

Nutrition in Congenital Heart Disease

Cape Town Metropole Paediatric Interest Group

Final: April 2007
Review: 2007

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Nutrition in the Paediatric Cardiac Patient

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1. Glossary

Term	Definition
% EHA	Percentage estimated height for age
% EHW	Percentage estimated height for weight
% EWA	Percentage estimated weight for age
ABW	Actual body weight
AMA	Arm muscle area [requires MUAC & TSF to calculate]
CHD	Congenital Heart Disease
CHO	Carbohydrate
DRV's	Dietary Reference Values [Appendix 1]
FBC	Full Blood Count
FBDG	Food Based Dietary Guidelines
FTT	Failure to Thrive
HA	Height age
Hb	Haemoglobin
IMCI	Integrated management of childhood illness
IMCI: Not Growing Well	<p><i>Severe Malnutrition:</i> Very low weight < 60% EWA. Visible signs of severe wasting Oedema on the feet</p> <p><i>Not Growing Well:</i> Low weight < 3rd centile; g Poor weight gain - gaining weight but curve flattening or Mother reports weight loss.</p> <p><i>Growing Well:</i> Not low weight and Good weight gain.</p>
LCPUFA	Long chain polyunsaturated fatty acids
LCT	Long Chain Triglyceride
MAC	Mid arm area circumference
MCT	Medium Chain Triglyceride
MUAC	Mid upper arm circumference [6months – 5 years of age] > 15cm normal >11.5cm - <14.5cm moderately malnourished <11.5 cm [<-3SD] severely malnourished
NOBI	Non Occlusive Bowel Injury
NSP	Nutrition supplementation programme (NSP)
NSP Definition: Growth faltering	<p>Birth – 5 years: when an infant or child's growth curve flattens or drops over two consecutive visits on his/her RtHC.</p> <p>>5 - < 18 yrs: when a child's growth curve flattens or drops over two consecutive months on his/her weight-for-age growth chart.</p>
NSP: Entry Criteria	<p>Supplementation must be continued for only 6 months if entered onto the Nutrition Supplementation Programme.</p> <p><i>Infants: 0 – 12months</i> growth curve flattens or drops over two consecutive visits on his/her RtHC and the mother is unable to breastfeed because of the following reasons: Serious systemic, on long-term medication or treatment e.g. chemotherapy, hypothyroidism; is addicted to alcohol or drugs (condition must be formally documented/assessed); is mentally disabled and poses a threat to the baby; the infant is in foster care.</p> <p><i>Children > 5 years ≤ 18 years:</i> When child's growth curve flattens or drops over two consecutive months.</p>
NSP: Exit Criteria	<p><i>Successful:</i> <i>Birth – 5 years:</i> gained sufficient weight to attain a growth curve in relation to his/her normal growth curve and maintains the curve for three consecutive months. >5< 18 years: gained sufficient weight to attain normal growth curve according to the growth chart within the 6 months period on the scheme</p> <p><i>Unsuccessful:</i> <i>Birth – 5 years:</i> Failure to attain growth curve in relation to his/her normal growth curve over a period of 6 months and if no underlying disease/condition is present e.g. Foetal Alcohol Syndrome >5< 18 years: who do not attain a normal growth curve according to the growth chart with in the 6 months period.</p> <p><i>Defaulter:</i> <i>Birth – 5 years:</i> Failure to attend the clinic for a period of</p>

	<p>three consecutive months.</p> <p>> 5 - <18 years: Failure to attend the clinic for a period of three consecutive months within the 6 months period.</p> <p>Client has a history of irregular clinic attendance (less than three visits in a 6 month period) with in the 6 months period.</p> <p>** Re-entry:</p> <p><i>UNSUCCESSFUL</i> and <i>DEFAULT</i> cases <i>MAY NOT</i> be re-entered onto the programme.</p> <p><i>SUCCESSFUL</i> cases <i>MAY</i> be re-entered onto the programme according to entry criteria.</p>
RDA	Recommended Daily Allowances
REE	Resting Energy Expenditure
RTHC	Road to health card (Clinic Card)
RTU/RTU	Ready to use/ Ready to hang
Schofield Equation	Predicting estimated energy requirements [Appendix 1]
SD	<p>Standard Deviations used to determine moderate to severe malnutrition:</p> <p>0 - <-1 SD Normally Nourished</p> <p>>-2 – -3 SD Moderately Malnourished</p> <p>>-3SD Malnourished</p>
TSF	Tricep Skinfold Thickness
TTO	To Take Out
WA	Weight age
Waterlow Criteria (WHO)	<p>Used to determine malnutrition:</p> <p><i>Acute malnutrition: Weight/ Height</i></p> <p>Normal WH >90%,</p> <p>Mild 81% - 90%,</p> <p>Moderate 70% - 80%,</p> <p>Severe <70%.</p> <p><i>Chronic malnutrition: height for age</i></p> <p>Normal >95%,</p> <p>Mild 90 –95%,</p> <p>Mild – moderate 85% to 89%</p> <p>Severe < 85%.</p>
WCC	White Cell Count
WH	Weight for height

2. Summary of recommendations for nutrition management of infants and children with congenital heart disease

Summary Recommendations: Congenital Heart Disease ^{1, 2, 12, 25}

2.1 Anthropometry		
Complete on admission & weekly until discharge.	Height Weight MUAC Head Circumference < 3 years of age <i>Calculate</i> % EWA % EWH % EHA HA WA WH Classify degree of malnutrition <i>Waterlow: Acute malnutrition: Weight for Height (wasting)</i> Normal WH >90% Mild 81% - 90% Moderate 70% - 80% Severe <70% <i>Waterlow: Chronic malnutrition: height for age (stunting)</i> Normal >95% Mild 90 –95% Mild – moderate 85% to 89% Severe < 85% <i>Gomez: Acute wasting: Weight for age</i> Obese >120% Normal > 90% Mild malnutrition 76 – 90% Moderate malnutrition 61 – 75% Severe malnutrition < 60%	Plot weight & height on appropriate growth charts. (CDC or WHO or disease specific e.g. Downs Syndrome) Expected weight gain for an infant (< 6 months) with CHD is 10 – 20g per day and for infants (6 – 12 months) 120 – 210g/week
2.2 Biochemistry		
Complete daily post operatively whilst in ICU Once in recovery complete x 2 week until discharge	<i>Monitor the following</i> U & E: Urea, creatinine, sodium, potassium Calcium, magnesium and phosphorus Glucose FBC: Hb, platelets, WCC	
2.3 Clinical		
Mechanisms of malnutrition effected by: Type of cardiac lesion Increased metabolic rate Inadequate caloric intake Weight at time of operation Prenatal factors Medication Cardiac cachexia Urinary sodium losses (especially on Frusemide-Lasix) Low Hb Microcytic anaemia Macrocytic anaemia Low Zinc or Selenium	Comments: High urinary sodium losses can result in failure thrive. Establish sodium balance over a 24 hour period Check Iron status Check folate and Vit B12 levels Infants with cyanotic CHD may have a normal Hb but iron deficient. Check iron status using ferritin, red cell indices and total iron binding capacity.	Common clinical signs are: Fatigue on feeding Early satiety Anorexia Failure to thrive Frequent Infections

2.4 Dietary

At each follow up a thorough nutrition history should be completed

Components of a nutrition history include Weight Change Appetite Satiety Level Taste Changes/ aversions Nausea/ vomiting Bowel habits – constipation, diarrhoea Chewing/ swallowing ability Shortness of breath on feeding		Components of a nutrition history include (cont.) Long-term disease(s) affecting absorption/use of nutrients Dietary history – 24 hour recall/ food frequency Use of vitamin/ mineral or nutritional supplements Medications Level of activity/ exercise Ability to secure and prepare food Over the counter medications, vitamins and herbal remedies.
Diet history Review through 24 hour dietary recall quarterly or at each follow up review. Use in conjunction with food frequency. Many patients may eat < 65% of RDI.		Method of feed administration (employ a stepwise downward approach) Offer smaller volumes and more frequent feeds orally Give any unfinished feeds via naso-gastric tube if required Give small frequent bolus feeds via naso-gastric tube Top up small frequent daytime feeds with continuous overnight feeds via an enteral feeding pump Give feeds continuously over 24 hours via an enteral feeding pump. NOBI (Non occlusive Bowel Injury) <i>Initiation of enteral feeds in patients with circulatory compromise (sepsis, cardiogenic shock, haemodynamic instability) may lead to deleterious changes on the structure and function of the gut. It is therefore imperative to monitor for any signs of feeding intolerance.</i>
Fluid	Fluid Ranges Age (years) Premature 0-1 1-3 3-6 7-10 10-15 Weight Premature < 2kg Neonates and infants 2 – 10kg 0 – 6 months 6 – 12 months Infants and children 10 -20kg Children > 20kg DO NOT ALTER MEDICALLY INDICATED FLUID RESTRICTION (Fluid requirements include fluid from feed, medication, IV fluids and oral sips)	ml/kg actual weight 180-200 150 100 90 70 60 Fluid Volume per 24 hours 150ml/kg 150ml/kg 120ml/kg 1000ml + 50ml/kg over 10kg 1500ml + 20ml/kg over 20kg
Energy	Infants: <u>Pre-operative or post shunt</u> Ventilated: 90 – 100 kcal/kg Non ventilated: 120 – 150kcal/kg (maximum 170 kcal/kg) <u>Post definitive operation (Cardiac Repair)</u> Ventilated: 90 – 100 kcal/kg Not ventilated: Schofield using abw + activity 1.2 + stress 1.5 – 1.6 In sedated, ventilated children's energy expenditure if often significantly reduced. Aim to feed at 150kcal/kg and only increase to 170kcal/kg if other factors effecting growth have been excluded	Children: <u>Pre-operative or post shunt</u> Ventilated: Schofield equation or WHO/FAO/UNU x 1.3 – 1.5 [No activity factor] Non ventilated: 120 – 150% or DRV's <u>Post definitive operation (Cardiac Repair)</u> Ventilated: Schofield equation or WHO/FAO/UNU x 1.3 – 1.5 [No activity factor] Non ventilated: Schofield using abw + activity 1.2 + stress 1.5 – 1.6

Energy Supplementation	<p><i>Infants:</i> No additional energy may be required in the pre-repair infant and breast milk and or standard ready to use/hang infant formula [0.67kcal/ml] should be given. If the patient is volume-restricted breast milk may be supplemented with a human milk fortifier or carbohydrate/fat powder and or a ready to use/hang energy dense infant feed [1kcal/ml] should be given.</p> <p><i>Children:</i> No additional energy may be required and a standard feed [1kcal/ml] should meet requirements in the volume prescribed. If the patient is volume restricted an energy dense [1.5 kcal/ml] ready to use/hang feed should be given.</p> <p>NB: No powders or liquids e.g. oil should be added to a sterile ready to use feed. If additional energy is required in non-ventilated children then flushes of energy boluses should be provided prior to a drink or feed including breastmilk. Recommendations for fat, protein and carbohydrate concentrations should not be exceeded. [See sections below]</p>	
Carbohydrate	<p><i>Glucose requirements</i> > According to tolerance</p> <p><i>Infants</i> 8-9mg/kg/min [11.5g –12.9g/kg/day] Max 12.5mg/min/kg [18g/kg/day]</p> <p><i>Toddlers</i> 7mg/kg/min [10g/kg/day]</p> <p><i>Adolescents</i> 4mg/kg/min [5.7g/kg/day]</p>	<p>The following concentrations of CHO per 100ml will be tolerated if a CHO/fat powder is used.</p> <p>10-12% carbohydrate concentrations in infants under 6 months (i.e. 7g from formula, 3-5g added) 12-15% in infants aged 6months to 1 year 15-20% in toddlers aged 1-2 years 20-30% in older children</p>
Protein	<p><i>Infants:</i> <u>Pre-operative or post shunt</u> 9 – 11% of total energy Up to 4 g/kg abw <u>Post definitive operation (Cardiac Repair)</u> 9 – 11% of total energy DRV's</p> <p><i>Children</i> Pre-operative, post shunt and post definitive operation (Cardiac Repair) Up to 2 g/kg abw</p>	<p>unless renal function is impaired</p>
Fat	<p><i>Birth - < 5 years of age</i> 40% NPE</p> <p><i>Children > 5 years of age</i> 30 – 35% NPE</p>	<p><i>Adding Fat to formula/enteral feeds:</i> Should be done as a last resort – rather add extra oil/margarine to food. Infants will tolerate a total fat concentration of 5 – 6 % [e.g. 5 – 6g per 100ml of feed]. Children > 1yr will tolerate a fat concentration of 7% - concentrations above this may cause nausea/ vomiting. It is recommended that a soluble carbohydrate/fat powder be used in bolus form over modulars such as oil and/or a glucose polymer</p>
Micronutrients	<p>A daily multi-vitamin should be given e.g. Abidec® or Vidaylin® Elemental Zn 1 – 3 mg/kg abw</p> <p>Selenium 2mg/kg abw with a max of 30mg/day</p> <p>Iron: 2mg/kg/day for prophylaxis 6mg/kg/day if Fe deficient</p>	<p>The multivitamin should contain folate, niacin, thiamine and B12 and vitamin E. Do not supplement Zinc for longer than 2 weeks. Selenium and Zinc should only be supplemented if failing to thrive and low serum levels. Do not supplement iron during the first 10 days post-operatively as it increases the risk of redox.</p>
Discharge Planning	<p>Educate the parent/caregiver on the supplementation of feeds (this can be started prior to discharge). The caregiver is asked to make up the child's supplemented feeds at ward level as a way of educating him/her under supervision. Provide caregiver with a date for dietetic follow up or refer to a private practising dietitian. Ask the doctor to write up a prescription TTO (To Take Out) for multivitamins</p>	<p>Government: Supply sufficient micronutrient supplements until follow up appointment Private: 7 day TTO on hospital discharge and provide a second script for at least 1 month supply. Continue multi-vitamins until catch up growth has been achieved.</p>
Post Discharge	<p>Frequency of follow up</p>	<p>Poor growth: monthly If failing to thrive, follow guidelines below Thriving: Quarterly</p>

2.5 Entry and Exit Criteria for Nutrition Support

<p>Entry Criteria Nutrition Support</p> <p>NSP Supplementation must be continued for only 6 months if entered onto the Nutrition Supplementation Programme. Children > 5 years < 18 years: When child's growth curve flattens or drops over two consecutive months.</p> <p>Or Private Patients Growth failure Downward crossing 2 or more centiles over a period of 1 month or 2 consecutive visits. MUAC < 12.5cm in children < 5years of age <i>Acute malnutrition: Weight/ Height</i> < 80% <i>Chronic malnutrition: height for age</i> < 89%</p>	<p>Exit Criteria for nutrition support</p> <p>NSP Birth – 5 years: gained sufficient weight to attain a growth curve in relation to his/her normal growth curve and maintains the curve for three consecutive months. > 5yrs – 18 years who attain normal growth curve according to the growth chart within the 6 months period on the NSP scheme.</p> <p>Or Private Patients Upward crossing of 2 or more centiles over a period of 1 month or 2 consecutive visits. MUAC >15cm in children < 5 years of age. WH >90%, HA >95%,</p>
<p>Referral NSP Scheme</p>	<p>Additional Requirements Nutritionally complete age appropriate supplement. Access from local day hospital/ CHC</p>

2.6 Complications
2.6.1 Chylothorax
Chylothorax is an uncommon post operative complication resulting in leakage of lymphatic fluid into the pleural space due to surgical disruption of the thoracic duct or increased venous pressure of one of its main tributaries resulting in increased pressure within the intrathoracic lymph system
<u>Diagnosis</u> The following needs to be present in the pleural fluid: 1) Triglycerides > 1.1 mmol/L 2) Chylomicrons positive 3) Chylomicrons negative with a lymphatic fraction > 80%
<u>Treatment</u> 1) Dietary Bowel rest with total parenteral nutrition Fat free diet or high LCT diet: this type of diet should be followed in a clinical environment only due to the high risk of developing essential fatty acid (EFA) deficiency and should not be followed for more than 2 weeks. High MCT enteral nutrition: Use monogen 2) Surgical 3) Octreotide Refer to Appendix 2 for the recommended treatment algorithm
2.6.2 Chylous Ascites
Chylous ascites is an accumulation of chyle in the peritoneal cavity due to obstruction or rupture of the peritoneal or reperitoneal lymphatic glands, increased venous pressure or congestive cardiac failure.
<u>Diagnosis (Paracentesis)</u> The following needs to be present in the fluid 1) Triglycerides 200mg/dl 2) Predominance of lymphocytes > 75%
<u>Treatment</u> Bowel rest with total parenteral nutrition
2.6.3 Acute Myocarditis
<u>Treatment</u> CCME: L-carnitine 5 – 15 mg/kg (max 1g) 6H(IV) or orally 25 mg/kg 6 – 12H (max 3g/day) Co-enzyme Q10 1 – 4 mg/kg daily oral Magnesium Sulphate IV 2 mmol/ml (max 10ml) 12H slow IV Vitamin E 50 – 1000IU < 3yr or 200 – 400IU >3yr

2.7 Appendix 1: The CHD patient

Goal: To ensure that each patient with congenital heart disease attains/ maintains an optimal nutrition status.

To read the chart:
Follow the arrows

Assess patient using the following approach:
A = Anthropometry
B = Biochemistry
C = Clinical
D = Dietary
Implement nutrition support where appropriate

Start Here

Anthropometric assessment determine patient's nutritional status & risk:

Height MAC TSF %EHA HC Mid parental height
MUAC Weight %EWA %EWH AMA Growth Velocity

Is there growth faltering or failing during last month or over 2 consecutive visits?

Yes

No

Monitor
3 month review

Assess dietary intake

- Complete 24 hour diet recall
- Food frequency
- Analyse where possible
- Is the intake appropriate according to the DRV's?

Yes

Good intake:
Encourage caregiver and child around good food intake.
Advise caregiver around food based dietary guidelines [FBDG]

No

Poor intake:
Encourage caregiver and child.
Advise caregiver around food based dietary guidelines [FBDG]
Promote small frequent meals x 3 and snacks 2 – 3 per day.
Recommend energy & nutrient dense foods & drinks

Entry to Nutrition Support:

Calculate Dietary Requirements & recommend nutrition supplementation according to treatment modality (pre operative/post shunt or post definitive operation – cardiac repair)

Exit Nutrition Support when:

Birth to 5 years – Normal growth curve RTCH following 3 months on NSP scheme.
> 5 – 18 yrs: Normal growth curve RTCH 6 months on NSP scheme.
Upward crossing of 2 or more centiles over a period of 1 month or 2 consecutive visits.
MUAC >15cm in children < 5 years of age.
WH >90%,
HA >95%,

Biochemistry & Clinical Monitor the following:

Urinary sodium losses
Hb
Infection

Provide sufficient energy & protein to support growth and weight gain.

Infants
3 – 4g/kg protein
120 – 150kcal/kg (max 170kcal/ml)
Children
2.g/kg protein
1.2 – 1.5 x RDA OR
Schofield equation or WHO x 1.5 – 1.6 [combined activity & stress factor]

Paediatric Supplements available: Hospitalised

Infants
Breast milk or
0.67kcal/ml RTU/H feed
1kcal/ml RTU/H feed (fluid restricted)
Children
1kcal/ml RTU/H nutritionally complete feed. (Standard)
1.5kcal/ml RTU/H nutritionally complete feed. (Fluid Restricted)

For additional energy required for both infants and children consider a super soluble CHO/fat powder.

Paediatric Supplements available: Discharged

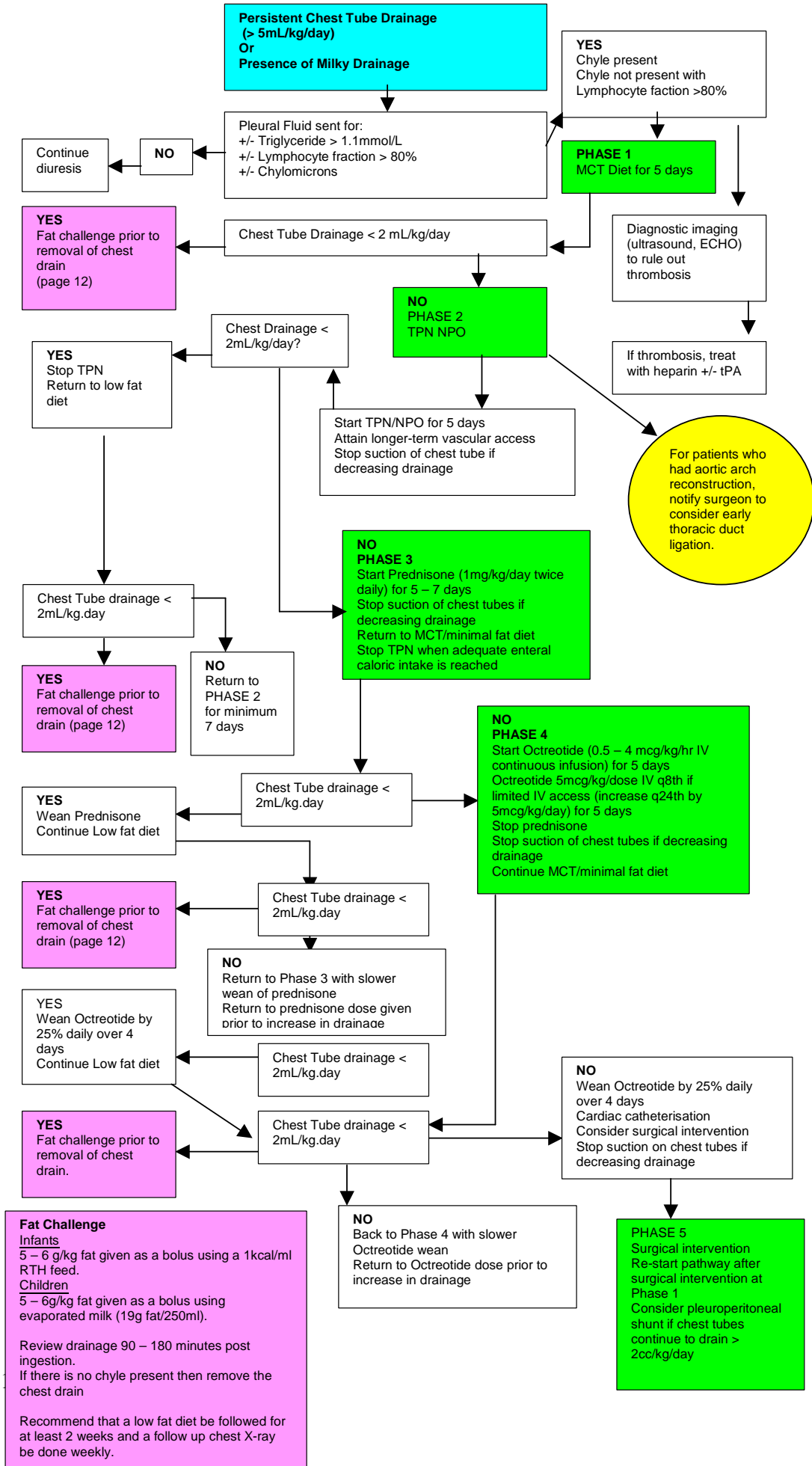
Infants
Breast milk with a breast milk fortifier if required
Children
Enriched maize meal porridge
Nutritionally complete age appropriate supplement.

Supplementation of complementary foods: Discharged

Infants
Soluble CHO powder
Long chain fat/oil

Children
Soluble CHO powder
Long chain fat/oil

2.8 APPENDIX 2⁹ Chylothorax Management Diagram



Maximum duration 10 – 14 days

Requirement of LCT: 1g LCT per year of life up to a maximum of 4 – 5g LCT per day

Suitable foods for use in a low LCT diet

Food	Average Portion Size (g)	LCT per portion (g)
Breakfast Cereals		
Cornflakes	25	0.2
Frosties	20	0.1
Special K	20	0.2
Cocopops	20	0.2
Rice Crispies	25	0.2
Weetbix	35 (1)	0.9
Bread		
White, large thin slice	35	0.4
Matzos	20	0.2
Crumpets Toasted	40(1)	0.4
Dairy Foods		
Reduced fat cottage cheese	50	0.7
Condensed milk, skimmed sweetened	50	0.5
Fish		
White hake fillet	100	0.7
Fish fingers	25 (1)	1.8
Tuna	100	0.5
Meat and Poultry		
Roast Turkey, light meat	70	1.0
Roast chicken, light meat	25	1.0
Roast lamb, lean	25	2.0
Roast beef, lean topside	45	2.0
Silverside, lean	40	2.0
Legumes, Pasta, Rice		
Baked beans in tomato sauce	200	1.0
Tinned spaghetti in tomato sauce	125	0.5
White rice, boiled	150	0.4
White pasta, boiled	130	1.0

Fortify skimmed milk with a glucose polymer.

Free Foods for a Minimal LCT Diet

All fruit, fresh, frozen or tinned (except olives and avocado)
 All vegetables fresh, tinned or frozen
 Sugar, honey, golden syrup, treacle, jam and marmalade
 Jelly and jellied sweets such as Jelly Tots, Jelly Babies, wine gums, lollie pops or fruit pastilles
 Boiled sweets, mints (not butter mints)
 Fruit sorbets (milk free), water ices and ice lollies
 Meringue, egg white
 Spices and essences
 Salt, pepper, vinegar, herbs, tomato sauce, most chutneys, Marmite, Oxo and Bovril
 Fruit juices, fruit squashes, bottle fruit sauces
 Fizzy drinks, lemonade, cola