



A practical guide to the use of **Lipistart™** in the dietary management of **long chain fatty acid oxidation disorders**



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dietary management of rare diseases

Important information

Purpose

This practical guide is for the use of **Lipistart™** in the dietary management of infants and young children from birth to 10 years with long chain fatty acid oxidation disorders (LC-FAOD). **Lipistart** can also be used in the dietary management of fat malabsorption and disorders requiring dietary management using a high medium chain triglyceride (MCT), low long chain triglyceride (LCT) formula, however, **this guide will focus on dietary management of LC-FAOD only with particular reference to long chain 3-hydroxy acyl-CoA, dehydrogenase deficiency (LCHAD deficiency) and very long chain acyl-CoA dehydrogenase deficiency (VLCAD deficiency).**

Intended users

This practical guide is:

- for use by healthcare professionals working with infants and children diagnosed with LC-FAOD.
- **not** for use by parents/caregivers of infants or children with LC-FAOD or patients themselves.
- for general information only and must not be used as a substitute for professional medical advice.

Important notice

Lipistart must be used under medical supervision. Lipistart is suitable from birth to 10 years of age.

Suitable as a sole source of nutrition from birth to 1 year of age. Can be used as a supplementary feed from 1 to 10 years of age. Not suitable for people with medium chain acyl-CoA dehydrogenase deficiency (MCADD).

Monitoring of essential fatty acid status and supplementation when required, is recommended when using Lipistart long term.

For enteral use only.

Target population

This practical guide is for use in infants or children with diagnosed/proven LC-FAOD.

Product information

Lipistart is a food for special medical purposes (FSMP).

Any product information contained in this practical guide, although accurate at the time of publication, is subject to change. The most current product information may be obtained by referring to product labels and **www.vitafloweb.com**. Please refer to these sources for information regarding allergens.

Introducing and adjusting **Lipistart** is dependent on the individual patient. Practical examples are given in this guide; however, it is the responsibility of the managing health care professional to use clinical judgement to introduce and adjust **Lipistart** in the most appropriate way for individual patients and it may not always be appropriate to use the practical guide.

Disclaimer

The information contained in the practical guide is for general information purposes only and does not constitute medical advice. The practical guide is not a substitute for medical care provided by a licensed and qualified healthcare professional and Vitaflo® does not accept any responsibility for any loss arising from reliance on information contained in this guide.

This practical guide should be read in conjunction with local, national and international guidelines and best practice for the dietary management of LC-FAOD.

Information contained within the guide is based on the most recent scientific evidence available on the management of LC-FAOD as of April 2020.

This practical guide does not establish or specify particular standards of medical care for the management of any conditions referred to in this practical guide.

Vitaflo International Limited does not recommend or endorse any specific tests, procedures, opinions, clinicians or other information that may be included or referenced in this practical guide.

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Abbreviations

| | | | |
|--------------------------|------------------------------------------------|-------------------------|--------------------------------------------------------|
| ALA | α-linolenic acid | FAOD | fatty acid oxidation disorder(s) |
| ArA | arachidonic acid | LA | linoleic acid |
| CPT I deficiency | carnitine palmitoyl transferase I deficiency | LC-FAOD | long chain fatty acid oxidation disorder(s) |
| CPT II deficiency | carnitine palmitoyl transferase II deficiency | LCHAD deficiency | long chain 3-hydroxy acyl-CoA dehydrogenase deficiency |
| CACT deficiency | carnitine acylcarnitine translocase deficiency | LCPUFA | long chain polyunsaturated fatty acid |
| DHA | docosahexaenoic acid | LCT | long chain triglyceride |
| DRI | dietary reference intake | MCT | medium chain triglyceride |
| DRV | dietary reference value | TFP deficiency | mitochondrial trifunctional protein deficiency |
| EAR | estimated average requirement | VLCAD deficiency | very long chain acyl-CoA dehydrogenase deficiency |
| EFA | essential fatty acid | | |

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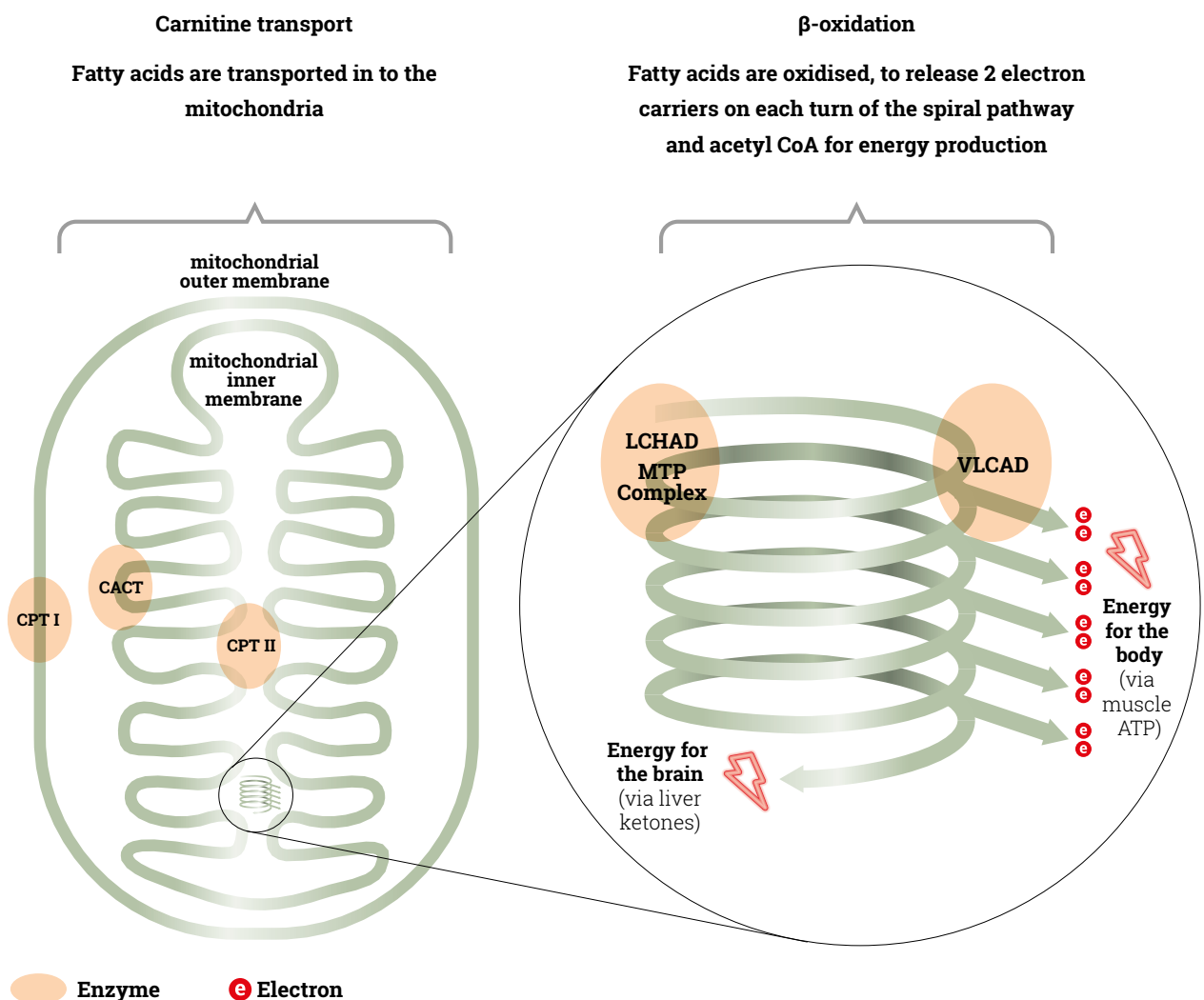
Introduction

1.0 Introduction

Long chain fatty acid oxidation disorders

Long chain fatty acid oxidation disorders (LC-FAOD) are a group of autosomal recessive inborn errors of metabolism categorized by specific enzyme defects within the fatty acid oxidation pathway. Enzyme deficiencies in the carnitine or β -oxidation pathway result in decreased energy production from long chain fatty acids. Clinical features, including cardiomyopathy, liver disease and rhabdomyolysis, are generally attributed to inadequate energy production and accumulation of toxic intermediates^(1, 2).

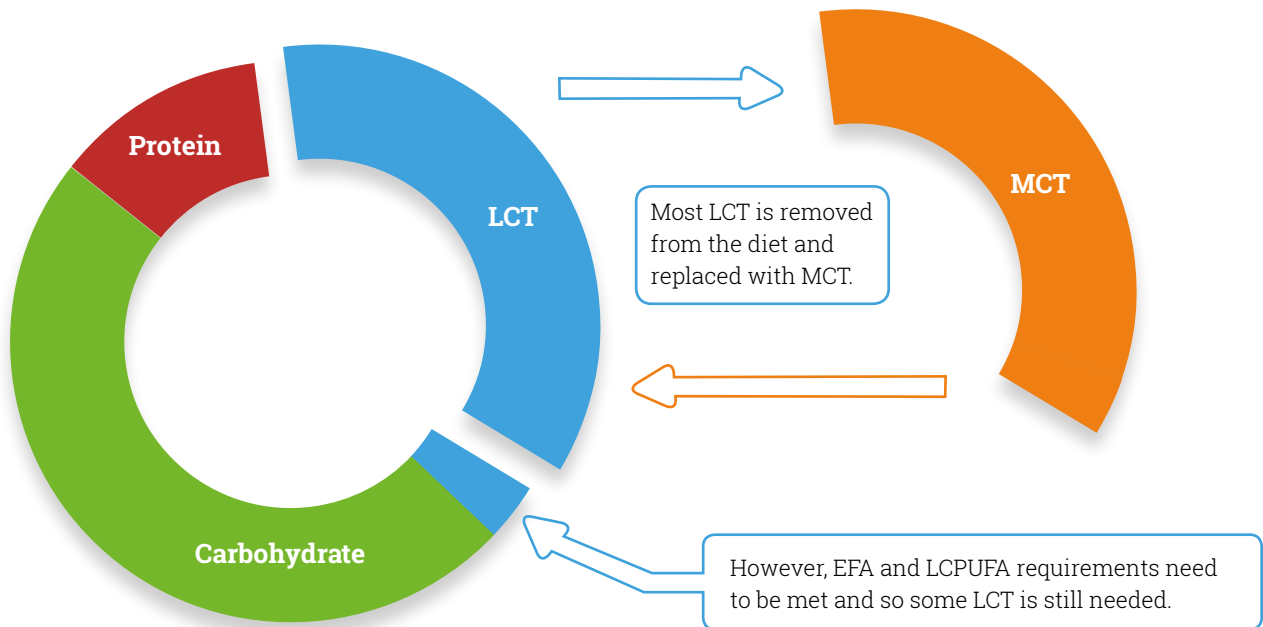
Enzymes involved in defects of long chain fatty acid oxidation



Deficiency of a particular enzyme within the pathway results in the corresponding LC-FAOD.

Dietary aims

Long chain triglyceride (LCT) must be restricted in the management of LC-FAOD because enzyme deficiencies prevent breakdown of LCT and consequently, toxic acylcarnitines accumulate. An alternative energy source used to substitute LCT is medium chain triglyceride (MCT) which provides an equivalent energy value of 9kcal/g.* LCT includes the essential fatty acids (EFA) and long chain polyunsaturated fatty acids (LCPUFA) thus some LCT is still needed in the diet to provide these nutrients.



The spectrum of LC-FAOD is clinically diverse in presentation, severity and LCT tolerance⁽²⁾ and requires bespoke management. Dietary management aims are to:

- provide sufficient energy and prevent prolonged fasting to minimise lipolysis and catabolism
- prevent nutritional deficiency, including EFA, LCPUFA and fat-soluble nutrients
- limit accumulation of disorder-specific acylcarnitines
- achieve healthy growth and development

The role of medium chain triglyceride

MCT is transported into the mitochondria *primarily* independent of carnitine. However, decanoic acid (C10) in particular, may enter the mitochondria via a carnitine dependent mechanism^(3,4). This is important in the nutritional management of carnitine pathway disorders. MCT can be given in these disorders, but intake may need to be limited^(3,4).

MCT bypasses β -oxidation resulting in ketone body formation which are used for energy, making MCT an important alternative energy source in LC-FAOD

Added advantages of MCT in LC-FAOD

- ✓ Dietary management where MCT is used as an alternative energy source to LCT, is shown to reverse cardiomyopathy^(5, 6).
- ✓ Supplementation with MCT is reported to decrease plasma lactate and long chain acylcarnitines^(7, 8)
- ✓ Supplementation with MCT is reported to suppress long chain fatty acid oxidation preventing accumulation of abnormal metabolites^(6, 9)

* The energy contribution used for MCT is 9kcal/g, in line with Regulation (EU) No 1169/2011 on food information for consumers⁽¹⁰⁾. This legislation does not differentiate between the energy provided by LCT and MCT. However, an alternative value for MCT may be used (8.3kcal/g) depending on local policy.

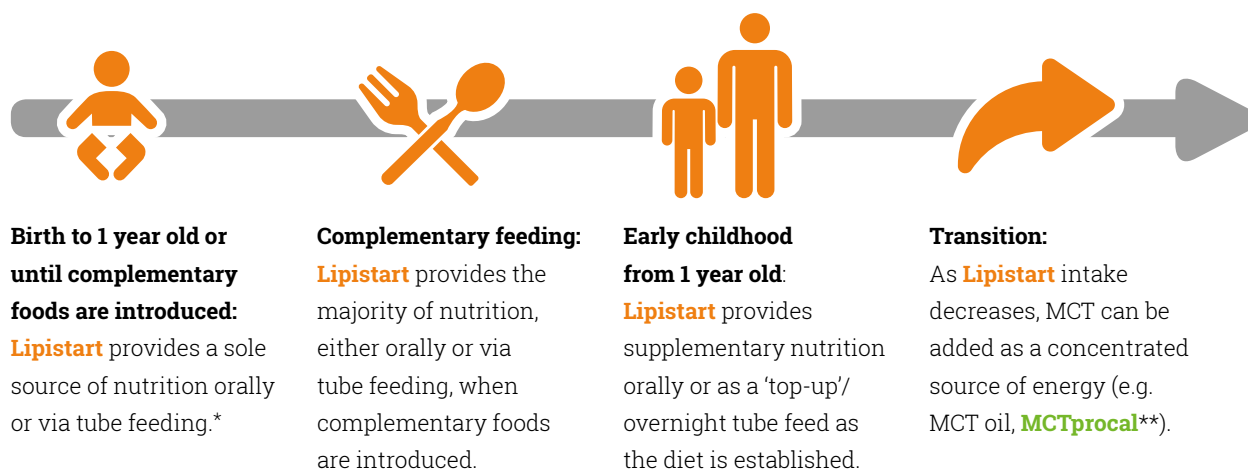
Lipistart in the management of long chain fatty acid oxidation disorders

Lipistart is a low LCT, high MCT formula designed specifically for the dietary management of LC-FAOD. The nutritional profile is formulated for infants and children up to 10 years of age. **Lipistart** provides a sole source of nutrition from birth to 1 year old* and supplementary nutrition from the introduction of complementary foods. LCT is present in minimal amounts to provide adequate EFA and LCPUFA. As well as LC-FAOD, **Lipistart** is suitable for individuals with fat malabsorption disorders such as chylothorax requiring a high MCT, low LCT formula.

See Appendix 1 for the nutritional content of key nutrients.

This practical guide focuses on the use of **Lipistart** in LC-FAOD, specifically:

- the introduction of **Lipistart** at diagnosis
- **Lipistart** and the introduction of complementary feeding
- the use of **Lipistart** from 1 year old onwards



The safety of Lipistart, a medium-chain triglyceride based formula in the dietary treatment of long chain fatty acid oxidation disorders: a phase I study⁽¹⁾

An open label, short-term phase I trial of **Lipistart** was undertaken in six well-controlled LC-FAOD children aged 7-13 years old. Participants took their conventional MCT feed for 7 days, followed by **Lipistart** for 7 days before returning to their conventional feed for 7 days.

During the study, the following observations were made:

- All children tolerated **Lipistart**
- Liver function tests remained within range apart from one participant who developed an ear infection during the study period
- No clinically significant differences between the two feeds for biochemical measurements were reported
- No reported muscle pain while using **Lipistart**
- In children taking >700ml **Lipistart**, there appeared no requirement for supplementation of LCPUFA during the study period

* when Lipistart is used as a sole source of nutrition, monitoring of essential fatty acid status is recommended when using long term.

** Please see **Appendix 2** for more information regarding **MCTprocal**.

2.0

Energy distribution of Lipistart compared with international recommendations

2.0

2.0 Energy distribution of Lipistart compared with international recommendations^(12, 13)

Recommendations are published for the management of LC-FAOD^(12, 13). Severity of disorders is variable and dietary management needs to be individualised.



Asymptomatic disorders

Newborn screening, available in some countries, has identified asymptomatic presentations of LC-FAOD. A consensus on dietary management continues to be debated^(14, 15). Although case studies and proposals have been reported⁽¹⁶⁾, specific recommendations or consensus on dietary management remains limited.

Guidelines⁽¹³⁾ and recommendations⁽¹²⁾ for fat provision in symptomatic disorders

| MCT | | |
|------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| | VLCAD deficiency | LCHAD deficiency and TFP deficiency |
| European consensus ⁽¹²⁾ | 20% total energy | High MCT formula for infants 20-25% total energy from introduction of solid foods |
| GMDI ⁽¹³⁾ | 10-45% total energy dependent on age (moderate and severe disorders) | No recommendation |

| Total LCT | | |
|------------------------------------|----------------------------------------------------------------------|-------------------------------------------------------|
| | VLCAD deficiency | LCHAD deficiency and TFP deficiency |
| European consensus ⁽¹²⁾ | 5-10% total energy | As low as possible 5-10% at introduction of solids |
| GMDI ⁽¹³⁾ | 10-30% total energy dependent on age (moderate and severe disorders) | No recommendation |




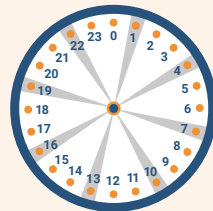

| Long chain polyunsaturated fatty acids | |
|--------------------------------------------------------|---------------------------------------------------------|
| VLCAD DEFICIENCY | LCHAD AND TFP DEFICIENCY |
| 60mg/day DHA ⁽¹³⁾ (infants and toddlers) | 60mg/day DHA ⁽¹²⁾ (<20 kg body weight) |

| Essential fatty acids | | | |
|---------------------------------------|-------------------------------|------------------------|-------------------------|
| | Total EFA (% total energy) | LA (% total energy) | ALA (% total energy) |
| European consensus ⁽¹²⁾ | 3-4.5 | 2.5-4 | 0.5 |
| GMDI ⁽¹³⁾ | not given | 3-6 | 0.5-1.2 |

- 3.1 Introducing **Lipistart** at diagnosis
- 3.2 **Lipistart** and the introduction of complementary foods
- 3.3 The use of **Lipistart** from 1 year onwards

3.1 Introducing Lipistart at diagnosis

The following section describes potential considerations for a symptomatic infant diagnosed by newborn screen or clinically presenting.







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| | <div> Diagnosis</div> | <div> Initiating Lipistart</div> | <div> Feeding pattern and fasting times</div> | | | | | | | | | | | | |
| | <p>Clinical presentation and age determines the management pathway. Local and national guidelines should be applied and every infant treated on an individual basis.</p> | <p>A symptomatic infant is likely to be acutely unwell, require nasogastric tube-feeding and have a limited fasting tolerance. The decision of when to introduce Lipistart should be a medical and clinical decision.</p> | <p>Tolerance to fasting varies with severity of defect, age and weight of the infant. Some guidance is published^(12, 13) based on healthy, steady state conditions however it is important to note that there is very little data or consensus on safe fasting times for the LC-FAOD population^(14, 17).</p> <p>Individual tolerance to fasting should always be determined and local/national guidelines applied.</p> | | | | | | | | | | | | |
| Using Lipistart | <p>When a diagnosis of a LC-FAOD is suspected, before initiating Lipistart, it should be confirmed that:</p> <ul style="list-style-type: none">• LCT restriction is indicated• MCT can be oxidised and is indicated | <p>Fluid and energy requirements should be calculated on an individual basis. Appendix 1 shows volumes of Lipistart required to meet estimated requirements for energy and other key nutrients.</p> <p>In severe defects, breast milk and standard infant formula are not given because the LCT content is too high. In milder disorders, such as asymptomatic VLCAD deficiency, these may be given. In these cases, nutrient content should be considered if given in combination with Lipistart. In most cases of LC-FAOD, breast milk and standard infant formula are contraindicated.</p> <p>Lipistart should be increased slowly according to clinical condition and titrated with intravenous glucose solution so that energy provision is maintained at a level to minimise lipolysis and metabolic decompensation.</p> <p>When first introducing Lipistart, consider tolerance as MCT can cause abdominal discomfort if introduced too quickly^(20, 21). MCT is an important energy source and some infants may initially require continuous nasogastric feeding to achieve tolerance.</p> <p>Lipistart may be given orally or by enteral feeding tube depending on feeding ability of the infant.</p> | <p>Once the infant is on the full, required volume of Lipistart, a feeding pattern can be established that should consider age, clinical condition and fasting tolerance.</p> <p>Example feeding patterns* using Lipistart may be</p> <ul style="list-style-type: none">• bolus feeds throughout the day and night• bolus feeds in the day and an overnight feed <p>The aim is to provide a frequent supply of feeds to minimise lipolysis. This can be achieved by dividing feeds evenly over 24 hours.</p> <table><tr><td>Example: new born male infant</td><td>Diagnosis: LCHAD deficiency</td></tr><tr><td colspan="2">Weight: 3.5kg (50th centile) 51cm (50th centile)⁽²²⁾</td></tr><tr><td colspan="2">Aims: Energy derived from LCT as low as possible⁽¹²⁾, provided by a specialist formula for infants^(12, 19) Meet fluid and volume requirements Adequate LCPUFA and EFA</td></tr><tr><td>Fluid requirement: 150ml/kg/d^(13, 23) = 525ml/d</td><td>Energy requirement: 120kcal/kg/d^(24, 25) = 420kcal/d</td></tr><tr><td colspan="2">Plan: 600ml Lipistart per day</td></tr><tr><td colspan="2">Plan provides: 420kcal, 52g carbohydrate, 14g MCT (30% total energy), 4g LCT (8.4% total energy), 11g protein, 1.3g LA, 0.2g ALA</td></tr></table> <p>Tailor the feeding plan to clinical presentation, tolerated fasting times and feeding ability of the infant. The example below demonstrates 3-hourly feeding however, safe fasting times should always be established and more frequent feeding may be required.</p> <div><div>75ml Lipistart x 8 feeds per 24 hours x 3-hourly</div></div> | Example: new born male infant | Diagnosis: LCHAD deficiency | Weight: 3.5kg (50th centile) 51cm (50th centile) ⁽²²⁾ | | Aims: Energy derived from LCT as low as possible ⁽¹²⁾ , provided by a specialist formula for infants ^(12, 19) Meet fluid and volume requirements Adequate LCPUFA and EFA | | Fluid requirement: 150ml/kg/d ^(13, 23) = 525ml/d | Energy requirement: 120kcal/kg/d ^(24, 25) = 420kcal/d | Plan: 600ml Lipistart per day | | Plan provides: 420kcal, 52g carbohydrate, 14g MCT (30% total energy), 4g LCT (8.4% total energy), 11g protein, 1.3g LA, 0.2g ALA | |
| | Example: new born male infant | Diagnosis: LCHAD deficiency | | | | | | | | | | | | | |
| Weight: 3.5kg (50th centile) 51cm (50th centile) ⁽²²⁾ | | | | | | | | | | | | | | | |
| Aims: Energy derived from LCT as low as possible ⁽¹²⁾ , provided by a specialist formula for infants ^(12, 19) Meet fluid and volume requirements Adequate LCPUFA and EFA | | | | | | | | | | | | | | | |
| Fluid requirement: 150ml/kg/d ^(13, 23) = 525ml/d | Energy requirement: 120kcal/kg/d ^(24, 25) = 420kcal/d | | | | | | | | | | | | | | |
| Plan: 600ml Lipistart per day | | | | | | | | | | | | | | | |
| Plan provides: 420kcal, 52g carbohydrate, 14g MCT (30% total energy), 4g LCT (8.4% total energy), 11g protein, 1.3g LA, 0.2g ALA | | | | | | | | | | | | | | | |
| | <div> Monitoring</div> <p>Clinical, nutritional and biochemical monitoring should take place^(13, 18, 19)</p> <p>Dietetic monitoring includes tracking:</p> <ul style="list-style-type: none">• anthropometry• gastrointestinal tolerance• nutritional completeness of intake | <p>Lipistart is designed to meet nutritional requirements up to 1 year old, however, nutritional and disorder-specific biochemistry should be monitored according to local policy.</p> | | | | | | | | | | | | | |

* dietary plans should always be calculated on an individual basis. This is an example only.

3.2 Lipistart and the introduction of complementary foods

First stages of complementary feeding

The introduction of complementary foods requires careful consideration of maintaining energy provision and safe fasting times. Shown below is a general guide however, customised feeding plans are needed for every individual. It should be noted that some children will already be weaned at diagnosis.

| | |
|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>When to start complementary feeding</p> <p>Introduction of complementary foods can commence around 6 months of age^(26, 27, 28) and readiness to wean should be assessed on an individual basis according to developmental stage.</p> <p>It is common for infants to be inconsistent in their acceptance of solid foods initially. Weaning may take longer in individuals with LC-FAOD due to their need for regular day and night feeds, limiting appetite for solid foods which means they may rely on formula milk for longer.</p> |
|  | <p>At this stage, food is supplementary to Lipistart. The volume of Lipistart remains the same, to meet nutritional requirements, until intake of solid food is established. Lipistart may be taken orally, via a feeding tube or a combination of both methods depending on feeding capabilities of the infant.</p> |
|  | <p>First complementary foods</p> <p>First foods should be based on very low fat, high carbohydrate foods which are an appropriate texture for the infant's development.</p> <p>Weaning should start by offering 1-2 teaspoons once per day, progressing to 3 small meals per day.</p> |
|  | <p>Lipistart can be added to recipes and first foods such as cereal, rice pudding and fruit puree. If the infant is receiving some of their Lipistart via an enteral feeding tube, the volume may be reduced by incorporating a proportion in complementary foods, but overall energy intake must be maintained.</p> |
|  | <p>Monitoring</p> <p>Dietetic monitoring should continue to check:</p> <ul style="list-style-type: none"> • growth trends • gastrointestinal tolerance • nutritional adequacy, in particular EFA, LCPUFA and fat-soluble vitamins • LCT and MCT intake |
|  | <p>While energy from Lipistart is being replaced by complementary foods, overall energy intake of the diet should be monitored carefully to minimise lipolysis.</p> <p>As intake of solids increase and the volume of Lipistart reduces and becomes supplementary, the overall diet should be assessed and monitored especially for EFA, LCPUFA, fat-soluble vitamins and MCT. See Appendix 1 for volumes of Lipistart required to meet estimated requirements for energy and other key nutrients.</p> |

Later stages of complementary feeding and reducing Lipistart

When food begins to reliably contribute energy to the diet, the volume of **Lipistart** can be slowly reduced to allow progression of solid foods without affecting satiety or compromising safe fasting times.

Lipistart should only be reduced:

- when solid foods can equal energy provision provided by the feed it is replacing
- during the day, maintaining overnight feeds

Due to limitations of the diet, complementary foods used are typically:



very low in **fat**



protein sources that are very low in fat



rich in starchy **carbohydrate** to provide energy



low in fat-soluble **micronutrients**

An MCT-rich formula, such as Lipistart, may remain a key source of energy, EFA, LCPUFA and micronutrients as complementary feeding is established and beyond.

Example meal plan demonstrating the use of Lipistart in complementary feeding for a 7-month-old female with severe VLCAD deficiency.

Weight:

8kg (50th-75th centile⁽²²⁾)

Energy requirements:

576 -632 kcal/d (72-79kcal/kg^(24, 25))

Fluid requirements:

960ml (120ml/kg⁽²³⁾)







| | Meal or feed | energy | LCT | MCT | protein |
|--------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------------------------------|-----------------------------------|----------------------------|
| Breakfast 7.30am | 1 tablespoon dried baby rice <i>mixed with</i> 40ml Lipistart water or baby juice to meet fluid requirements | 20kcal 28kcal | 0.3g | 1g | 0.4g 0.7g |
| Mid-morning 9.00am | 100ml Lipistart | 70kcal | 0.7g | 2.3g | 1.8g |
| Lunch 12 noon | 40g puréed cod 30g puréed sweet potato 30g pureed carrot 60ml Lipistart water or baby juice to meet fluid requirements | 40kcal 25kcal 10kcal 42kcal | 0.3g 0.1g 0.2g 0.4g | - 1.4g | 9g 0.3g 0.2g 1.0g |
| Mid-afternoon 3.00pm | 100ml Lipistart | 70kcal | 0.7g | 2.3g | 1.8g |
| Evening meal 4.30pm | Small custard pudding made with skimmed milk ½ small banana puréed 2 strawberries puréed water or baby juice to meet fluid requirements | 25kcal 15kcal 5kcal | 0.1g 0.02g 0.1g | - | 1.2g 0.2g 0.1g |
| Evening feed 6.00pm | 100ml Lipistart | 70kcal | 0.7g | 2.3g | 1.8g |
| Night time feed 8.00pm-6.30am | 300ml Lipistart at 30ml/hr x 10½ hours or 3 x 100ml x 3 hourly | 210kcal | 2g | 7g | 5.4g |
| | | 630kcal | 5.6g | 16.3g | 24g |
| | | | 8% energy derived from LCT | 23% energy derived from MCT | 3g/kg |
| 700ml Lipistart provides: ✓ LA: 1547mg/d = 2.2% total energy ✓ ALA: 245mg/d = 0.4% total energy ✓ DHA: 105mg/d ✓ ArA: 105mg/d | | | | | |

* As a general rule, complementary foods with a fat content lower than 0.5g/100g (wet foods) or 2g/100g (dried foods) are allowed freely. Any food with a fat content above this should be avoided or counted within the daily fat allowance⁽¹⁹⁾

3.3 The use of Lipistart from 1 year onwards

Lipistart is designed to provide a sole source of nutrition from birth to 1 year and supplementary nutrition from 1 to 10 years. When a child is over 1 year, nutritional needs change from those of infancy. **Lipistart** therefore plays a different role in these early years of childhood. The examples below show the use of **Lipistart** at different developmental stages.

REMEMBER : When **Lipistart** is reduced to supplementary volumes, addition of nutrients deficient in a LCT-restricted diet require adding.

| | Developmental stage | Example meal plan | Nutrition from Lipistart | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | As a tube feed 1-year-old boy requiring severe LCT restriction estimated energy requirement: 850kcal/d ^(24,25) target energy derived from MCT: 25-30% | Some children with LC-FAOD may continue to require most nutrition from Lipistart if intake of solid food is reduced or compromised. Lipistart can continue to provide nutrition either orally or via enteral feeding tube. Appendix 1 gives nutritional information at increasing volumes to meet nutritional requirements and the need for further supplementation should be assessed and monitored. |  <ul style="list-style-type: none">• Solid food appropriate to developmental stage and feeding ability Provides: 80kcal• 1100ml Lipistart taken via enteral feeding tube or a combination of oral and tube feeding depending on feeding ability Provides: 770kcal and 26g MCT Total: 850kcal, 26g MCT (27% total energy) | 1100ml Lipistart provides: Energy: 770kcal/d LCT: 7.3g MCT: 26g LA: 2.4g ALA: 0.4g DHA: 165mg ArA: 165mg As a child grows, the volume of Lipistart needed to meet requirements may become unmanageable and time-consuming. Lipistart can be concentrated to reduce the volume required. See Appendix 1 for nutritional information when Lipistart is concentrated to 20% dilution. |
| | As supplementary nutrition 1-year-old girl requiring severe LCT restriction estimated energy requirement: 780kcal/d ^(24,25) target energy derived from MCT: 20% | For infants and young children that have progressed on to a varied solid diet, Lipistart provides supplementary nutrition alongside diet. |  <ul style="list-style-type: none">• 3 small meals<ul style="list-style-type: none">• low LCT, starchy carbohydrate, very-low fat protein sources• 4g MCT from a suitable MCT source used in cooking/added to mealsProvides: 350kcal/d and 4g MCT• Daytime feeds of 3 x 100ml Lipistart taken orally between meals to provide supplementary nutrition Provides: 210kcal/d and 7g MCT• Overnight feed of 250ml Lipistart and 20g glucose polymer either orally or via enteral feeding tube Provides: 220kcal/d and 6g MCT Total: 780kcal/day, 17g MCT (20% total energy) | 550ml Lipistart provides*: Energy: 385 kcal LCT: 3.6g MCT: 13g LA: 1.2g ALA: 0.2g DHA: 83mg ArA: 83mg As a child grows, the volume of Lipistart required to prevent lipolysis may become too great and hinder appetite or compromise tolerance. If clinically indicated, a glucose polymer can be added to Lipistart to increase carbohydrate content. As the volume of Lipistart reduces, a concentrated source of MCT can also be incorporated in to meals to provide energy |
| | As overnight provision of energy 3-year old boy requiring severe LCT restriction estimated requirements: 1200kcal/d ^(24,25) target energy derived from MCT: 20% | As children grow up and feeding skills develop, intake of solid food provides the majority of nutrition and Lipistart is used to provide supplementary nutrition as a more complete alternative to skimmed milk. At this time, Lipistart may be used alongside further MCT supplementation to provide energy. |  <ul style="list-style-type: none">• 4 small meals<ul style="list-style-type: none">• low LCT, starchy carbohydrate, very-low fat protein sourcesProvides: 770kcal/d• MCTprocal<ul style="list-style-type: none">• 2 x 16g sachets per dayProvides: 224kcal/d and 20g MCT• Overnight feed of 300ml Lipistart taken either orally or via enteral feeding tube Provides: 210kcal/d and 7g MCT Total: 1204kcal/day, MCT 27g/day (20% total energy) | 300ml Lipistart provides*: Energy: 210kcal LCT: 2g MCT: 7g LA: 0.7g ALA: 0.1g DHA: 45mg ArA: 45mg If oral feeding is compromised or difficult eating behaviours are present, it may be hard to achieve target energy requirements from diet. In this scenario, MCTprocal , a MCT powder, can be used to provide additional energy as MCT is not found sufficiently in foods. MCTprocal can be taken on its own or incorporated in to meals. See Appendix 2. |

4.0 References

4.0 References

- Salomons G, Jakobs C, Pope LL, Errami A, Potter M, Nowaczyk M, et al. Clinical, enzymatic and molecular characterization of nine new patients with malonyl-coenzyme A decarboxylase deficiency. *Journal of Inherited Metabolic Disease*. 2007; 30(1): 23-8.
- Bennett M. Pathophysiology of fatty acid oxidation disorders. *Journal of Inherited Metabolic Disease*. 2010; 33(5): 533-7.
- Schaefer, J., Jackson, S., Taroni, F., Swift, P. and Turnbull, D.M., Characterisation of carnitine palmitoyltransferases in patients with a carnitine palmitoyltransferase deficiency: implications for diagnosis and therapy. *Journal of Neurology, Neurosurgery & Psychiatry* 1997; 62(2): 169-176.
- Parini R, Invernizzi F, Menni F, Garavaglia B, Melotti D, Rimoldi M, et al. Medium-chain triglyceride loading test in carnitine–acylcarnitine translocase deficiency: Insights on treatment. *Journal of inherited metabolic disease*. 1999; 22(6):733-9.
- Cox GF, Souri M, Aoyama T, Rockenmacher S, Varvogli L, Rohr F, et al. Reversal of severe hypertrophic cardiomyopathy and excellent neuropsychologic outcome in very-long-chain acyl-coenzyme A dehydrogenase deficiency. *The Journal of Pediatrics*. 1998; 133(2): 247-53.
- Spiekerkoetter U, Bastin J, Gillingham M, Morris A, Wijburg F, Wilcken B. Current issues regarding treatment of mitochondrial fatty acid oxidation disorders. *Journal of Inherited Metabolic Disease*. 2010; 33(5): 555-61.
- Duran M, Wanders R, De Jager J, Dorland L, Bruinvis L, Ketting D, et al. 3-Hydroxydicarboxylic aciduria due to long-chain 3-hydroxyacyl-coenzyme A dehydrogenase deficiency associated with sudden neonatal death: protective effect of medium-chain triglyceride treatment. *European Journal of Pediatrics*. 1991; 150(3): 190-5.
- Gillingham M. Optimal dietary therapy of long-chain 3-hydroxyacyl-CoA dehydrogenase deficiency. *Molecular Genetics and Metabolism*. 2003; 79(2): 114-23.
- Bach AC, Babayan VK. Medium chain triglycerides: An update. *The American Journal of Clinical Nutrition*. 1982; 36: 950-62.
- Hagenmeyer M. Food information regulation: Commentary on regulation (EU) No. 1169/2011 on the provision of food information to consumers: Lexxion Verlagsgesellschaft; 2012.
- MacDonald A, Gerrard A, A D, Preece A, et al. The safety of Lipistart, a medium-chain triglyceride based formula, in the dietary treatment of long chain fatty acid disorders: a phase 1 study. *Journal of Pediatric Endocrinology and Metabolism*. 2018; 31(3): 297-304.
- Spiekerkoetter U, Lindner M, Santer R, Grotzke M, Baumgartner MR, Boehles H, et al. Treatment recommendations in long-chain fatty acid oxidation defects: consensus from a workshop. *Journal of Inherited Metabolic Disease*. 2009; 32(4): 498-505.
- GMDI. VLCAD Nutrition Management Guidelines: GMDI; 2019 accessed at https://southeastgenetics.org/ngp/guidelines_vlcad.php.
- Arnold GL, Van Hove J, Freedenberg D, Strauss A, Longo N, Burton B, et al. A Delphi clinical practice protocol for the management of very long chain acyl-CoA dehydrogenase deficiency. *Molecular Genetics and Metabolism*. 2009; 96(3): 85-90.
- Yamada K, Taketani T. Management and diagnosis of mitochondrial fatty acid oxidation disorders: focus on very-long-chain acyl-CoA dehydrogenase deficiency. *Journal of Human Genetics*. 2019; 64(2): 73-85.
- Bleeker JC, Kok IL, Ferdinandusse S, de Vries M, Derks TG, Mulder MF, et al. Proposal for an individualized dietary strategy in patients with very long-chain acyl-CoA dehydrogenase deficiency. *Journal of Inherited Metabolic Disease*. 2018; 1-10.
- Walter JH. Tolerance to fast: rational and practical evaluation in children with hypoketonaemia. *Journal of Inherited Metabolic Disease*. 2009; 32(2): 214-7.
- Lund AM, Skovby F, Vestergaard H, Christensen M, Christensen E. Clinical and biochemical monitoring of patients with fatty acid oxidation disorders. *Journal of Inherited Metabolic Disease*. 2010; 33(5): 495-500.
- Dixon M, Stafford J, White F, Clayton N, Gallagher J. Disorders of Mitochondrial Energy Metabolism, Lipid Metabolism and Other Disorders. *Clinical Paediatric Dietetics*. 2015: 588-636.
- Ledeboer M, Masclee A, Jansen JB, Lamers CB. Effect of equimolar amounts of long-chain triglycerides and medium-chain triglycerides on small-bowel transit time in humans. *Journal of Parenteral and Enteral Nutrition* 1995; 19 (1) 5-8.
- Hopman WP, Jansen JB, Rosenbusch G, Lamers CB. Effect of equimolar amounts of long-chain triglycerides and medium-chain triglycerides on plasma cholecystokinin and gall bladder contraction. *American Journal of Clinical Nutrition* 1984; 39 356-359.
- RCPCH. UK-WHO growth charts 0-4 years 2013 [Available from: <https://www.rcpch.ac.uk/resources/uk-who-growth-charts-0-4-years>].
- Shaw V, McCarthy H. Chapter 1: Nutritional Assessment, Dietary Requirements, Feed Supplementation. In: *Clinical Paediatric Dietetics*. 4: John Wiley & Sons Ltd.; 2015. p. 13 - 6.
- SACN. Dietary Reference Values for Energy. London: Scientific Advisory Committee on Nutrition; 2011.
- WHO. Human energy requirements. Report of a Joint FAO/WHO/UNU Expert Consultation, Rome. 2001.
- WHO, UNICEF. Global strategy for infant and young child feeding. Geneva; 2003.
- Fleisher Michaelsen K, Weaver L, Branca F, Robertson A. Feeding and Nutrition of Infants and Young Children Guidelines for the WHO European Region with emphasis on the former soviet countries. 2003.
- Fewtrell M, Bronsky J, Campoy C, Domellof M, Embleton N, Fidler M, et al. Complementary Feeding: A Position Paper by the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) Committee on Nutrition. *Journal of Pediatric Gastroenterology & Nutrition*. 2017; 64(1): 119-32.

5.1 Appendix 1: Volume of **Lipistart** to achieve estimated energy and key nutrient requirements

5.2 Appendix 2: Practical use of **MCTprocal**

5.3 References

5.1 Appendix 1: volume of Lipistart to achieve estimated energy and key nutrient requirements*



An online calculator is available at www.VitaFlo-VIA.com to make it easier for you to decide how to meet the MCT requirements of your patients using Lipistart and MCTprocal. Visit the website and register to access this helpful tool.

Appendix 1 – Nutritional content of Lipistart per 100g of powder and at increasing volumes when prepared to standard dilution or 20% dilution.

| Nutrient | 100g | 100ml | | 200ml | | 300ml | | 400ml | | 500ml | | 600ml | | 700ml | | 800ml | | 900ml | | 1000ml | | 1500ml | |
|----------------------|------|-------|--------------|-------|--------------|-------|--------------|-------|--------------|-------|--------------|-------|--------------|-------|----------|-------|--------------|-------|--------------|--------|--------------|--------|--------------|
| | | SD | 20% dilution | SD | 20% dilution | SD | 20% dilution | SD | 20% dilution | SD | 20% dilution | SD | 20% dilution | SD | 1kcal/ml | SD | 20% dilution | SD | 20% dilution | SD | 20% dilution | SD | 20% dilution |
| Energy (kcal) | 469 | 70 | 94 | 141 | 188 | 211 | 281 | 281 | 375 | 352 | 469 | 422 | 563 | 492 | 657 | 563 | 750 | 633 | 844 | 704 | 938 | 1055 | 1407 |
| Total fat (g) | 21 | 3 | 4 | 6 | 8 | 9 | 13 | 13 | 17 | 16 | 21 | 19 | 25 | 22 | 29 | 25 | 34 | 28 | 38 | 32 | 42 | 47 | 63 |
| LCT (g) | 4.4 | 0.7 | 0.9 | 1.3 | 1.8 | 2.0 | 2.6 | 2.6 | 3.5 | 3.3 | 4.4 | 4.0 | 5.3 | 4.6 | 6.2 | 5.3 | 7.0 | 5.9 | 7.9 | 6.6 | 8.8 | 9.9 | 13.2 |
| Energy from LCT (%) | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 |
| MCT (g) | 16 | 2 | 3 | 5 | 6 | 7 | 9 | 9 | 12 | 12 | 16 | 14 | 19 | 16 | 22 | 19 | 25 | 21 | 28 | 23 | 31 | 35 | 47 |
| Energy from MCT (%) | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| LA (mg) | 1470 | 221 | 294 | 441 | 588 | 662 | 882 | 882 | 1176 | 1103 | 1470 | 1323 | 1764 | 1544 | 2058 | 1764 | 2352 | 1985 | 2646 | 2205 | 2940 | 3308 | 4410 |
| ALA (mg) | 230 | 35 | 46 | 69 | 92 | 104 | 138 | 138 | 184 | 173 | 230 | 207 | 276 | 242 | 322 | 276 | 368 | 311 | 414 | 345 | 460 | 518 | 690 |
| Energy from EFAs (%) | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 |
| DHA (mg) | 100 | 15 | 20 | 30 | 40 | 45 | 60 | 60 | 80 | 75 | 100 | 90 | 120 | 105 | 140 | 120 | 160 | 135 | 180 | 150 | 200 | 225 | 300 |
| ArA (mg) | 100 | 15 | 20 | 30 | 40 | 45 | 60 | 60 | 80 | 75 | 100 | 90 | 120 | 105 | 140 | 120 | 160 | 135 | 180 | 150 | 200 | 225 | 300 |
| Carbohydrate (g) | 58 | 9 | 12 | 17 | 23 | 26 | 35 | 35 | 46 | 44 | 58 | 52 | 70 | 61 | 81 | 70 | 93 | 78 | 104 | 87 | 116 | 131 | 174 |
| Protein (g) | 12.0 | 1.8 | 2.4 | 3.6 | 4.8 | 5.4 | 7.2 | 7.2 | 9.6 | 9.0 | 12.0 | 10.8 | 14.4 | 12.6 | 16.8 | 14.4 | 19.2 | 16.2 | 21.6 | 18.0 | 24.0 | 27.0 | 36.0 |
| Salt (g) | 0.5 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.6 | 0.8 | 0.7 | 1.0 | 0.8 | 1.1 | 1.2 | 1.6 |
| Calcium (mg) | 400 | 60 | 80 | 120 | 160 | 180 | 240 | 240 | 320 | 300 | 400 | 360 | 480 | 420 | 560 | 480 | 640 | 540 | 720 | 600 | 800 | 900 | 1200 |
| Iron (mg) | 5.8 | 0.9 | 1.2 | 1.7 | 2.3 | 2.6 | 3.5 | 3.5 | 4.6 | 4.4 | 5.8 | 5.2 | 7.0 | 6.1 | 8.1 | 7.0 | 9.3 | 7.8 | 10.4 | 8.7 | 11.6 | 13.1 | 17.4 |
| Zinc (mg) | 4.7 | 0.7 | 0.9 | 1.4 | 1.9 | 2.1 | 2.8 | 2.8 | 3.8 | 3.5 | 4.7 | 4.2 | 5.6 | 4.9 | 6.6 | 5.6 | 7.5 | 6.3 | 8.5 | 7.1 | 9.4 | 10.6 | 14.1 |

SD = standard dilution (15%) = 3 level scoops in a final volume of 100ml

20% dilution = 4 level scoops in a final volume of 100ml

*product information presented, although correct at the time of publication, is subject to change. To ensure accuracy, please check product labels.
Please note that some figures have been rounded.

5.2 Appendix 2: practical use of MCTprocal

MCTprocal is a neutral tasting powder high in MCT for the dietary management of LC-FAOD, fat malabsorption and other disorders requiring a high MCT, low LCT diet from 3 years of age onwards provided by Vitaflo.



1 sachet of MCTprocal (16g) = 10g MCT, 112kcal and 2g protein

| | Per 100g | Per 16g sachet |
|------------------|---------------------------------------|----------------|
| Energy (kcal) | 703 | 112 |
| Total fat (g) | 63.5 | 10 |
| MCT (g) | 60.7 | 10 |
| LCT (g) | 0.9 | 0.1 |
| Carbohydrate (g) | 20.6 | 3.3 |
| Protein (g) | 12.2 | 2 |
| Osmolality | 1 sachet plus 50ml water = 198mOsm/kg | |

Product information presented, although correct at the time of publication, is subject to change. To ensure accuracy, please check product labels. See product data label and compendium for additional nutritional information

MCTprocal can be used in LC-FAOD:

- when additional energy is required in the diet to prevent lipolysis
- prior to exercise to:
 - provide an alternative substrate to muscle when exercising which can be more effective than carbohydrate⁽¹⁾
 - suppress long-chain fatty acid oxidation⁽²⁾
 - improve exercise tolerance
- as a modular component of an enteral tube feed
- with a carbohydrate polymer to provide energy overnight

Important notice

MCTprocal is a food for special medical purposes.

Use under medical supervision.

Not suitable for use as a sole source of nutrition.

Suitable from 3 years of age and onwards.

For enteral use only.

5.3 References

1. Behrend AM, Harding CO, Shoemaker JD, Matern D, Sahn DJ, Elliot DL, et al. Substrate oxidation and cardiac performance during exercise in disorders of long chain fatty acid oxidation. *Molecular Genetics and Metabolism*. 2012; 105(1): 110-5.
2. Gillingham MB, Scott B, Elliott D, Harding CO. Metabolic control during exercise with and without medium-chain triglycerides (MCT) in children with long-chain 3-hydroxy acyl-CoA dehydrogenase (LCHAD) or trifunctional protein (TFP) deficiency. *Molecular Genetics and Metabolism*. 2006; 89(1-2): 58-63.




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