17 1.5.20 Give daily intravenous trace elements ideally from the outset, but as soon  
18 as possible after starting parenteral nutrition.

To find out why the committee made the recommendations on general principles of other constituents of neonatal parenteral nutrition and how they might affect practice, see [rationale and impact](#).

19 **1.6 Standardised neonatal parenteral nutrition formulations**  
20 ***(‘standardised bags’)***

21 1.6.1 When starting neonatal parenteral nutrition for preterm and term babies,  
22 use a standardised neonatal parenteral nutrition formulation  
23 (‘standardised bag’).

24 1.6.2 Standardised bags should:

- 1           • be formulated to allow delivery of parenteral nutrition as recommended
- 2           in the sections on [neonatal parenteral nutrition volume](#) and [constituents](#)
- 3           [of neonatal parenteral nutrition](#)
- 4           • be prepared following nationally agreed quality standards.

5 1.6.3      Continue with a standardised bag unless an [individualised parenteral](#)  
6           [nutrition formulation](#) is indicated, for example, if the baby:

- 7           • has complex disorders associated with a fluid and electrolyte imbalance
- 8           • has renal failure.

To find out why the committee made the recommendations on standardised neonatal parenteral nutrition formulations ('standardised bags') and how they might affect practice, see [rationale and impact](#).

## 9 **1.7        Monitoring neonatal parenteral nutrition**

10 1.7.1      When taking blood samples to monitor neonatal parenteral nutrition:

- 11           • collect the minimum blood volume needed for the tests
- 12           • use a protocol agreed with the local clinical laboratory to retrieve as
- 13           much information as possible from the sample **and**
- 14           • coordinate the timing of blood tests to minimise the number of blood
- 15           samples needed.

### 16 **Blood glucose**

17 1.7.2      Measure the blood glucose level:

- 18           • 1 to 2 hours after first starting parenteral nutrition **and**
- 19           • 1 to 2 hours after each change of parenteral nutrition bag (usually every
- 20           24 or 48 hours).

21 1.7.3      Measure blood glucose more frequently if:

- 22           • the baby has previously had hypoglycaemia or hyperglycaemia
- 23           • the dosage of intravenous glucose has been changed
- 24           • there are clinical reasons for concern, for example, sepsis or seizures.

1 **Blood pH, potassium, chloride and calcium**

2 1.7.4 Measure the blood pH, potassium, chloride and calcium levels:

- 3
- daily when starting and increasing parenteral nutrition
  - twice weekly after reaching a maintenance parenteral nutrition.
- 4

5 1.7.5 Measure blood pH, potassium, chloride or calcium more frequently if:

- 6
- the baby has previously had levels of these components outside the
  - 7 normal range
  - the dosages of intravenous potassium, chloride or calcium have been
  - 8 changed
  - 9
  - there are clinical reasons for concern, for example, in critically ill
  - 10 babies.
  - 11

12 **Serum triglycerides**

13 1.7.6 Measure serum triglycerides:

- 14
- daily while increasing the intravenous lipid dosage
  - weekly after reaching a maintenance intravenous lipid dosage.
- 15

16 1.7.7 Measure serum triglycerides more frequently, but not more than once a

17 day, if:

- 18
- the level is greater than 2.8 mmol/litre
  - there are clinical reasons for concern, for example, in critically ill babies
  - 19 or if a blood sample is lipaemic.
  - 20

21 1.7.8 Be aware that ongoing serum triglycerides monitoring may not be needed

22 for stable babies transitioning from parenteral nutrition to enteral nutrition.

23 **Serum or plasma phosphate**

24 1.7.9 Measure the serum or plasma phosphate level:

- 25
- daily while increasing the intravenous phosphate dosage
  - weekly after reaching a maintenance intravenous phosphate dosage.
- 26

- 1 1.7.10 Consider measuring serum or plasma phosphate more frequently:
- 2
- 3 • if the level has been outside the normal range
  - 4 • if there are clinical reasons for concern, for example, metabolic bone disease
  - 5 • for babies born at less than 32<sup>+0</sup> weeks.

## 6 **Iron status**

- 7 1.7.11 Measure ferritin, iron and transferrin saturation if a preterm baby is on
- 8 parenteral nutrition for more than 28 days.

## 9 **Liver function**

- 10 1.7.12 Measure liver function weekly in babies on parenteral nutrition.
- 11 1.7.13 Measure liver function more frequently than weekly if there are clinical
- 12 concerns or previous liver function test levels outside the normal range.

To find out why the committee made the recommendations on monitoring neonatal parenteral nutrition and how they might affect practice, see [rationale and impact](#).

## 13 **1.8 Stopping neonatal parenteral nutrition**

- 14 1.8.1 For all babies, take into account the following when deciding when to stop
- 15 parenteral nutrition:
- 16 • the baby's tolerance of enteral feeds
  - 17 • the amount of nutrition being delivered by enteral feeds (volume and
  - 18 composition)
  - 19 • the relative contribution of parenteral nutrition and enteral nutrition to
  - 20 the baby's total nutritional requirement
  - 21 • the likely benefit of the nutritional intake compared with the risk of
  - 22 venous catheter sepsis
  - 23 • the individual baby's particular circumstances, for example, a baby with
  - 24 complex needs such as short bowel syndrome, increased stoma losses
  - 25 or slow growth may need long-term parenteral nutrition.

1 1.8.2 For babies born before 28<sup>+0</sup> weeks, consider stopping parenteral nutrition  
2 within 24 hours once the enteral feed volume is 140 to 150 ml/kg/day.

3 1.8.3 For preterm babies born at or after 28<sup>+0</sup> weeks, consider stopping  
4 parenteral nutrition within 24 hours if the enteral feed volume tolerated is  
5 120 to 140 ml/kg/day.

To find out why the committee made the recommendations on stopping neonatal parenteral nutrition and how they might affect practice, see [rationale and impact](#).

## 6 **1.9 Service design**

7 1.9.1 Neonatal parenteral nutrition services should be supported by a specialist  
8 multidisciplinary team. Such teams could be based locally or within a  
9 clinical network.

10 1.9.2 The neonatal parenteral nutrition multidisciplinary team should include a  
11 consultant neonatologist or paediatrician with a special interest in  
12 neonatology, a neonatal pharmacist and a neonatal dietitian, and should  
13 have access to the following:

- 14 • a neonatal nurse
- 15 • a paediatric gastroenterologist
- 16 • an expert in clinical biochemistry.

17 1.9.3 The neonatal parenteral nutrition multidisciplinary team should be  
18 responsible for:

- 19 • governance, including:
  - 20 – agreeing policies and protocols for the neonatal parenteral nutrition
  - 21 service
  - 22 – ensuring that policies and protocols for neonatal parenteral nutrition
  - 23 are followed and audited
  - 24 – monitoring clinical outcomes
- 25 • supporting delivery of parenteral nutrition, including:
  - 26 – providing clinical advice

- 1                   – providing enhanced multidisciplinary team input for babies with  
2                   complex needs, for example, babies with short bowel syndrome who  
3                   may need long-term parenteral nutrition.

To find out why the committee made the recommendations on service design and how they might affect services, see [rationale and impact](#).

4   **1.10    Information and support for parents and carers**

5   1.10.1   Ask parents and carers how and when they would like to receive  
6            information and updates, and how much information they would like about  
7            their baby’s care.

8   1.10.2   Topics to discuss with parents or carers include:

- 9            • why their baby needs parenteral nutrition  
10           • what parenteral nutrition involves  
11           • the importance of good nutrition for newborn babies  
12           • how long their baby is likely to need parenteral nutrition for  
13           • common concerns, for example, central venous catheter placement,  
14            the risk of catheter-related infections, taking blood samples, and  
15            whether they can hold and care for their baby  
16           • simultaneous enteral feeding, unless this is not possible  
17           • how their baby’s progress will be monitored  
18           • how their baby will be weaned off parenteral nutrition.

19  1.10.3   Give information to parents or carers that:

- 20           • is tailored to their baby’s circumstances  
21           • meets their needs and preferences  
22           • is up to date, relevant and consistent between healthcare professionals  
23           • is available in suitable formats (written and spoken, with information  
24            available to take away).

25           For more guidance on communication (including different formats and  
26            languages), providing information, and shared decision making, see the  
27            [NICE guideline on patient experience in adult NHS services](#).

- 1 1.10.4 Provide regular opportunities and time for parents and carers to discuss  
2 their baby's care, ask questions about the information they have been  
3 given, and discuss concerns.

To find out why the committee made the recommendations on information and support for parents and carers of babies who need neonatal parenteral nutrition and how they might affect practice, see [rationale and impact](#).

#### 4 ***Terms used in this guideline***

##### 5 **Individualised parenteral nutrition formulations**

6 Aqueous and lipid parenteral nutrition solutions that meet the nutritional  
7 requirements of an individual baby. The solutions are not pre-formulated and have to  
8 be prescribed and made up each time they are needed, on an individual basis for  
9 each baby. Electrolytes can be added and macronutrients or micronutrients can be  
10 adjusted as necessary.

##### 11 **Nominal group consensus method**

12 This is a structured method focusing on the opinions of individuals within a group to  
13 reach a consensus. Because of the focus on individuals, it is referred to as a  
14 'nominal group' technique. It involves anonymous voting with an opportunity to  
15 provide comments. Options with low agreement are eliminated and options with high  
16 agreement are retained. Using the comments that individuals provide, options with  
17 medium agreement are revised and then considered in a second round.

##### 18 **Osmolality or osmolarity**

19 Measurement of the number of dissolved particles present in a solution to indicate  
20 fluid concentration. It is defined as the number of osmoles of solute per kilogram of  
21 solvent (osmolality), or the number of osmoles of solute per litre of solution  
22 (osmolarity).

##### 23 **Preterm**

24 A baby born before 37<sup>+0</sup> weeks. This can be subdivided further:

- 25
- extremely preterm: babies born at less than 28<sup>+0</sup> weeks



- 1 • very preterm: babies born at between 28<sup>+0</sup> and 31<sup>+6</sup> weeks
- 2 • moderate to late preterm: babies born at between 32<sup>+0</sup> and 36<sup>+6</sup> weeks.

### 3 **Standardised neonatal parenteral nutrition ('standardised bags')**

4 Standardised bags contain pre-formulated aqueous and lipid parenteral nutrition  
5 solutions made to a set composition that is not varied. They are ready to use and  
6 aim to meet the nutritional and clinical needs of a defined group of babies. Additional  
7 intravenous infusions are sometimes used to meet more individualised fluid or  
8 electrolyte requirements.

9 Standardised bags are prescribed as part of a standardised parenteral nutrition  
10 regimen: a choice of standardised bags that are given at the appropriate volume to  
11 meet the nutritional and clinical needs of a defined group of babies.

## 12 **Recommendations for research**

13 The guideline committee has made the following recommendations for research.

### 14 ***Key recommendations for research***

#### 15 **1 Information and support**

16 What are the information and support needs of parents and carers with babies on  
17 parenteral nutrition?

18 To find out why the committee made the research recommendation on information  
19 and support, see [rationale and impact](#).

#### 20 **2 Ratios of non-nitrogen energy to nitrogen**

21 What is the optimal ratio of non-nitrogen energy to nitrogen in parenteral nutrition for  
22 preterm and term babies?

23 To find out why the committee made the research recommendation on the ratio of  
24 non-nitrogen energy to nitrogen in parenteral nutrition, see [rationale and impact](#).

#### 25 **3 Timing of starting neonatal parenteral nutrition**

26 What is the optimal timeframe for starting parenteral nutrition in term babies who are  
27 critically ill or require surgery?

1 To find out why the committee made the research recommendation on the timing of  
2 starting neonatal parenteral nutrition, see [rationale and impact](#).

### 3 **4 Venous access**

4 What overall [osmolality](#) (or concentration of calcium and glucose/dextrose) in  
5 parenteral nutrition can determine whether to administer centrally or peripherally?

6 To find out why the committee made the research recommendation on using  
7 osmolality to determine whether to administer centrally or peripherally, see [rationale](#)  
8 [and impact](#).

## 9 **Rationale and impact**

10 These sections briefly explain why the committee made the recommendations and  
11 how they might affect services. They link to details of the evidence and a full  
12 description of the committee's discussion.

### 13 ***Indications for, and timing of, neonatal parenteral nutrition***

14 Recommendations [1.1.1 to 1.1.6](#)

### 15 **Why the committee made the recommendations**

#### 16 ***Indications for neonatal parenteral nutrition (recommendations 1.1.1 to 1.1.3)***

17 There was no evidence on the indications for neonatal parenteral nutrition, and  
18 limited evidence about the timeframe in which it should be provided, so the  
19 committee used their knowledge and clinical expertise to make the  
20 recommendations.

21 The committee agreed that all preterm babies born before 31<sup>+0</sup> weeks should receive  
22 parenteral nutrition from birth until they transition to enteral feeds. Even though there  
23 was no specific evidence for this, the committee agreed that there is a risk of  
24 significant deficits in nutrition and short-term and long-term adverse events if babies  
25 born at 30<sup>+6</sup> weeks or earlier are not supported by parenteral nutrition from birth.

26 For preterm babies born at or after 31<sup>+0</sup> weeks, it needs to be established whether  
27 adequate progress is made with enteral feeding within the first 72 hours after birth. If  
28 babies have difficulties tolerating enteral feeds during this time, parenteral nutrition

1 should be provided without delay. The committee was aware of evidence that this  
2 group of moderately preterm babies is at increased risk of long-term  
3 neurodevelopmental problems, and that optimal early nutrition may reduce the risk.

4 The committee discussed the influence of gestational age and birthweight on gut  
5 maturity and the baby's ability to tolerate enteral feeds. Although weight is closely  
6 linked to age, the committee had concerns that including more than 1 parameter may  
7 lead to uncertainty in deciding when to start parenteral nutrition, so they based the  
8 recommendations solely on gestational age at birth.

9 Critically ill term babies (with, for example, sepsis), and babies with a congenital gut  
10 disorder or a major cardiac disorder, may be unlikely to make progress on enteral  
11 feeding. Because of this, the committee made a recommendation on parenteral  
12 feeding for these babies.

13 ***Indications for starting neonatal parenteral nutrition if enteral feeds are***  
14 ***stopped (recommendations 1.1.4 and 1.1.5)***

15 The committee agreed the timings based on their experience and expertise, and  
16 because preterm babies have limited stores and the potential for accumulating  
17 deficits. For term babies, the committee based the recommendation on current  
18 practice and their knowledge of the more replete nutritional stores of a baby born at  
19 term.

20 ***Timing of starting parenteral nutrition (recommendation 1.1.6)***

21 There was evidence to show that, for preterm babies, there are some benefits to  
22 starting parenteral nutrition early. However, the definition of 'early' varied in the  
23 evidence (ranging from 2 hours to 36 hours without very clear descriptions of the  
24 enteral feeding regimen), and there was no consistent pattern of findings. There was  
25 no evidence for term babies.

26 The timeframe for starting parenteral nutrition is therefore based on what the  
27 committee believe is achievable and safe. The committee agreed that starting  
28 parenteral nutrition within 8 hours of the decision being made to provide it would  
29 reduce the risks of a nutritional deficit developing for the smallest babies (born at

1 less than 31 weeks). In addition, the committee noted that this timeframe would allow  
2 for placement of central lines if needed.

3 The committee discussed whether different timeframes should be recommended for  
4 preterm and term babies. Based on their experience, they noted that without  
5 parenteral nutrition, preterm babies will develop a nutritional deficit more rapidly than  
6 term babies who have greater nutritional reserves; therefore, the committee agreed  
7 that it may take longer to decide whether parenteral nutrition in term babies is  
8 needed. However, once the decision is made that parenteral nutrition is needed, it  
9 should be started within 8 hours, regardless of whether babies are term or preterm.

10 The committee recognised the need for further research to inform the timing of  
11 starting parenteral nutrition for term babies who are critically ill or require surgery.

### 12 **How the recommendations might affect practice**

13 The committee agreed that the recommendations would improve consistency of care  
14 across neonatal units, and ensure that the nutritional needs of vulnerable babies are  
15 met. Hospitals providing care for babies for whom parenteral nutrition is indicated  
16 would have to provide access to parenteral nutrition. If a hospital does not have  
17 access to neonatal parenteral nutrition, babies would need to be transferred to a unit  
18 that could provide it.

19 Early provision may be more costly because parenteral nutrition and staff would  
20 need to be available out-of-hours (including during weekends) to administer  
21 parenteral nutrition within the first 8 hours. However, costs can be reduced by using  
22 standardised parenteral nutrition bags that can be stored and be readily accessible.

23 The committee believe that there should be no reason why neonatal units cannot  
24 stock standardised bags because they have a long enough shelf life to enable  
25 storage, as long as a system of stock rotation is in place. The committee also agreed  
26 that the costs of early administration would be offset by the positive impact of early  
27 optimal nutrition.

28 Full details of the evidence and the committee's discussion are in [evidence review](#)  
29 [A1: predictors of enteral feeding success](#) and [evidence review A2: optimal timeframe](#)  
30 [to start parenteral nutrition](#).

1 [Return to recommendations](#)

## 2 ***Administration of neonatal parenteral nutrition***

3 Recommendations [1.2.1 to 1.2.4](#)

### 4 **Why the committee made the recommendations**

#### 5 ***Venous access (recommendations 1.2.1 and 1.2.2)***

6 There was some evidence that included a comparison of fluid concentrations (as  
7 measured by [osmolality or osmolarity](#), which depends on the level of calcium and  
8 glucose within the same amount of fluid) for peripheral venous lines. This showed  
9 peripheral insertion to be safe at 2 different levels of concentration. However, there  
10 was no evidence that compared centrally with peripherally inserted catheters for any  
11 given level of concentration of parenteral nutrition. Therefore, the committee made  
12 their recommendations using the presented data, as well as their knowledge and  
13 clinical expertise.

14 The committee discussed the risks and benefits associated with centrally and  
15 peripherally inserted catheters. The committee acknowledged that there is variation  
16 in clinical practice, and some units routinely use peripherally inserted catheters,  
17 whereas others prefer centrally inserted catheters and avoid using peripherally  
18 inserted catheters.

19 The committee agreed that centrally inserted catheters should normally be the  
20 preferred option for delivering neonatal parenteral nutrition. This is because centrally  
21 inserted catheters have a longer lifespan, and the central vein is bigger and has a  
22 lower risk of thrombophlebitis. However, they also agreed that peripherally inserted  
23 catheters can be used safely (which was supported by the evidence) when  
24 parenteral nutrition is given over short periods, and should be used when parenteral  
25 nutrition would otherwise be delayed or interrupted (for example, because a central  
26 venous catheter has stopped working and needs to be removed, or there were  
27 concerns about line infection).

28 The benefits and risks of surgically inserted central catheters were also discussed by  
29 the committee and recommendations were made that these should only be used in

1 exceptional circumstances when non-surgical insertion is not possible, or it is  
2 expected that parenteral nutrition would be needed for a long time.

3 Because of the limited evidence, the committee decided to prioritise this topic for  
4 further research. This is important because peripheral lines (although not the  
5 preferred choice of the committee) are generally easier to insert, and are very  
6 commonly used for a number of indications on neonatal units. However, they have a  
7 shorter life span and therefore would need to be changed more frequently. As the  
8 infusions run into a smaller peripheral vein, there is a greater risk of the infusion  
9 causing direct damage to the vein. This is particularly true if there is a higher  
10 concentration (as measured by osmolality or osmolarity, depending on the unit of  
11 measurement) of the parenteral nutrition infusion fluid, for example, a formulation  
12 with a higher dextrose load.

### 13 ***Protection from light (recommendations 1.2.3 and 1.2.4)***

14 Photo-degradation and oxidation are processes that do not lend themselves to  
15 comparative clinical studies (because of safety risks if the integrity of the solution is  
16 compromised) that are commonly used as evidence in NICE guidelines, so the  
17 committee made the recommendation based on a formal [nominal group consensus](#)  
18 [method](#) and their knowledge and experience.

19 The committee discussed photo-degradation and oxidation of parenteral nutrition  
20 solutions (including aqueous and lipid components), which can be managed by  
21 protecting both the infusion set (tubing) and bag from light. The committee discussed  
22 whether to recommend protecting just the bag, or the bag, the tubing and syringe.  
23 They recognised that it is simple to cover the bag and this is already done in current  
24 practice. However, they agreed that it would also be best practice to protect the  
25 infusion set and syringe of both aqueous and lipid parenteral nutrition solutions. They  
26 recommended that this should be considered even though this would, in some units,  
27 involve needing to use a different type of infusion set.

### 28 ***Filtration***

29 The committee acknowledged that adding a terminal filter to the infusion set makes  
30 giving parenteral nutrition significantly more expensive. Moreover, they were not  
31 convinced that the evidence underpinning the consensus statements would be

1 strong enough for to support their use given the economic implications. Given these  
2 uncertainties and costs, the committee were not able to make a recommendation  
3 related to filtration.

#### 4 **How the recommendations might affect practice**

##### 5 ***Venous access***

6 The recommendations reinforce current best practice. The recommendations may  
7 affect clinical practice by reducing the current delay that some units experience when  
8 siting a central line for giving parenteral nutrition, because peripherally inserted  
9 catheters may now be used as a short-term alternative.

##### 10 ***Protection from light***

11 Any likely changes in practice and costs associated with light-protected bags and  
12 light-protected tubing will be outweighed by the benefits associated with preserving  
13 the integrity of the parenteral nutrition solution.

14 Full details of the evidence and the committee's discussion are in in [evidence review](#)  
15 [B: venous access](#) and [evidence review J: general principles](#).

16 [Return to recommendations](#)

#### 17 ***Energy needs of babies on neonatal parenteral nutrition***

18 Recommendations [1.3.1 to 1.3.3](#)

##### 19 **Why the committee made the recommendations**

20 There was limited evidence on energy needs for babies on parenteral nutrition, so  
21 the committee used their knowledge and clinical expertise to give a starting and  
22 maintenance range, and an example of how this should be increased gradually. The  
23 committee discussed the number of days over which energy intake should increase  
24 to reach the intended maintenance level, and agreed to align this with the  
25 recommendations on lipid, glucose and amino acid increases.

26 The committee agreed that babies who start parenteral nutrition in the first 4 days  
27 after birth should have a starting range and increase up to a maintenance range over  
28 approximately 4 days. This timeframe was selected because fluid volume targets are

1 commonly increased over the first few days of life and this allows increasing  
2 amounts of nutrition to be given parenterally.

3 For babies who start parenteral nutrition more than 4 days after birth, the fluid targets  
4 will have already increased, so this allows parenteral nutrition to be started using  
5 maintenance ranges.

6 The energy requirements were taken from the committee's knowledge, informed (to  
7 a limited extent) by the evidence, and cross-referenced to the energy delivered by  
8 the combined constituent components (in the section on [constituents of neonatal  
9 parenteral nutrition](#)).

10 The committee acknowledged that parenteral nutrition-related complications may be  
11 more likely in term babies who are critically ill or have just had surgery. They agreed  
12 that giving energy at the lower range would be more appropriate for these groups  
13 because the energy stores of term babies tend to be more replete.

#### 14 **How the recommendations might affect practice**

15 The committee agreed that the recommendations would improve consistency of care  
16 across neonatal units and would not incur extra costs or increase resource use.  
17 Providing the appropriate nutritional intake may avoid additional costs associated  
18 with nutritional deficit or providing excess energy.

19 Full details of the evidence and the committee's discussion are in [evidence review C:  
20 energy needs](#).

21 [Return to recommendations](#)

#### 22 ***Neonatal parenteral nutrition volume***

23 Recommendation [1.4.1](#)

#### 24 **Why the committee made the recommendation**

25 The recommendation on parenteral nutrition fluid volume was not developed by the  
26 usual NICE guideline systematic review process. The committee agreed the  
27 recommendation using a formal [nominal group consensus method](#) as well as their  
28 knowledge and experience.



1 The total fluid requirement for preterm and term babies is a complex topic, and was  
2 outside the scope of this guideline. Nevertheless, it is an important factor in providing  
3 neonatal parenteral nutrition. In some situations, the total fluid allowance may be  
4 restricted or a significant proportion of the allowance might be required for other  
5 purposes (for example, other intravenous drug infusions). The committee recognised  
6 that this could result in difficulties in giving the required amount of parenteral  
7 nutrition. In order to minimise this risk, the committee agreed that standardised  
8 neonatal parenteral nutrition formulations ('standardised bags') should use the  
9 smallest fluid volume possible (see the section on [standardised neonatal nutrition](#)  
10 [formulations](#)). Concentrating parenteral nutrition in this way will facilitate the  
11 provision of nutritional requirements within the total fluid allowance.

### 12 **How the recommendation might affect practice**

13 The committee agreed that the recommendation will reinforce current best practice.

14 Full details of the evidence and the committee's discussion are in [evidence review J:](#)  
15 [general principles](#).

16 [Return to recommendations](#)

### 17 ***Constituents of neonatal parenteral nutrition – glucose***

18 Recommendation [1.5.1](#)

#### 19 **Why the committee made the recommendation**

20 The evidence on glucose was difficult to interpret and draw any conclusions from.  
21 Only 1 study has been conducted that varied glucose intake without also varying  
22 other constituents (such as amino acids and lipids), so it is difficult to see what effect  
23 different levels of glucose intake have. Because of this, the committee used their  
24 knowledge and experience of physiological and metabolic requirements, and took  
25 into account the glucose doses used in the studies as well as current practice and  
26 international guidelines, when making their recommendation.

27 The committee decided that the maintenance range should be given for babies who  
28 start parenteral nutrition more than 4 days after birth. This is consistent with the  
29 approximate 4 days by which a maintenance dosage would be reached in babies

1 starting parenteral nutrition from birth, because tolerance would increase during the  
2 first few days of life.

### 3 **How the recommendation might affect practice**

4 The committee agreed that the recommendation will reinforce current best practice.

5 Full details of the evidence and the committee's discussion are in [evidence review](#)  
6 [D1: glucose](#).

7 [Return to recommendations](#)

### 8 ***Constituents of neonatal parenteral nutrition – amino acids***

9 Recommendations [1.5.2 and 1.5.3](#)

#### 10 **Why the committee made the recommendations**

11 There was a lot of evidence related to amino acid intake. However, the evidence was  
12 uncertain, for example, because the studies involved small numbers of babies and  
13 the results were inconsistent, so the committee also used their experience, expertise  
14 and knowledge of current practice to make the recommendations.

15 For preterm babies, 1.5 g/kg/day was chosen as the lower starting dose threshold,  
16 because less than this can result in a negative nitrogen balance. The committee did  
17 not look for evidence on how different amino acid doses affect nitrogen balance, but  
18 used their knowledge of metabolic studies, which are widely used to estimate the  
19 minimum amount of amino acids needed to prevent negative nitrogen balance. The  
20 upper starting dose threshold of 2 g/kg/day was selected because there was  
21 evidence of better growth at a starting dose of 2 g/kg/day of amino acids compared  
22 with less than 2 g/kg/day, but these benefits did not persist at higher amino acid  
23 starting doses (3 g/kg/day).

24 Studies using different maximal amino acid intakes were considered in the evidence  
25 review, and informed the recommended maintenance range. There was some  
26 evidence that a maximal amino acid intake of 3 g/kg/day or more compared with less  
27 than 3 g/kg/day improved growth outcomes, but there was no evidence of reduced  
28 sepsis or neurodevelopmental problems. There was some evidence of appropriate  
29 growth at a maximal intake of 2.7 g/kg/day, but this was supported by early (within

1 the first 24 hours) and progressive enteral feeding. Some babies receiving neonatal  
2 parenteral nutrition will be on no or minimal enteral feeds, or will be unable to  
3 increase enteral feeding in a timely manner. This, combined with the weak evidence  
4 of improved growth at 3 g/kg/day or more, meant that 3 g/kg/day was selected as the  
5 lower end of the maintenance range. However, the committee were split on this point  
6 so a majority decision was taken.

7 The committee agreed, based on their expertise, that it was important to provide an  
8 upper limit for amino acid intake because of possible adverse events such as  
9 acidosis, high serum urea, hypercalcaemia or hypophosphatemia, hypokalaemia and  
10 re-feeding syndrome. The maximal amino acid intake in the studies reviewed was  
11 4 g/kg/day. The committee looked for adverse effects across all the studies in the  
12 evidence review, including those using maximal amounts of over 3.5 g/kg/day, and  
13 found no evidence of harm. However, the committee were concerned that the  
14 absence of evidence of harm is not the same as evidence of absence. It was noted  
15 that higher amino acid intakes need to be supported by sufficient non-nitrogen  
16 energy. The committee followed the evidence in agreeing an upper maintenance  
17 range limit of 4 g/kg/day. They suggested being more vigilant for adverse effects  
18 when using the top half of this maintenance range.

19 Babies on enteral feeds will receive macronutrients from milk in addition to those  
20 from parenteral nutrition. The committee acknowledged that for those babies on  
21 enteral feeds, the proportional decrease in parenteral nutrition as enteral intake  
22 increases will decrease the delivery of amino acids from parenteral nutrition, thus  
23 alleviating risks of excessive amino acid delivery. However, they noted that the  
24 enteral feeding regimen was outside the scope of this guideline, so did not  
25 recommend different ratios for babies on enteral feeds.

26 Most of the studies gradually increased amino acid intake over a number of days to  
27 reach a target dose. However, there was not enough consistent evidence to specify  
28 the number of days over which intake should be increased. The committee  
29 recommended 4 days, based on informal consensus agreement, using their clinical  
30 experience. In addition, the committee agreed that this is approximately how long it  
31 would take to reach the maintenance range if incrementing from the starting range at  
32 rates similar to those used in the included studies. This also matched the

1 recommendations made for glucose and lipids, which is important because nitrogen  
2 to non-nitrogen ratios need to be maintained within the range specified in the  
3 guideline.

4 There was no evidence about amino acids for term babies, so the committee  
5 recommended a lower starting and maintenance dose based on their own expert  
6 consensus and knowledge of nitrogen balance studies. These studies show that  
7 term babies lose less protein than preterm babies, and suggest the amount of amino  
8 acids needed to achieve similar weight gain to term babies on milk feeds.

9 There was no evidence for babies who did not start parenteral nutrition from birth.  
10 The committee agreed, based on their expertise, that babies starting parental  
11 nutrition more than 4 days after birth would be able to tolerate the maintenance  
12 dosage of amino acids.

### 13 **How the recommendations might affect practice**

14 The committee noted that the recommendations will reduce variation in practice.

15 Full details of the evidence and the committee's discussion are in [evidence review](#)  
16 [D2: amino acids](#).

17 [Return to recommendations](#)

### 18 ***Constituents of neonatal parenteral nutrition – lipids and lipid*** 19 ***emulsions***

20 Recommendations [1.5.4 and 1.5.5](#)

### 21 **Why the committee made the recommendations**

22 The evidence was uncertain (there was an inconsistent pattern of benefit and harm),  
23 so the committee also used their experience, expertise and knowledge of current  
24 practice to make the recommendations by informal consensus.

25 There was evidence of both benefit and harm when giving lipids compared with no  
26 lipids but the committee agreed that the benefits of giving lipids outweighed possible  
27 risks. There was evidence that giving lipids in the ranges provided in the studies was  
28 not associated with any harm in the short term. In addition, there was evidence that

1 higher doses may reduce retinopathy of prematurity and necrotising enterocolitis  
2 compared with lower doses. The committee concluded that the ranges in the studies  
3 were safe and effective.

4 In relation to how the target dose is reached, the evidence showed that slowly  
5 increasing lipids from a low starting dose to a target dose may be associated with a  
6 reduced risk of retinopathy of prematurity and hypertriglyceridaemia, compared with  
7 starting at a higher dose and rapidly increasing to the same target dose. The  
8 committee agreed to use similar parameters in the recommendations. Based on their  
9 knowledge of doses of lipids exceeding those used in the studies and the risk of  
10 problems such as hypertriglyceridemia, the committee recommended an upper limit  
11 for the maintenance dose.

12 The committee recommended fish oil-containing lipid emulsions in preterm and term  
13 babies with parenteral nutrition-associated liver disease (PNALD). This was based  
14 on evidence of improved growth, greater resolution of PNALD, and reduced mortality  
15 and hypertriglyceridaemia with fish oil-containing lipid emulsions compared with lipid  
16 emulsions that did not contain fish oils. The available evidence was from preterm  
17 and late preterm babies. However, the recommendation was extended to cover term  
18 babies based on expertise from the committee that late preterm and term babies  
19 often have the same treatment, and similar benefits would be likely for term babies.

20 The committee did not make recommendations for babies with surgical conditions  
21 because there was no evidence of advantage of any type of lipid emulsion over other  
22 lipid formulations. Recommendations were not made for babies without PNALD,  
23 including those at high risk, because there was not conclusive evidence of benefit.

#### 24 **How the recommendations might affect practice**

25 The committee agreed that the recommendations will reinforce and standardise  
26 current best practice.

27 Full details of the evidence and the committee's discussion are in [evidence review](#)  
28 [D3: lipids](#) and [evidence review D4: lipid emulsions](#).

29 [Return to recommendations](#)

1 ***Constituents of neonatal parenteral nutrition – ratios of non-***  
2 ***nitrogen energy to nitrogen, and carbohydrates to lipids***

3 Recommendations [1.5.6 and 1.5.7](#)

4 **Why the committee made the recommendations**

5 ***Ratio of non-nitrogen energy to nitrogen***

6 There was limited evidence, and the evidence did not provide sufficient data to  
7 inform optimal ratios. The committee used their knowledge and experience to agree  
8 ratios, taking into account the available evidence and current practice.

9 When the amount of parenteral nutrition is changing (for example, when transitioning  
10 onto enteral feeding), there is a risk of negative outcomes associated with too low or  
11 too high ratios. Too low a ratio (non-nitrogen energy to nitrogen below 20 kcal per  
12 gram) could cause oxidation of amino acids and high blood urea. Too high a ratio  
13 (non-nitrogen energy to nitrogen above 30 kcal per gram) could result in deposition  
14 of excess body fat, which is associated with metabolic ill health in later life (for  
15 example, risk of cardiovascular disease, diabetes and obesity-related conditions).  
16 Because of these risks, the committee recommended keeping the ratios the same  
17 when changing the amount of parenteral nutrition.

18 The evidence supported the need to give babies enough energy to ensure the  
19 nitrogen provided is retained.

20 Because of the limited evidence, the committee decided to prioritise this topic for  
21 further research. This is important because insufficient non-nitrogen energy  
22 (carbohydrates and lipids) leads to nitrogen (protein) being used for non-growth  
23 purposes so is not available to generate new tissues. An excess of non-nitrogen  
24 energy can lead to increased adiposity and may cause hyperglycaemia or  
25 hypertriglyceridemia. Having more evidence about the optimal ratio of non-nitrogen  
26 energy to nitrogen in parenteral nutrition is therefore needed.

27 ***Ratio of carbohydrates to lipids***

28 There was limited evidence, so the committee used their knowledge and experience  
29 to agree the ratio, taking into account the available evidence and current practice.

1 One study provided lipids in a range from 18% to 40% (meaning that the other 82%  
2 to 60% of non-nitrogen energy was made up of glucose), with better growth  
3 associated with 40% lipid intake.

4 The committee also discussed the recommendations developed for glucose and lipid  
5 dosages (recommendations 1.5.1 and 1.5.4). They agreed that it should be clear to  
6 those prescribing parenteral nutrition that when calculating the relative amounts of  
7 carbohydrate and lipid, the recommended dosages of each of these components  
8 should not be exceeded.

9 The committee decided not to recommend the lower end of the lipid range (18%) that  
10 was used in the evidence because that would lead to a high glucose intake, for  
11 which the risk of hyperglycaemia was considered to be too high. Therefore, the  
12 committee agreed that a lower level of 25% lipid is needed to limit the risk of  
13 hyperglycaemia, and to provide sufficient essential fatty acids and fat-soluble  
14 vitamins. The committee agreed, based on their experience and expertise, that there  
15 should be an upper limit of 40% fat. Even though there is no evidence available to  
16 firmly state the risks of higher lipid provision, the committee agreed 40% would be  
17 safe and not risk fatty liver or raised triglyceride levels.

18 The recommended ranges aim to provide sufficient lipid energy to optimise growth,  
19 provide essential fatty acids and fat-soluble vitamins, and minimise the risk of  
20 hyperglycaemia. However, it is important not to give too much lipid because this  
21 could risk high triglyceride levels, fatty liver and increased fat deposition.

## 22 **Why the committee did not make a recommendation on ratios of phosphate to** 23 **amino acids**

24 The evidence on the relative amounts of amino acids and phosphate to be given in  
25 parenteral nutrition was limited.

26 The committee agreed that the phosphate to amino acid ratios derived from following  
27 the phosphate and amino acid recommendations (1.5.12, 1.5.2 and 1.5.3) in this  
28 guideline are appropriate. However, because the evidence was limited and did not  
29 provide enough detail on the exact amount of phosphate needed per gram of amino  
30 acid, the committee decided not to make a recommendation on specific relative  
31 amounts.

1 **How the recommendations might affect practice**

2 The committee agreed that the recommendations reflect current best practice and  
3 should have little impact on practice. They should reduce any variation across units.

4 Full details of the evidence and the committee's discussion are in [evidence review](#)  
5 [D7: ratio of non-nitrogen energy to nitrogen](#), [evidence review D8: ratio of](#)  
6 [carbohydrates to lipids](#) and [evidence review D10: ratio of phosphate to amino acids](#).

7 [Return to recommendations](#)

8 ***Constituents of neonatal parenteral nutrition – iron***

9 Recommendations [1.5.8 and 1.5.9](#)

10 **Why the committee made the recommendations**

11 There was limited evidence about intravenous iron supplementation for babies  
12 younger than 28 days. The evidence did not show a substantial benefit or harm. The  
13 committee recognised that usual clinical practice in the UK is not to include  
14 intravenous iron in the parenteral nutrition regimen for babies younger than 28 days,  
15 and agreed that there was not enough new evidence to change current practice. In  
16 addition, preterm babies often have blood transfusions that can result in  
17 unpredictable amounts of iron. The committee discussed the potential for iron  
18 overload and toxicity, and used their expertise and experience to recommend that  
19 early supplementation should not be used.

20 The committee agreed that healthcare professionals may need to reconsider iron  
21 supplementation for preterm babies who are 28 days or older based on monitoring  
22 for iron deficiency.

23 **How the recommendations might affect practice**

24 The recommendations reflect current practice, so should not result in any changes.

25 Full details of the evidence and the committee's discussion are in [evidence review](#)  
26 [D5: iron](#).

27 [Return to recommendations](#)



## 1 ***Constituents of neonatal parenteral nutrition – acetate***

2 Recommendation [1.5.10](#)

### 3 **Why the committee made the recommendation**

4 Evidence was limited so the committee also used their knowledge and clinical  
5 expertise to make the recommendation. There was some evidence that using  
6 acetate in parenteral nutrition reduces the risk of hyperchloraemia, but there was no  
7 evidence about the amount of acetate needed. The evidence did not explain how  
8 chloride had been provided and the committee were unconvinced that the  
9 interventions used in the studies reflect current practice. The committee agreed that  
10 using the right balance of parenteral nutrition components and the use of  
11 standardised bags would avoid an excess of chloride and the need to add acetate.

12 The committee acknowledged that parenteral nutrition is not the only source of  
13 chloride (for example, some trace elements are in the form of chloride salts), so an  
14 imbalance may need to be addressed by adding acetate. The committee decided to  
15 highlight that if there is evidence of hyperchloraemia despite trying to reduce chloride  
16 intake, adding acetate to parenteral nutrition should be considered to reduce the risk  
17 of metabolic acidosis secondary to hyperchloraemia.

### 18 **How the recommendation might affect practice**

19 The committee agreed there is variation in clinical practice about the use of acetate.  
20 The recommendation aims to reduce this variation and reinforce best practice by  
21 ensuring that acetate is not used routinely, but only after other attempts to reduce  
22 hyperchloraemia have not been sufficient.

23 Full details of the evidence and the committee's discussion are in [evidence review](#)  
24 [D6: acetate](#).

25 [Return to recommendations](#)

## 26 ***Constituents of neonatal parenteral nutrition – calcium and*** 27 ***phosphate***

28 Recommendations [1.5.11 to 1.5.14](#)

1 **Why the committee made the recommendations**

2 ***Calcium and phosphate (ratio and absolute amounts)***

3 Evidence was limited, and there was inconsistency in the definitions of high and low  
4 levels or concentrations of calcium and phosphate across the included studies, so  
5 the committee also used their knowledge and clinical expertise to make the  
6 recommendations.

7 Although the evidence that was reviewed focused on relative amounts, the  
8 committee decided that recommendations for absolute values were also needed  
9 because the amounts of calcium and phosphate in the evidence reviewed were  
10 lower than those currently given in UK clinical practice. However, the evidence also  
11 showed that higher amounts of calcium and phosphate were beneficial in reducing  
12 the incidence of rickets, fractures and hypercalciuria, and increasing bone mineral  
13 density. This guided the committee to agree that higher amounts of calcium and  
14 phosphate are preferable for preterm and term babies. They decided that a decision  
15 about the absolute amounts would then determine the ratio between these  
16 constituents rather than the other way around.

17 The committee made recommendations for an initial and maintenance dosage and  
18 dosage range of calcium and phosphate that overlap, which means that this would  
19 lead to a ratio between of 0.75:1 and 1:1. The committee recommended total  
20 amounts and a ratio of calcium to phosphate according to the timing of when babies  
21 would start parenteral nutrition after birth (before or after the first 48 hours) rather  
22 than whether or not they are preterm or term. This is because of body fluid  
23 adjustments in the first days of life. A too low or too high amount of calcium and  
24 phosphate and the ratio between them will result in suboptimal bone mineralisation  
25 and urinary losses. They noted that preterm babies may need more calcium and  
26 phosphate, based on their knowledge, fetal accretion studies and potential urinary  
27 phosphate losses. However, they decided not to make different recommendations for  
28 preterm or term babies because blood monitoring will indicate whether this is  
29 needed.

30 The committee also agreed to be more prescriptive in recommending absolute  
31 amounts of phosphate by restricting the dose to set amounts instead of a range. This

1 was because of practical considerations: in most current parenteral preparations,  
2 2 mmol of sodium would be administered for every 1 mmol of phosphate, and higher  
3 sodium intakes would not be recommended within the first 48 hours, before the  
4 expected postnatal diuresis. More flexibility could be applied in the amount of  
5 calcium given to babies because calcium would not alter other electrolyte delivery.  
6 The amounts of both calcium and phosphate would also be restricted by stability  
7 issues, but the committee noted that the amounts recommended could be achieved  
8 within these restrictions.

### 9 **How the recommendations might affect practice**

10 The recommendations on phosphate and calcium are largely in line with existing  
11 guidance and reflect current best practice. There is variation in practice so the  
12 recommendations should ensure consistency of care across different care settings.

13 Full details of the evidence and the committee's discussion are in [evidence review](#)  
14 [D9: ratio of calcium to phosphate](#).

15 [Return to recommendations](#)

### 16 ***Other constituents of neonatal parenteral nutrition – general*** 17 ***principles***

18 Recommendations [1.5.15 to 1.5.20](#)

### 19 **Why the committee made the recommendations**

20 The recommendations were not developed by the usual NICE guideline systematic  
21 review process. The committee agreed the recommendations' evidence statements  
22 using a formal [nominal group consensus method](#), and based the recommendations  
23 on their knowledge and experience.

### 24 ***Vitamins (recommendations 1.5.15 and 1.5.16)***

25 The committee agreed that vitamins are an essential part of a baby's nutritional  
26 needs, and discussed whether vitamins should be provided daily. Babies gain most  
27 of their vitamin reserves from their mother in the third trimester of pregnancy, so  
28 babies born preterm are relatively vitamin deficient. The committee decided that daily  
29 vitamins would improve the vitamin accretion rate and represent best clinical

1 practice. The committee agreed that the recommendation would apply to term  
2 babies, because term babies who need parenteral nutrition are likely to have surgical  
3 problems or to be critically unwell, so will not establish enteral feeding rapidly. In  
4 addition, there was no consensus about making a separate recommendation for term  
5 babies. Although the committee acknowledged that some initial or 'starter' parenteral  
6 nutrition preparations may not contain vitamins, they stressed that starting parenteral  
7 nutrition should not be delayed.

8 Putting fat- and water-soluble vitamins in the lipid emulsion improves their stability  
9 but shortens the shelf life of the lipid emulsion. However, the committee decided that  
10 ensuring vitamin stability was important and putting the vitamins in the lipid emulsion  
11 was therefore recommended. The committee noted that modern parenteral nutrition  
12 preparations generally have longer shelf lives, and so this was a smaller concern  
13 than in the past.

#### 14 ***Electrolytes (recommendations 1.5.17 and 1.5.18)***

15 Serum sodium and potassium levels can change frequently in babies on neonatal  
16 units, and these changes may not be related to parenteral nutrition. How often  
17 sodium and potassium levels need to be checked depends on multiple factors and  
18 will be decided by the local clinical team based on the overall clinical situation.  
19 Sodium and potassium supplementation, in addition to that already contained in  
20 parenteral nutrition, can be given using an additional intravenous infusion. This  
21 allows standardised parenteral nutrition bags to contain sufficient sodium and  
22 potassium to cover usual daily maintenance requirements but allows adjustments to  
23 sodium and potassium delivery to cover additional requirements without having to  
24 interfere with the parenteral nutrition.

#### 25 ***Magnesium (recommendation 1.5.19)***

26 The committee agreed that magnesium is an essential component of parenteral  
27 nutrition because of its important role in skeletal development and in nervous system  
28 and muscle membranes. Although the committee noted that magnesium may not be  
29 immediately available in some initial or 'starter' parenteral nutrition preparations, they  
30 stressed that parenteral nutrition should not be delayed and magnesium should be  
31 added as soon as possible after starting parenteral nutrition.

1 ***Trace elements (recommendation 1.5.20)***

2 The committee agreed that trace elements are an essential component of parenteral  
3 nutrition. Although the committee noted that trace elements may not be immediately  
4 available in some initial or ‘starter’ parenteral nutrition preparations, they stressed  
5 that parenteral nutrition should not be delayed and trace elements should be added  
6 as soon as possible after starting parenteral nutrition.

7 **How the recommendations might affect practice**

8 The committee agreed that the recommendation will reinforce current best practice.

9 Full details of the evidence and the committee’s discussion are in [evidence review J:  
10 general principles](#).

11 [Return to recommendations](#)

12 ***Standardised neonatal parenteral nutrition formulation***  
13 ***(‘standardised bags’)***

14 Recommendations [1.6.1 to 1.6.3](#)

15 **Why the committee made the recommendations**

16 There was limited evidence on whether healthcare professionals should use  
17 parenteral nutrition formulations that are standardised (‘standardised bags’) or  
18 individualised. The committee used the limited evidence, and their knowledge and  
19 clinical expertise, to make the recommendations.

20 The committee agreed that healthcare professionals should use standardised bags  
21 routinely because:

- 22 • standardised bags are immediately available when needed, and suitable for most  
23 babies
- 24 • they help to minimise prescribing errors and clinical variation
- 25 • they can improve compliance with national recommendations on quality control of  
26 parenteral nutrition manufacturing, dispensing, prescribing and administration,  
27 because they must comply with nationally agreed quality standards (in line with

1 the [Royal Pharmaceutical Society and NHS Pharmaceutical Quality Assurance](#)  
2 [Committee standards for the quality assurance of aseptic preparation services](#))

- 3 • they have lower acquisition costs.

4 Individualised bags are not immediately available on a neonatal unit and are more  
5 complex to prescribe. The committee agreed that without good evidence to support  
6 the use of individualised bags, the additional complexity and cost is not justified.

7 Although the committee agreed that standardised bags should be used routinely and  
8 continued once started, individualised parenteral nutrition may be needed for babies  
9 with complex needs, for example, babies with a fluid imbalance.

10 Standardisation of parenteral nutrition is a concept which means that its  
11 effectiveness depends on optimal content for the average baby and its safety is  
12 related to the process of standardisation. Although there was some evidence  
13 suggesting that growth-related outcomes favoured an individualised approach, these  
14 findings were largely dependent on the specifics of what was in the standardised bag  
15 being trialled (which for most studies was not what would currently be  
16 recommended). The committee therefore agreed that, to be effective formulations,  
17 the standardised bags would be made up using the constituents outlined in the  
18 section on [constituents of neonatal parenteral nutrition](#) to provide optimal nutrition.

### 19 **How the recommendations might affect practice**

20 The committee agreed that the recommendations will lead to greater consistency in  
21 clinical practice and improve safety through compliance with national  
22 recommendations for parenteral nutrition manufacturing, dispensing, prescribing and  
23 administration.

24 Full details of the evidence and the committee's discussion are in [evidence review E:](#)  
25 [standardised neonatal parenteral nutrition formulations](#).

26 [Return to recommendations](#)

### 27 ***Monitoring neonatal parenteral nutrition***

28 Recommendations [1.7.1 to 1.7.13](#)

1 **Why the committee made the recommendations**

2 There was no evidence so the committee used their knowledge and clinical expertise  
3 to make the recommendations.

4 ***Monitoring (recommendation 1.7.1)***

5 The committee agreed that regular blood monitoring is needed to detect potential  
6 abnormalities and inform the baby's care. They agreed that the frequency of blood  
7 sampling needs to take into account the clinical stability of the baby, the amount of  
8 blood taken, and should also strike a balance between minimising distress to the  
9 baby (and parents) and obtaining enough information to guide clinical care. To  
10 minimise distress resulting from repeated monitoring, the committee emphasised the  
11 need to retrieve as much information as possible from one sample, so they  
12 recommended combining testing wherever possible and agreeing with the laboratory  
13 the best ways to coordinate this. The committee agreed that taking minimal blood  
14 volumes would be best for the baby, and that this could be achieved by liaising with  
15 the laboratory.

16 The committee recommended minimum frequencies for monitoring parameters, but  
17 they also described situations when increased monitoring may be needed (for  
18 example, when there is a change in the composition of parenteral nutrition or when  
19 the baby is unstable). They also recommended more frequent monitoring when  
20 babies had previous abnormal levels of a particular constituent. However, the  
21 committee did not want to be too prescriptive about the level of abnormality or how  
22 recently this occurred to allow for a degree of clinical judgement tailored to the needs  
23 of each baby.

24 ***Blood glucose (recommendations 1.7.2 and 1.7.3)***

25 The committee agreed that glucose should be monitored when starting parenteral  
26 nutrition and at every change of the bag, for safety reasons. After that, monitoring  
27 should depend on the stability of the baby – that is, an unstable glucose level should  
28 be monitored more frequently because of the risks associated with hyperglycaemia  
29 or hypoglycaemia.

1 **Blood pH, serum potassium, chloride and calcium (recommendations 1.7.4 and**  
2 **1.7.5)**

3 The committee agreed that blood pH, serum potassium, chloride and calcium would  
4 usually need to be monitored when starting and when increasing parenteral nutrition.  
5 Blood pH is important for a number of reasons, for example, chloride levels cannot  
6 be interpreted without knowing the pH, and it is also informative when titrating  
7 acetate. Serum sodium is considered in the section on [other constituents of neonatal](#)  
8 [parenteral nutrition – general principles](#).

9 **Serum triglycerides (recommendations 1.7.6 to 1.7.8)**

10 The committee discussed the variability in monitoring triglycerides in clinical practice,  
11 where some neonatal units monitor more or less frequently, and some neonatal units  
12 do not monitor triglycerides at all. The committee agreed that recommendations  
13 would be useful to improve consistency across clinical practice. They agreed that  
14 triglycerides should be monitored when increasing dosages of lipid, because they  
15 were aware of evidence that suggests that around 10% of babies do not tolerate  
16 recommended intakes of lipids. Monitoring should continue when the maintenance  
17 dosage is reached. The committee agreed that when a baby is unstable, triglycerides  
18 should be monitored to ensure the safety of the baby.

19 **Serum or plasma phosphate (recommendations 1.7.9 and 1.7.10)**

20 The committee agreed that phosphate would initially require daily monitoring  
21 because amino acid intake affects phosphate levels and amino acid intake is  
22 changed every day for the first 4 days of parenteral nutrition.

23 The committee decided that after the maintenance dosage is reached, weekly  
24 monitoring would be safe. More frequent monitoring would be needed if there are  
25 concerns about recent abnormal levels or phosphate levels and bone development,  
26 and for preterm babies born at less than 32<sup>+0</sup> weeks (because preterm babies are at  
27 risk of metabolic bone disease of prematurity where their bones become very brittle  
28 as a result of insufficient mineralisation).

29 **Iron status (recommendation 1.6.11)**

30 The committee agreed that a number of different factors could affect iron status in  
31 babies on parenteral nutrition for longer than 28 days, including the number of



1 transfusions administered as well as the amount of enteral nutrition achieved. It is  
2 therefore important to measure ferritin, and iron and transferrin saturations for babies  
3 who remain on parenteral nutrition after this time.

#### 4 ***Liver function (recommendations 1.6.12 and 1.6.13)***

5 Abnormal liver function tests could indicate the onset of parenteral nutrition-  
6 associated liver disease, so the committee agreed it was important to carry out  
7 regular liver function tests for babies on parenteral nutrition.

#### 8 **How the recommendations might affect practice**

9 Because there is no current consensus on the monitoring of lipids, these  
10 recommendations may change clinical practice. All other recommendations reflect  
11 current practice so the committee agreed there would be no change in practice.

12 Full details of the evidence and the committee's discussion are in [evidence review F:  
13 monitoring neonatal parenteral nutrition](#).

14 [Return to recommendations](#)

#### 15 ***Stopping neonatal parenteral nutrition***

16 Recommendations [1.8.1 to 1.8.3](#)

#### 17 **Why the committee made the recommendations**

18 There was some evidence indicating better growth with stopping parenteral nutrition  
19 at a higher volume of enteral feeds (140 ml/kg/day). However, there were some  
20 inconsistencies between different studies so the committee also used their  
21 knowledge and clinical expertise to make the recommendations. The committee  
22 based the ranges on the baby's age because the balance between prioritising  
23 nutritional intake and minimising the risk of line sepsis may differ depending on the  
24 size of the baby.

25 The lower limit for stopping parenteral nutrition in extremely preterm babies was  
26 taken from the evidence, but the upper limit was based on the committee's  
27 knowledge and experience. In clinical practice, enteral feeds are not normally  
28 fortified at 140 ml/kg/day (as was done in the available evidence), so stopping at this  
29 point may risk nutritional deficits, so the committee recommended an upper

1 threshold of 150 ml/kg/day. This may be considered the threshold at which the risks  
2 of continuing parenteral nutrition outweigh the benefits. The thresholds for stopping  
3 parental nutrition in babies born at or after 28<sup>+0</sup> weeks were based on the  
4 committee's expertise. The energy stores of older preterm babies and term babies  
5 are more replete than those of extremely preterm babies, allowing parenteral  
6 nutrition to be stopped at a lower volume.

7 The committee agreed, based on their expertise, that there were other factors apart  
8 from the volume of enteral feeds that should be considered for all babies before  
9 stopping parenteral nutrition.

### 10 **How the recommendations might affect practice**

11 The committee agreed that the recommendations would reduce variation in clinical  
12 practice. For some services, these recommendations may result in a longer duration  
13 of parenteral nutrition, which would have associated costs. However, for other  
14 services, these recommendations would result in providing parenteral nutrition for a  
15 shorter duration and may produce cost savings.

16 The committee discussed whether the recommendations could result in smaller  
17 volumes of parenteral nutrition being prescribed during the transition from parenteral  
18 to enteral nutrition, and that these small volumes would not be an efficient use of  
19 costs or resources. However, the committee agreed this could be mitigated by giving  
20 consideration to residual prescribed volumes of parenteral nutrition when making the  
21 decision to stop parenteral nutrition.

22 Full details of the evidence and the committee's discussion are in [evidence review G:  
23 stopping parenteral nutrition](#).

24 [Return to recommendations](#)

### 25 ***Service design***

26 Recommendations [1.9.1 to 1.9.3](#)

### 27 **Why the committee made the recommendations**

28 There was some evidence that multidisciplinary team services improve outcomes in  
29 newborn babies. However, there were many limitations relating to the evidence, and

1 none of the studies were conducted in the UK. The committee made  
2 recommendations that they considered would provide optimum care for babies on  
3 parenteral nutrition, using the limited evidence (relating to the clinical role of  
4 multidisciplinary teams), and their knowledge of current clinical practice reports in the  
5 public domain (particularly related to the team's role in service governance).

6 The committee acknowledged that inadequacies in the provision of neonatal  
7 parenteral nutrition had been highlighted nearly a decade ago in a 2011 report from  
8 the Paediatric Chief Pharmacists Group, which highlighted the need for  
9 improvements in practice ([Improving practice and reducing risk in the provision of](#)  
10 [parenteral nutrition for neonates and children](#)).

11 To address these shortcomings and ensure the safety of babies receiving parenteral  
12 nutrition, the committee agreed that neonatal parenteral nutrition services should be  
13 overseen and supported by a multidisciplinary team with expertise in neonatal  
14 parenteral nutrition. The committee specified the membership of the team to ensure  
15 that there is expertise in the clinical, prescribing and nutritional core components of  
16 neonatal parenteral nutrition (a consultant neonatologist or paediatrician with a  
17 special interest in neonatology, as well as a neonatal pharmacist and dietitian). The  
18 committee also recognised that access to other roles may be required, such as  
19 neonatal nursing, paediatric gastroenterology or expertise in clinical biochemistry to  
20 cover specific clinical or specialist areas of parenteral nutrition. The committee listed  
21 these different professionals, but agreed that all those listed would not need to see  
22 every baby routinely within the unit. The committee decided that an oversight or  
23 support team could be available at a local level or within a clinical network to ensure  
24 that every unit has access to these professionals when needed.

25 The committee agreed that enhanced multidisciplinary team input (for assessment  
26 and management) may be needed for babies with complex needs, for example,  
27 babies with short gut who need parenteral nutrition for long time periods and who  
28 therefore have an increased risk of complications. This may involve more frequent  
29 meetings between multidisciplinary team members, and may also mean that other  
30 specialists are included in the multidisciplinary team, for example, a  
31 gastroenterologist. The committee did not want to be prescriptive about which

1 professionals should be in the 'enhanced' multidisciplinary team because this would  
2 depend on the needs of each baby.

### 3 **How the recommendations might affect services**

4 The committee noted that there is currently variation in practice regarding the  
5 availability of specialists who are included within multidisciplinary teams, but agreed  
6 that these professionals would be available somewhere within a network of care.  
7 Arranging and formalising this access may require extra resources. However, babies  
8 with complex needs would invariably be seen by professionals from multiple  
9 disciplines, so this would not be a change in practice. The recommendations  
10 therefore would reduce variation and reinforce current best practice.

11 Full details of the evidence and the committee's discussion are in [evidence review H:  
12 service design](#).

13 [Return to recommendations](#)

### 14 ***Information and support for parents and carers of babies who need 15 neonatal parenteral nutrition***

16 Recommendations [1.10.1 to 1.10.4](#)

### 17 **Why the committee made the recommendations**

18 There was no evidence so the committee used their knowledge and clinical expertise  
19 to make the recommendations.

20 Good nutrition underpins good neonatal care, so the committee agreed that giving  
21 parents and carers information about parenteral nutrition is important.

22 The committee recognised that having a baby in a neonatal unit is a challenging and  
23 stressful situation, and agreed that the best approach to working with parents and  
24 carers is a collaborative one. This should involve giving parents and carers  
25 information tailored to their needs, and helping them to feel involved in their baby's  
26 care.

1 The committee noted that principles of good information sharing and communication,  
2 as well as encouraging shared decision making, are covered in the [NICE guideline](#)  
3 [on patient experience in adult NHS services](#).

4 Given that there was no evidence, the committee made a recommendation for  
5 further research. This is important because having a baby in a neonatal unit can be a  
6 stressful and difficult time for parents and carers. Information and support can help  
7 parents manage these circumstances and help them feel involved and part of their  
8 baby's care, which can improve outcomes. Given that the number of babies needing  
9 parenteral nutrition is likely to increase as prematurity survival rates improve,  
10 understanding what information and support parents need will help to support good  
11 outcomes.

## 12 **How the recommendations might affect practice**

13 The committee agreed there is variation in practice. These recommendations should  
14 improve consistency in how healthcare professionals support parents and carers,  
15 and ensure that they are given timely, consistent and appropriate information about  
16 parenteral nutrition.

17 Full details of the evidence and the committee's discussion are in [evidence review 1:](#)  
18 [information and support](#).

19 [Return to recommendations](#)

## 20 **Context**

21 Parenteral nutrition refers to intravenous feeding, a technique for providing nutrition  
22 to those who are unable to tolerate adequate enteral nutrition (orally or through an  
23 enteral tube). It is frequently needed by preterm babies while they establish enteral  
24 feeds, critically ill babies, and babies with gastrointestinal disorders who need  
25 surgery.

26 Inadequate nutrition, particularly in preterm babies, can have short-term and long-  
27 term health effects, including longer stays in the neonatal unit, an increased risk of  
28 infection, and worsened developmental outcomes. There is also evidence that

1 inappropriate nutritional management soon after birth is linked to the development of  
2 metabolic syndrome in adults.

3 Approximately 95,000 babies born in the UK each year need neonatal care (National  
4 Neonatal Audit Programme 2016). Parenteral nutrition is widely used in neonatal  
5 care. It has become common practice to start it in preterm babies within the first few  
6 hours of life, and also to support term babies who are critically ill.

7 Parenteral nutrition contains nutrients such as glucose, electrolytes, amino acids,  
8 lipids, minerals, trace elements and vitamins. It may complement enteral feeding or,  
9 in some situations, replace it.

10 The NCEPOD [enquiry into the care of hospital patients receiving parenteral nutrition](#)  
11 (2010) reviewed 264 cases of neonatal parenteral nutrition. It found that 73% of  
12 cases represented less than 'good practice', 40% had metabolic complications, 40%  
13 did not meet nutritional needs, and in 28% the start of parenteral nutrition was  
14 delayed. In 37%, the first parenteral nutrition provided was considered inadequate  
15 for the patient's needs.

16 Parenteral nutrition is normally formulated in an aseptic pharmacy unit. It can be in  
17 standardised or individualised forms. Prescribing is complex and open to error.  
18 Simplified, [standardised regimens](#) may reduce this risk, and may reduce costs.

19 In current practice virtually all babies born before 31<sup>+0</sup> weeks who weigh less than  
20 1.5 kg need parenteral nutrition for a period that depends on gestation, birthweight  
21 and other morbidities. Postnatal growth failure is common in babies born before  
22 31<sup>+0</sup> weeks. It is associated with an increased need for respiratory support and  
23 increased risk of infection. It is also a risk factor for neurocognitive impairment.  
24 Optimal use of parenteral nutrition could potentially avoid postnatal growth failure.

25 Parenteral nutrition is expensive: for a large tertiary neonatal unit, it costs  
26 approximately £175,000 a year.

27 Given the wide variation in practice, safety concerns and costs, this guideline is  
28 needed to ensure that the provision of parenteral nutrition for babies is consistent  
29 across units and provides optimal care.

1 **Finding more information and resources**

2 To find out what NICE has said on topics related to this guideline, see our web page  
3 on [postnatal care](#).

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