NUTRITION

The ability of newborn infants to absorb enteral feeds depends on their maturity, that is gestational age, and clinical status. Those at risk of developing problems with enteral feeding are those with impairment of gastric emptying and/or intestinal peristalsis.

- Infection
- Shock
- Acidosis
- Perinatal Hypoxia
- Extreme Prematurity

These are also risk factors for necrotizing enterocolitis (NEC).

The advantages of the early introduction of enteral feeds are:

1. enhances gut hormone production and development;

2. earlier tolerance of full feeds;

3. improved weight gain;

4. reduced jaundice, including TPN cholestasis.

However, the rapid early introduction of full enteral feeding to pre-term and sick infants has been associated with increased mortality, apnoea, cyanosis and NEC. NEC is clearly lower in babies fed breast milk exclusively in early life, ie. is greater in formula fed babies. Therefore, breast milk, usually as mother's own EBM, should be the preferred milk wherever possible in pre-term babies. Mothers should be encouraged to express their breast milk, and those giving antenatal counselling should include advice and encouragement about breast feeding in that consultation.

Catabolism at a rate of 1g/kg/day of protein occurs in low birth weight babies who have no protein intake. They can achieve optimal growth rates with exclusive TPN. However, there is also important morbidity associated with TPN, including line related problems (sepsis, extravasation of fluid, thrombosis) and metabolic disturbances, including cholestasis.

Therefore, the decision to start enteral and parenteral nutrition should be individual for each baby and take into account the baby's clinical condition and risk factors for NEC.

Possible contra-indications to starting enteral feeds are:

1. respiratory rate > 60;

2. arterial or capillary blood gas pH < 7.25;

3. babies who are paralysed and ventilated.

4. Acute respiratory disease until the baby's clinical course has stabilised.

Fluid requirements

Sick and low birthweight newborns start:

Day 1 10% dextrose iv
Day 2 10% dextrose plus calcium gluconate iv

TABLE 1
Suggested Daily Fluid Intake

DAY	ml/kg/day	
	BW > 1000g	BW < 1000g
1	60	80
2	90	110
3	120	140
4	150	160

This table is a starting point. The absolute requirements of water and electrolytes are difficult to predict for individual babies. Adjustments should include consideration of the baby's weight (including birth weight, current weight and age), urine output, serum electrolytes and urea, any current disorders such as asphyxia, RDS, meningitis or sepsis, and requirements for other losses.

TABLE 2
Water requirements in sick newborns

Factors Increasing Requirements: FactorsDecreasing Requirements:

-Radiant warmers. -Heat shields.
-Conventional single walled incubators. -Thermal blankets.
-Phototherapy. -Double walled incubators.
-Ambient temperature above thermal range. -High ambient humidity.
-Respiratory distress. -Humidification of warmed inhaled
-Elevated body temperature. endotracheal gas.
-Diuretic therapy. -Renal oliguria.
-Diarrhoea.
-Glycosuria (with osmotic diuresis).
Consider adding 30 ml/kg/day for each
- phototherapy
- overhead radiant heater

Fluids may need to be restricted in

babies with a significant PDA - decrease by one third
babies with birth asphyxia - decrease by one third
babies with renal failure - 30 ml/kg/day + urine output recalculated 8 hourly

When such changes are made, hydration and electrolyte balance should be assessed daily by some of the following: weight, 24 hour urine output, serum and urine electrolytes and osmolality or specific gravity.

10% Dextrose is used unless there is glycosuria (more than 1/4%) when 5% Dextrose is used. Once the sugar tolerance is resolved 10% Dextrose should be reintroduced.

SGA babies and hypoglycaemic babies who do not need to be restricted start at 90 ml/kg/day with 10% Dextrose (6.3 mg/kg/min). See hypoglycaemia protocol for use of higher Dextrose concentration regimes.

Fluids are calculated on birth weight until this has been regained and on actual weight thereafter

Nutritional Requirements
Plan ahead - try to give Pharmacy as much notice as possible to prepare the solution, it may need to be ordered on Day 1.Try to predict the need on fridays and order TPN for the weekend.

Consider starting small amounts of enteral feeds if EBM is available on Day 2. This should be 1ml/kg EBM every two to six hours initially, depending on the clinical status of the baby. EBM should be used wherever possible. If EBM is not available, enteral feeds should be delayed. When the baby is stable and absorbing feeds for about twenty-four hours, the volume and the frequency of the feeds can be increased slowly. Again, the pattern of feeding should be discussed on the morning ward round and agreed between the nursing and medical staff. The overall aim should be to achieve full enteral feeds after about five to seven days.

IUGR <3rd centile
with Abnormal Umbilical Arterial Doppler Blood Flow Velocity
These infants may be at increased risk of NEC. Feeds, preferably with mother's own breastmilk, should be introduced slowly and according to the baby's clinical status.

Large for dates
Cared for on Postnatal Ward
All of these babies should have regular medical review by the SHO/ANNP at least once a day. Feeds should initially be three hourly, with Accuchek glucose monitoring prior to feeds until they are stable. The frequency of the feeds may need to be increased to two hourly. If the blood sugar is low, the policy on hypoglycaemia should be followed.

Type of milk
(See table 4)
Expressed breast milk should be used initially if available. It may be given in volumes up to 210 ml/kg/day with phosphate supplements for babies BW below 1.5 kg. Breastmilk fortifier should be commenced if the baby is not growing (10-20 g/kg/day) adequately on 200 ml/kg/day, is unable to tolerate high volumes and the plasma urea is less than 2.0 mmol/l.

Alternatively, if EBM is not available, low birthweight formulas should be introduced in babies less than 1.8 kg birthweight. Rarely higher volumes of LBW formula are used. LBW formula is usually continued until the baby has reached 1.8 kg in weight

but may be stopped sooner if the baby is otherwise ready for discharge, or later if the baby has BPD.

If mother has insufficient breast milk or the supply is erratic, the volume of feed should be made-up with pre-term formula. However, breast milk fortifier should not be used, ie. breast milk fortifier and pre-term formula should never be mixed in a feed. If there is no breast milk available, pre-term formula should be used. Again, this should be continued until the baby is at least 1800g. The babies' urea, electrolytes and phosphate should be checked weekly.

Vitamin and Iron Supplements (for Enterally Fed Babies)
ABIDEC: 0.6ml Daily for Babies Established on Pre-term formula feeds until weaned on toa mixed diet.
SYTRON See Ch 11
FOLATE Recommended daily intake for preterm infants is 65mcg/day. Normal feeding should supply adequate Folic acid. Infants with haemolysis requiring exchange transfusion need Folic acid supplementation of 100 mcg (0.2 ml/day) for 21 days post- transfusion.

Babies who are taking breast milk fortified with Nutriprem do not require vitamin supplements. Those fed on Prematil or breast milk without fortifier should receive vitamin supplements as Abidec, 0.6ml daily once they have established full feeds. All babies should receive Sytron independent of the type of milk feed they are on, according to the guideline in Chapter 11.

Calcium and Phosphate Supplements
CALCIUM
Premature formulae contain approx 75mg/100ml. at 150ml/kg/day the infant receives 115mg/kg/day. Preterm formulas therefore contain sufficient calcium.

PHOSPHATE
Unsupplemented breast milk contains approx 15 mg phosphorus/100ml (4.8mmol/litre). Additives are required to increase this to 30 mg/100ml. If baby is on nutraprem, no additional phosphate is required.

Prem formulae contain 35mg/100ml of phosphorous and therefore should require no supplementation.

Management
Neonates have higher normal values for Phosphate (1.8-2.5mmol/l)

If PO_4 is persistently high the decision to stop should be discussed with the Registrar or Consultant.

Potassium Phosphate (17.42% w/v) contains 1mmol phosphate per ml. therefore if using calculations above divide by 10 to give mls of Potassium Phosphate NB K+ load.

Table 4

NUTRIENTS per 100ml	ESPGAN Guidelines for Low Birth Weight Formulas[1]	Preterm Breast Milk	Preterm Breast Milk + Nutriprem Breast Milk Fortifier	Prematil Low Birth Weight Formula
Energy (kcal)	65-85	70	80	70
Protein (g)	1.8-2.5	1.8	2.5	2.0
Fat (g)	3.5-4.8[3]	4.0	4.0	3.5
Carbohydrates (g)	6-11	7.0	9.0	7.7
Minerals				
Ca (mg)	56-112	22	82	70
P (mg)	40-72	14	54	42
Mg (mg)	5-10	2.5	6.5	6
Fe (mg)	ns	ns	-	0.1
Zn (mg)	0.4-0.9	0.4	0.7	0.39
Mn (µg)	1.7-6	ns	-	13
Cu (µg)	72-96	63	89	64
I (µg)	8-36	ns	11	10
Na (mg)	18-42	29	35	27
K (mg)	59-98	60	63	71
Cl (mg)	39-57	59	66	38
Vitamins				
Vit A (µg)	72-120	ns	130	63
Vit D (µg)	ns-2.4	ns	10	2.1
Vit E (mg -TE)	0.48-8[3]	ns	2.6	2.0
Vit K (µg)	3.2-16[3]	ns	3.0	2.8
Vit C (mg)	5.6-32	ns	10	15
Thiamin (mg)	0.02-0.25	0.01	0.03	40

Riboflavin (mg)	0.05-0.48	0.03	0.15	0.14
Niacin (mg NE)	0.6-4	0.21	0.35	0.55
Vit B_6 (mg)	0.03-0.25	0.01	0.07	0.09
Folic Acid (µg)	48-ns	3.1	53.1	43
Vit B_{12} (µg)	0.12-ns	0.02	0.12	0.15
Pantothenic Acid (mg)	0.2-ns	0.2	0.2	1.1
Biotin (µg)	1.2-ns	0.5	0.5	1.8

Electrolytes

Mineral requirements must be assessed regularly. In very sick infants with risk factors for hypernatraemia or hyperkalaemia (first week of life, ELBW, IVH), twice daily sodium and potassium may need to be monitored. Careful monitoring of urine output, urine specific gravity and the baby's daily weight are also needed for evaluation of fluid and electrolyte status.

An adequate sodium and phosphate intake is needed for efficient protein synthesis.

ELBW neonates, who are on prolonged TPN, are most at risk of phosphate deficiency. This is a major factor in the development of bone disease of prematurity. Hypophosphataemia and hypercalcaemia are early biochemical indications of phosphate deficiency.

To calculate additives it is assumed that the baby is nil by mouth initially and thereafter the maintenance fluids may be increased or decreased accordingly depending on tolerance of oral fluids.

Sodium Normal range 138 - 146 mmol/l

Requirements vary according to age
<30/40 5 mmol/kg/day
30-35/40 4 mmol/kg/day
>35-40 3 mmol/kg/day

'Maintenance fluids' = fluid requirements - volume from ia or extra iv infusions
= A (eg Dopamine etc)

All the daily supplements will be added to maintenance fluids A (line 1)

Na requirements (mmol/kg/day) = ... (3,4, or 5)
Na requirements (mmol/day) = ... (x wt (kg)
= X

Na obtained from arterial line = Ymmol
= 0.9 mmol if 0.45% saline @ 0.5 ml/hr
= 1.8 mmol if 0.45% saline at 1.0 ml/hr

Na to be added to fluids A = X - Y
= Z mmol

Na to be added to 500 ml bag = $\frac{500}{\text{Dextrose (mmol)}} \times Z$
A

NaCl 30% = 5 mmol in ml

Hypernatraemia

- if dehydration is present increase clear fluids by 25%
- if not dehydrated reduce supplementary sodium

Hyponatraemia

- consider appropriate investigations
- if patient is fluid overloaded reduce fluid intake by 25%
- if not and Na< 133 give supplementary sodium:
  Na supplement = (138 - serum sodium) x 0.6 x body weight (kg)
  This should be given in addition to the usual Na supplements

Potassium

Potassium requirements generally 2 mmol/kg/day
K to be added to fluids A (mmol) = 2 x wt (kg)
K to be added to 500 ml bag = $\frac{500}{\text{Dextrose}} \times 2 \times \text{wt (kg)}$
A

15% KCL = 20 mmol in 10 ml

Hypokalaemia

- if serum potassium is < 3 mmol/l a supplement of 1 mmol/kg/day may be given.

Calcium

2.29 mmol/l +/- 0.27 in preterm infants in first week of life
1.6 - 2.3 mmol/l in term infants

Give maintenance calcium from day 2 in all sick and preterm infants 1 mmol/kg/day.

Supplement 1 mmol/kg/day only if corrected calcium < 1.8 mmol/l.
Corrected calcium = actual calcium + (0.025 (40 - serum albumin)).

Ca to be added to fluids A (mmol) = 1 x wt (kg)
Ca to be added to 500 ml bag = $\frac{500}{\text{Dextrose (mmol)}} \times \text{wt (kg)}$
A
1 mmol Ca is provided by 4.5 mls 10% calcium gluconate

Ca to be added to 500 ml bag = $\frac{500}{}$ x wt x 4.5

Dextrose (mls 10% Ca gluconate) A

Other
When replacing naso-gastric aspirates 0.9% saline is usually used with added potassium 1g to 500 ml NaCl.

Enhancing Lactation in Nursing Mothers

Breast feeding has well known benefits for both mothers and infants. Many of the mothers in the Neonatal Unit have to establish and maintain lactation by milk expression until their baby is fit to feed directly from the breast. We find that some mothers have problems providing sufficient milk to feed their baby successfully under these conditions. If, despite attempts to increase this with advice, support and encouragement, the milk supply is still insufficient then medical treatment with antidopaminergic drugs may be helpful.
Dopamine suppresses the excretion of prolactin from the anterior pituitary. By antagonising its action with antidopaminergic drugs the level of serum prolactin and hence breast milk production rise.
Metoclopramide has been used for this purpose and is recommended ini obstetric texts at doses of 10mg t.d.s. and its effect of enhancing milk lactation is well documented. In studies it has not caused significantly more side-effects than in mothers treated with placebo and no adverse effects have been noted in the infants. The levels of metoclopramide that infants (>1 month of age) are exposed to are less than the recommended daily dose (300 mcg/kg/day).
Domperidone has similar effects to metoclopramide in enhancing lactation. It has advantages over metoclopramide in that:

1. It is not an alkaline drug like metoclopramide and so does not have the same tendency to be concentrated in the acidic breast milk

	Serum drug level	**Breast milk level**
Metoclopramide 10 mg t.d.s.	17 - 76 ng/ml	28 - 157 ng/ml
Domperidone 10 mg t.d.s.	10.3 ng/ml	2.6 ng/ml

2. Domperidone does not cross the blood-brain barrier as readily as metoclopramide and is less likely to cause central side effects such as sedation and acute dystonic reactions.

3. In reference to Domperidone the BNF in Appendix 5 states that “the amount is too small probably to be harmful” but for Metoclopramide states that “although the amount in milk is small, avoid unless essential”.

We would recommend that Domperidone can safely be given to enhance lactation in mothers who wish to continue the benefits of breast feeding but have an insufficient supply when other measures have been unsuccessful.

- Treatment: Domperidone 10 mg tds orally for 10-14 days.
- Contra-indications: known history of neuroleptic malignant syndrome.
- Potential side effects: drowsiness, increased frequency and/or looseness of stool and abnormal movements.