



A practical guide for the use of **betaquik[®]** as a source of **medium chain triglyceride (MCT)** in the **ketogenic diet**



Vitafo in Association
With You

Supporting education in the
dietary management of rare diseases

Disclaimer

Purpose

This practical guide is for use of **betaquik**[®] as a source of medium chain triglycerides (MCT) in the ketogenic diet (KD) for the dietary management of children aged 3 years or over and adults with epilepsy or an inherited neurometabolic disease, i.e. Glut-1 deficiency syndrome (Glut-1 DS) or pyruvate dehydrogenase deficiency (PDHD).

Betaquik can also be used in the dietary management of other conditions as a source of MCT, however, this guide will focus on dietary management of epilepsy, Glut-1 DS or PDHD only.

Intended users

This practical guide is:

- For use by health care professionals working with children aged over 3 years or over and adults diagnosed with epilepsy, Glut-1 DS or PDHD.
- Not for use by parents/caregivers of patients with epilepsy, Glut-1 DS or PDHD, or patients themselves.
- For general information only and must not be used as a substitute for professional medical advice.

Target population

This practical guide is for use in children aged 3 years and over and adults with diagnosed/proven epilepsy, Glut-1 DS or PDHD.

Product information

Betaquik 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 **betaquik** 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 **betaquik** in the most appropriate way for individual patients and it may not always be appropriate to use the practical guide.

IMPORTANT INFORMATION

Betaquik must be used under strict medical supervision.

Suitable from 3 years of age onwards.

For enteral use only.

Not for use as a sole source of nutrition.

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 epilepsy, Glut-1 DS or PDHD. Information contained within the guide is based

on the most recent scientific evidence available on the use of MCT in the dietary management of epilepsy, Glut-1 DS or PDHD (January 2019).

This practical guide does not establish or specify particular standards of medical care for the treatment 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.

Abbreviations

| | | | |
|-------------|-------------------------------|----------------------|---|
| CKD | Classical ketogenic diet | MCFA | Medium chain fatty acid |
| GI | Gastro-intestinal | MCT | Medium chain triglyceride |
| KD | Ketogenic diet | MCTKD | Medium chain triglyceride ketogenic diet |
| LCT | Long chain triglyceride | MKD | Modified ketogenic diet |
| LGIT | Low glycaemic index treatment | Modified KD's | All modified KD's, i.e. MAD, LGIT and MKD (umbrella term) |
| MAD | Modified Atkins diet | | |



Contents

| | |
|--|-----------|
| Foreword | 3 |
| 1.0 What is betaquik? | 4 |
| 2.0 Betaquik in the KD - attributes and uses | 5 |
| 3.0 Using betaquik as a source of MCT in the versions of the KD | 6 |
| 3.1 Incorporating MCT into the CKD and a modified KD | 6 |
| 3.1.1 Introduction | 6 |
| 3.1.2 Practical guidance for amounts of MCT and betaquik to use in the CKD or a modified KD | 7 |
| 3.1.3 Important factors to consider when using MCT in the CKD or a modified KD | 8 |
| 3.1.4 Case Scenarios using betaquik as a source of MCT in the CKD or a modified KD | |
| ○ Case Scenario 1 - CKD | 10 |
| ○ Case Scenario 2 - CKD | 14 |
| ○ Case Scenario 3 - MKD | 17 |
| 3.2 Using betaquik as a source of MCT in the MCTKD | 20 |
| 3.2.1 Introduction and practical guidance | 20 |
| ○ Case Scenario 4 - MCTKD | 21 |
| 4.0 References | 24 |
| 5.0 Appendices | 26 |
| Appendix 1: Energy values, calculation symbols and measurement units | 26 |

Betaquik is designed as a global use product. The energy contribution of MCT is 9kcal per gram, in line with the Regulation (European Union) No. 1169/2011 on the provision of food information to consumers¹. This legislation does not differentiate between the energy provided by LCT and MCT, i.e. they are both assigned an energy value of 9kcal per gram. However, an alternative for MCT may be preferred, e.g. 8.3kcal per gram, depending on **keto-team** policy. This may affect the amount of MCT (and hence **betaquik**) that is actually prescribed in practice.

For information on the ketogenic diet, Vitaflo products for use in the ketogenic diet and recipes, visit the Vitaflo websites:

www.vitafloweb.com

www.myketogenicdiet.com

www.myketogenicdiet.co.uk/de

www.myketogenicdiet.co.uk/nl

www.myketogenicdiet.co.uk

www.myketogenicdiet.co.uk/ie

<https://www.facebook.com/Myketogenicdiet-Befr-1224510894355569/>

Other Vitaflo resources for the KD can be accessed on the VIA website www.nestlehealthscience.com/Vitaflo/VIA



Collaborators

Written by Bridget Lambert MSC, RD, Clinical Science Dietitian, and dietitians at Vitaflo® International Ltd.

In collaboration with Elizabeth Neal MSc PhD RD, Specialist Ketogenic Dietitian - Matthew's Friends Clinics and Honorary Research Associate, UCL-Institute of Child Health, London, UK.

The Classical version of the ketogenic diet originally devised in the 1920's and 30's²⁻⁴ is still in worldwide use today. The diet uses foods naturally rich in fat as long chain triglyceride (LCT) to provide an abundance of fatty acids for conversion to ketones. However, the diet is challenging to undertake, despite its proven success in the dietary management of drug resistant epilepsy and neurometabolic disorders⁵.

In the 1970's, an adaptation of the Classical ketogenic diet was devised - the Medium Chain Triglyceride ketogenic diet to take advantage of the observed greater ketogenic potential of fat comprised of medium chain fatty acids⁶⁻⁹. This approach also aimed to improve palatability, acceptability and application of the ketogenic diet. Inclusion of MCT oil as a substitute for a proportion of LCT retained clinical efficacy, enabled a reduction in total fat content and allowed more protein and carbohydrate foods to be included.

A randomised trial of the MCT and Classical versions of the ketogenic diet in children with epilepsy found them comparable in efficacy and tolerability, and concluded both had their place in the treatment of childhood epilepsy that was difficult to manage pharmacologically¹⁰.

Aside from heightened ketone production, a specific antiepileptic effect of MCT, and the individual medium chain fatty acids octanoic and decanoic *per se*, has been proposed, resulting from studies of children on the MCT ketogenic diet^{8,11,12}.

More recently, research has emerged that reinforces and extends these observations,^{13,14} so potentially meriting the inclusion of MCT, in combination with LCT, as a beneficial and advantageous constituent in all versions of the ketogenic diet.

Betaquik is a palatable source of MCT and can be readily incorporated into meals, snacks and a range of tasty recipes. The use of this product may enhance acceptability of the ketogenic diet and be beneficial in the dietary management of epilepsy and neurometabolic disease.

On a practical note, it is advisable to introduce MCT in a gradual, step-wise fashion, starting with small quantities and making step-wise, incremental increases. This careful approach, along with ensuring MCT is always taken with other foods, will usually help promote gastrointestinal tolerance and aid determination of the optimal amount of MCT best suited to your patient and their individual dietary needs. Both they and their caregivers will need regular support and user-friendly guidance to help with the 'day to day' challenges and demands of the ketogenic diet. Vitaflo have developed this practical guide to illustrate how **betaquik** can be incorporated into all versions of the ketogenic diet to help dietitians advise on its use accordingly.

Elizabeth Neal MSc, PhD, RD.

Specialist Ketogenic Dietitian, Matthew's Friends Clinics, Lingfield, Surrey, UK.

Honorary Research Associate, UCL- Institute of Child Health, London, UK.

1.0 What is betaquik?

Betaquik:

A food for special medical purposes (FSMP) intended for use under medical supervision.

A ready to use, liquid emulsion of medium chain triglycerides (MCT). With sweetener (sucralose).

For the dietary management of conditions requiring a source of MCT including use in the ketogenic diet.

Suitable from 3 years of age.

For enteral use only. **Betaquik** is not for use as a sole source of nutrition.

Betaquik is best consumed with food to promote gastrointestinal tolerance of MCT.

The recommended daily intake and administration is to be determined by a clinician or dietitian and is dependent on the age, body weight and medical condition of the patient, and the version of the KD they are following.

Table 1. Nutritional information for **betaquik**

| | Unit | Per 100ml | Per 225ml (one bottle) |
|---------------------|----------|-------------|------------------------|
| Energy | kJ | 777 | 1750 |
| | kcal | 189* | 426* |
| Fat | g | 21 | 47.3 |
| of which saturates | g | 19.8 | 44.6 |
| LCT | g | 1.0 | 2.3 |
| MCT | g | 20 | 45 |
| Carbohydrate | g | 0 | 0 |
| Protein | g | 0 | 0 |

*Energy value for MCT = 9kcal per gram¹.

Product Overview

Betaquik is a 20% emulsion of MCT oil.

The ratio of C8 (caprylic or octanoic) to C10 (capric or decanoic) medium chain fatty acids (MCFA) in betaquik is approximately 55:45.

As a source of MCT, betaquik can be:

- Used as an integral part of the medium chain triglyceride ketogenic diet (MCTKD).
- Included in versions of the KD primarily based on LCT, i.e. Classical (CKD), Modified Atkins (MAD), Low Glycaemic Index Treatment (LGIT), and Modified Ketogenic diet (MKD), to take advantage of the unique attributes of MCT.
- Consumed on its own, in combination with suitable foods and drinks, or used as an ingredient in ketogenic recipes.

2.0 Betaquik in the KD - attributes and uses

Clinical and scientific evidence, in combination with practical dietetic experience of use, suggests that inclusion of MCT as a source of fat in the KD may:

- Promote and enhance ketogenesis^{6, 15-20}.
- Provide a potential anti-epileptic effect²¹⁻²⁶.
- Enhance dietary palatability and acceptability^{8,9,27,28}.
- Be helpful in the management of KD related side effects, e.g. dyslipidaemia, gastro-esophageal reflux (GOR), constipation²⁹⁻³².

Preferred sources of MCT in the KD are commercially-produced oils, emulsions (e.g. **betaquik**) and powders derived from coconut and palm kernel oils. They have a history of safe and efficacious use within the KD⁸⁻¹¹. These products contain high proportions of the 'ketogenic' MCFA, C8 (caprylic or octanoic acid) and C10 (capric or decanoic acid). In comparison, the predominant fatty acid in pure coconut oil is C12 (lauric or dodecanoic acid), and it provides only small amounts of C8 and C10³³.

For further information, refer to the Vitaflo resource 'A practical guide to the use of medium chain triglyceride (MCT) in the ketogenic diet'.

Why use betaquik in the KD?

Betaquik is:

- Flexible** **Betaquik** is simply an emulsion of MCT (with a small quantity of LCT from an emulsifier). It does not contain any added protein or carbohydrate.

This enables it to fit flexibly into all versions of the KD:
 - The **CKD** and **MCTKD**, where protein and carbohydrate intakes are precisely calculated and measured.
 - The **modified KD's** where carbohydrate intake is strictly limited.
- Palatable** In comparison to alternative, liquid sources of MCT (oil, emulsion), **betaquik** was found to have favourable palatability (Data on file from sensory testing by Vitaflo International Ltd). A reduction in the characteristic burning sensation, GI side effect, typically experienced in the mouth and throat after taking MCT, has also been reported by those taking **betaquik** (Data on file from **betaquik** patient acceptability studies, Vitaflo International Ltd). An explanation of reasons for the commonly reported GI side effects of taking MCT and how to overcome these are available in the Vitaflo resource 'A practical guide for establishing gastrointestinal tolerance of medium chain triglyceride (MCT) and **betaquik** in the ketogenic diet'.
- Convenient** Ready to use straight from the bottle - no additional dilution is required.
- Versatile** Easily incorporated into the KD. **Betaquik** can be given as:
 - A drink on its own, either consumed directly from the bottle, or poured or measured out into a drinking vessel.
 - A drink flavoured with permitted ingredients.
 - A milk replacement, e.g., added to hot drinks or breakfast cereals.
 - An ingredient in simple and tasty recipes, along with other permitted foods.
 - An MCT 'boost', either orally or via an enteral feeding tube.
 - An ingredient in a modular ketogenic feed.

3.0 Using betaquik as a source of MCT in the versions of the KD

For an overview of the versions of the KD, and for practical guidance on their implementation, refer to the Vitaflo resource 'An introductory guide for the practical implementation of the ketogenic diet for the dietary management of epilepsy and neurometabolic disease'.

Whilst MCT is an integral part of the MCTKD, it can be readily incorporated into the LCT versions of the KD, i.e. the CKD and a modified KD.

In this section, for each version of the KD there is:

- Guidance on how to incorporate **MCT** and advice on suitable amounts to give.
- A case scenario(s) with sample menu plans to illustrate how to include **betaquik as a source of MCT** in meals, snacks and recipes.

Only small quantities of MCT may be required to take advantage of its dietary attributes within the KD. However, initial use of MCT (and therefore **betaquik**), especially in large quantities all at once, can be associated with adverse side effects. This is related to its assimilation by the body and can be a limiting factor in its use and acceptability. A graded introduction is advised, to help promote GI tolerance. Any symptoms that do occur normally resolve in the majority of individuals, given time and persistence with taking it. Support and encouragement to continue with introducing and taking MCT is vital.

Even small quantities of MCT in an LCT based KD, such as 10 – 15g daily (equivalent to 50 – 75ml **betaquik**), may induce an effect, e.g. an increased ketosis or promotion of laxation. Therefore, always monitor patients closely for excess ketone levels and/or GI intolerance, and adjust the amount given accordingly.

For advice on establishing GI tolerance to MCT, refer to the Vitaflo resource 'Practical guidance for establishing gastrointestinal tolerance to MCT and **betaquik**'.

3.1 Incorporating MCT into the CKD and a modified KD

3.1.1 Introduction

To achieve higher ketosis in a CKD or a modified KD, lowering carbohydrate intake and/or increasing LCT content can be effective. However, this may reduce palatability. Instead, incorporation of MCT, to take advantage of its ability to produce ketones more rapidly than LCT on a gram for gram basis, offers an alternative approach. In addition, using MCT in these versions of the KD may confer the benefits outlined previously in Section 2.0.

In the CKD and a modified KD, MCT can be:

- **ADDED as an additional source of fat. This increases both total fat and energy intakes.**
- OR
- **EXCHANGED with an equivalent amount in grams of LCT. Total fat and energy remain the same when 9kcal is used per gram of MCT and LCT¹.** If an alternative value is used for MCT, e.g. 8.3kcal per gram, then additional energy MAY need providing from extra MCT or LCT depending on individual patient needs.

Both these approaches can be achieved by either:

- Choosing a target percentage of daily energy requirements, e.g. 10%, 20%, 30% (**Table 2**), and calculating the amount required in grams of MCT to provide this.

OR

- Choosing a target amount of MCT in grams, e.g. 30g, 45g, 60g, per day.

Note: The amount of MCT and how it is used within a KD should always be decided on an individual patient basis in the context of their daily energy requirement, GI tolerance and level of ketosis. For guidance, refer to the section on Page 8, 'Energy contribution from MCT', and Vitaflo resources 'A practical guide for establishing gastrointestinal tolerance of medium chain triglyceride (MCT) and **betaquik** in the ketogenic diet' and 'A practical guide to the use of medium chain triglyceride (MCT) in the ketogenic diet'.

3.1.2 Practical guidance for amounts of MCT and betaquik to use in the CKD or a modified KD

Evidence to recommend specific quantities of MCT to incorporate into the LCT-based versions of the KD for a beneficial effect is lacking. However, two ways for inclusion of suggested quantities of MCT are outlined below, followed by practical advice on implementation. Either can be used when adding MCT into the CKD or a modified KD, or when exchanging the equivalent amount of LCT for MCT, gram for gram.

*** Note:** For advice on calculating an introduction schedule for MCT, refer to the Vitaflo resource 'Practical guidance for establishing gastrointestinal tolerance to MCT and betaquik'. Table 5 in this resource shows how to calculate an introduction schedule for betaquik.

1. As a percentage of daily energy requirements

Use MCT to provide from 10% and up to 30% of daily energy requirements. This amount provides a lower proportion of MCT than is used in the MCTKD, which incorporates a minimum of 30% of daily energy needs from MCT³⁴.

- Choose a target percentage of energy and calculate the equivalent amount of MCT in grams. **Table 2** shows the approximate amounts of MCT in grams (and betaquik in mls) required to provide 10 - 30% of daily energy requirements.
- Commence the introduction of MCT at a lower % of daily energy requirements, e.g. start at 5% if aiming for 30%. Increase MCT gradually e.g. in increments of 5%, in a stepwise fashion, over the chosen time period towards the chosen target %.
- Monitor individual patient GI tolerance of MCT carefully. Adjust the rate of increase or quantity of MCT added, and/or the target amount, as required.
- If the amount of MCT required to improve ketosis or seizure control is greater than 30%, consider switching over from the CKD or a modified MKD to the MCTKD. This may be a more effective way of managing MCT intake, as well as permitting less total fat and more protein and carbohydrate in the diet, so enhancing palatability.

Table 2: Examples of approximate intakes of MCT (rounded to the nearest whole gram) and betaquik (rounded up to nearest 5ml), as a percentage (%) of daily energy requirements for the CKD or a modified KD.

Handy Hint: To convert grams of MCT to ml of betaquik divide the grams by 0.2.

| % of daily energy requirement | per 1000kcal | | per 1500kcal | | per 2000kcal | | per 2500kcal | |
|-------------------------------|--------------|------------------|--------------|----------------|--------------|----------------|--------------|----------------|
| | MCT# g | betaquik## ml | MCT g | betaquik ml | MCT g | betaquik ml | MCT g | betaquik ml |
| 10 | 11 | 55 | 17 | 85 | 22 | 110* | 28 | 140 |
| 15 | 17 | 85 | 25 | 125 | 33 | 165 | 42 | 210 |
| 20 | 22 | 110* | 33 | 165 | 44 | 220** | 56 | 280 |
| 25 | 28 | 140 | 42 | 210 | 56 | 280 | 69 | 345 |
| 30 | 33 | 147 | 50 | 250 | 67 | 335 | 83 | 415 |

9kcal per gram of MCT. ## betaquik provides 0.2g MCT per ml.

*½ bottle betaquik = 112.5ml, 22.5g MCT. ** 1 bottle betaquik = 225ml, 45g MCT.

2. As a target daily amount of MCT in grams

For children, Magrath²⁷ recommends aiming for up to 20g MCT per meal (at breakfast, lunch, dinner; always with food), to give a maximum total of 60g MCT per day.

- The guidance is to start with 2.5g MCT per meal, and increase by this amount incrementally²⁷. (**Note:** in practice, to facilitate accurate weighing/measuring, this can be rounded down to 2g MCT (10ml betaquik) or up to 3g (15ml betaquik). Other amounts that could be used are 4g or 5g MCT (20ml or 25ml betaquik).

3.0 Using betaquik as a source of MCT in the versions of the KD (continued)

- Although this guidance is intended for children, the recommended maximum of 60g MCT daily may also be useful as a reference amount for adolescents and adults. In practice, 45-50g MCT daily for children, adolescents and adults may be adequate (**Note:** one bottle of **betaquik** (225ml) provides 45g MCT). Larger quantities of MCT are reported as being used in adults as part of a modified KD, e.g. up to 100g per day³⁵.
- If more than 60g MCT daily is required for an effect (and/or energy intake becomes too high due to the extra calories from MCT if added into the diet plan), consider changing over to the MCTKD.

3.1.3 Important factors to consider when using MCT in the CKD or a modified KD

General principles of MCT introduction

- When choosing a target amount of MCT, take into consideration age and individual energy requirements. Younger children may not need, or be able to tolerate, as much as an older child. The same may apply to smaller vs larger adults.
- MCT is best divided up into equal portions, distributed evenly throughout the day and always taken with food, e.g. at each of three meals and as a bedtime snack⁴⁰.
- Introduce MCT carefully and incrementally. Add it in slowly by making small increases of measured quantities, over a period of time.
- Construct a plan to introduce MCT in a step-wise fashion, e.g. by 1g, 2g or 5g, on a meal by meal or daily basis.
- Once started, review the patient regularly to gauge the impact of MCT on their GI system, ketosis and seizure control.
- Adjust the quantity of MCT (more/less) and speed of introduction (rapid/slow), depending on individual sensitivity. Examples of changes that can be made during an introduction include to:
 - Alter the incremental amounts of MCT, e.g. increase by 5g instead of 2g, or vice versa.
 - Amend the time period e.g. faster, over 5 days instead of 7. Or more slowly, e.g. over 10 days rather than 4.
 - Stop completely, then restart, at a lower amount, and increase more slowly.
 - Pause the introduction for a few days, continue on the same amount, then start to increase up to the target again.
- The time period for achieving the target amount of MCT varies. Some individuals will take 3 - 5 days, others will need longer, maybe 7, 10 or up to 14 days.
- The optimal amount of MCT for an individual may be less than the original target amount.
- It may be more appropriate to encourage consumption of a lower, more comfortably tolerated amount of MCT that has some benefit rather than having a higher quantity that causes GI symptoms.
- Always check that the percentage of daily energy from a specific amount of MCT is not above 30%*. If so, changing over to the MCTKD will give flexibility with the amount of MCT that can be used, as well as allowing more protein and carbohydrate in the diet plan.

* **Note:** Using the value 9kcal per gram of MCT, 60g of MCT provides 540kcal. For energy needs below 1600kcal per day, this amount of MCT will provide in excess of 30% of daily energy intake.

Energy contribution from MCT

As MCT is an energy source, its use needs to be tailored so individual requirements are appropriately met. **In this practical guide, the energy contribution of MCT is calculated as 9kcal per gram, in line with the Regulation (European Union) No. 1169/2011 on the provision of food information to consumers¹.** This legislation does not differentiate between the energy provided by LCT and MCT, i.e. they are both assigned an energy value of 9kcal per gram. However, an alternative value for MCT may be preferred, e.g. 8.3kcal per gram, depending on **keto-team** policy. This may affect the amount of MCT (and hence **betaquik**) that is actually used in the KD.

3.0 Using betaquik as a source of MCT in the versions of the KD (continued)

Prior to including MCT in either the CKD or a modified KD, a dietary and anthropometric assessment should be carried out to estimate daily energy requirements. This is particularly important for children, adolescents and those with feeding difficulties and/or poor nutritional status.

Use the daily energy requirement as a guide for the amount of MCT to be used, i.e. if energy intake needs to be:

- ↑ **Increased**, e.g. to promote weight gain, **ADD MCT**.
- **Maintained**. **REPLACE** an appropriate amount of LCT **with MCT on a gram for gram basis**. Either calculate the quantity in grams that equates to a chosen percentage of total fat or daily energy intake, or choose a specific amount in grams.
- ↓ **Reduced**, e.g. to promote weight loss. Recalculate macronutrient requirements according to the energy needs of the patient and update their daily meal plan. **REPLACE** an appropriate amount of LCT **with MCT on a gram for gram basis**. Either calculate the quantity in grams that equates to a chosen percentage of total fat or daily energy intake, or choose a specific amount in grams.

Effect of MCT on ketosis

The incorporation of MCT into an existing LCT-based KD can be used to enhance ketone levels. However, it can potentially induce an excessive level of ketosis. Ketone levels should be monitored regularly, especially during introduction of MCT and for an initial period of time after reaching the target amount. Use local **keto-team** guidelines to pre-empt the development of hyperketonaemia and for its management if it occurs.

Monitoring

To ensure the beneficial use of MCT, the quantity may need adjusting, on an individual basis, and over time. Continue to monitor weight and energy requirements regularly after incorporation of MCT, as excessive or insufficient energy intake, and associated weight gain or loss, may compromise ketosis²⁷.

3.1.4 Case Scenarios using betaquik as a source of MCT in the CKD or a modified KD.

These use the information from sections 3.2.1 and 3.2.2 to illustrate how to incorporate **betaquik** into these versions of the KD.

○ **Case Scenario 1** shows the principle of **exchanging** grams of LCT for MCT in a CKD to **maintain** daily energy intake.

○ **Case Scenario 2** illustrates the **addition** of a specific amount of MCT into the CKD to **increase** daily energy intake.

In both these examples, the **CKD** is calculated on an individual patient basis, taking into account daily energy and protein requirements. The amount of energy provided by **betaquik*** is factored into the daily meal plan, and the percentage of energy provided from MCT checked to ensure it remains below 30%.

○ **Case Scenario 3** demonstrates the **addition** of a target amount of MCT into a modified KD (MKD).

In this example, age, nutritional status and estimated daily energy requirements are taken into consideration to help decide on an appropriate target amount of MCT to aim for, and the percentage of daily energy from MCT calculated to ensure it is below 30%.

* MCT and LCT each providing 9kcal per gram¹. **Betaquik** has an energy content of 1.89kcal per ml from 0.2g MCT and 0.01g LCT combined.



This scenario illustrates how to exchange a set amount of LCT to MCT in the CKD, gram for gram, to maintain energy intake*. The aim is to try and improve ketone production as an alternative to increasing the ketogenic ratio from 3 to 1 up to 4 to 1.

In this example, LCT from food sources such as butter and oil is exchanged for **betaquik**. The small amount of LCT provided by **betaquik** is taken into account.

* The energy content of MCT and LCT is considered equal at 9kcal per gram¹.

Harry, 8 years and 6 months old, was diagnosed with Glut-1 DS aged 6. He became seizure free on a 3 to 1 CKD.

Over the previous few months, Harry had begun to tire more easily, and to complain of lack of energy, especially when playing football after school and at weekends. He had had a few minor seizures after exercise. His parents had noticed his urinary ketone levels were lower than usual.

At a clinic review, Harry's anthropometry³⁶ and dietary intake were assessed by the **keto-team** (**Table 3**).

Table 3: Harry's anthropometry and dietary intake.

| | | |
|---------------------------------------|---|--|
| Anthropometry³⁶ | Weight 30kg (75th centile) Height 136cm (75th centile) | |
| 3 to 1 CKD³⁷, daily | Protein | 30g (1g per kg) |
| | Carbohydrate | 36g |
| | Fat | 198g |
| | Energy | 2046kcal (100% estimated energy intake for age, PAL 1.8, active) ³⁸ |

Harry's daily meal plan is shown in **Table 4**. This details the grams of fat, protein and carbohydrate he had at each meal and snack.

Under the supervision of the MDT dietitian, Harry's parents used a ketogenic meal planner, the Electronic Ketogenic Manager (EKM)³⁹ to calculate meals, snacks and recipes accurately at home.

Table 4: Harry's daily meal plan (3 to 1 CKD), showing grams of macronutrients at each meal and snack.

| Meal or snack | Macronutrients | | | |
|----------------------|-----------------------|----------------------|---------------------------|------------------------|
| | Fat g | Protein g | Carbohydrate g | Energy kcal |
| Breakfast | 50.4 | 7.6 | 9.2 | 521 |
| Mid-am | 15.6 | 2.4 | 2.8 | 161 |
| Lunch | 50.4 | 7.6 | 9.2 | 521 |
| Mid-pm | 15.6 | 2.4 | 2.8 | 161 |
| Evening meal | 50.4 | 7.6 | 9.2 | 521 |
| Supper | 15.6 | 2.4 | 2.8 | 161 |
| Total per day | 198 | 30 | 36 | 2046 |



Incorporation of MCT into Harry's CKD

- As Harry's weight was proportional to his height (both on the 75th centile³⁶), and he did not complain of hunger, his daily energy intake was considered appropriate. Therefore, to try and improve Harry's level of ketosis, it was decided to replace 60g of LCT with a target amount of 60g MCT daily as an alternative to increasing his diet up to a 4 to 1 ratio²⁷. This would provide 540kcal (26% of his daily energy intake from MCT*).
- The MCT would be divided into 4 equal amounts, taken at each of his three meals and as a pre-exercise snack, so Harry had a boost of ketones for supplying energy whilst playing football.
- Firstly, the target amount of MCT (60g) was converted into the equivalent quantity of **betaquik** (300ml) (Steps 1 and 2, **Table 5**).
- Next, a schedule was planned so that the **betaquik** was introduced slowly, over several days, to help establish GI tolerance to the MCT. The method for calculating this is illustrated in **Table 6**.
- Harry's parents were given a written plan for introducing the **betaquik** into his meals and snacks, so that over 5 days, 60g of LCT from food sources such as double (heavy) cream, oils and butter was gradually exchanged for 60g MCT from 300ml **betaquik** (**Table 7**).
- With help from the **keto-team** dietitian, they used the EKM³⁹ to adjust Harry's meals, snacks and recipes during the MCT introduction period to contain less LCT and include the required amounts of **betaquik**.

The required amounts of **betaquik** were to be measured out in a graduated container, e.g. a measuring cup, or syringe, or, alternatively, weighed out on a digital electronic gram scale.

*Note: 1g MCT providing 9kcal¹

Table 5: Calculation of a daily introduction schedule for **betaquik** to help establish GI tolerance to MCT.

| | |
|--------|--|
| STEP 1 | Decide on a target amount of MCT per day in grams. |
| STEP 2 | Divide by 0.2# to convert to the equivalent quantity of betaquik . |
| STEP 3 | Choose the number of days for the introduction period, e.g., 5, 7 or 10 days. |
| STEP 4 | Divide the daily target amount of betaquik by the number of introduction days. This gives the daily incremental increase (in mls) of betaquik . |
| STEP 5 | Decide the number of meals and snacks per day that will include MCT (typically, this is at every meal or snack, or 3-4 times daily, always with food). |
| STEP 6 | Divide the daily incremental increase in betaquik by the number of meals and snacks that will include MCT. This equals the incremental increase of betaquik at each meal and snack, for each day of the introduction schedule. |

Table 6: Calculation of **betaquik** introduction schedule for Harry.

| | |
|--|-----------------------------------|
| Daily target for MCT | 60g |
| Equivalent daily target of betaquik | 60 divided by 0.2# = 300ml |
| Chosen introduction period (number of days) | 5 |
| Daily target increase of betaquik | 300ml divided by 5 = 60ml per day |
| Daily number of meals and snacks with MCT | 4 |
| Daily incremental addition of betaquik per meal or snack, each day of introduction period | 60ml divided by 4 = 15ml |

betaquik contains 0.2g MCT per ml (g).



Case Scenario 1 - CKD, continued

Table 7: Plan for introducing **betaquik** into Harry's meals and snacks, over 5 days, by exchanging 60g of LCT for 60g MCT (from 300ml **betaquik**).

Key: LCT MCT from **betaquik**, BQ

| | Original LCT at meal or snack (g) | Day 1 | | Day 2 | | Day 3 | | Day 4 | | Day 5 | |
|---------------------|-----------------------------------|------------|-----------------|------------|-----------------|------------|-----------------|------------|-----------------|------------|-----------------|
| | | LCT (g) | BQ, ml (MCT, g) |
| Breakfast | 50.4 | 47.4 | 15 (3) | 44.4 | 30 (6) | 41.4 | 45 (9) | 38.4 | 60 (12) | 35.4 | 75 (15) |
| Mid-am | 15.6 | 15.6 | 0 | 15.6 | 0 | 15.6 | 0 | 15.6 | 0 | 15.6 | 0 |
| Lunch | 50.4 | 47.4 | 15 (3) | 44.4 | 30 (6) | 41.4 | 45 (9) | 38.4 | 60 (12) | 35.4 | 75 (15) |
| Mid-pm | 15.6 | 12.6 | 15 (3) | 9.6 | 30 (6) | 6.6 | 45 (9) | 3.6 | 60 (12) | 0.6 | 75 (15) |
| Evening meal | 50.4 | 47.4 | 15 (3) | 44.4 | 30 (6) | 41.4 | 45 (9) | 38.4 | 60 (12) | 35.4 | 75 (15) |
| Supper | 15.4 | 15.6 | 0 | 15.6 | 0 | 15.6 | 0 | 15.6 | 0 | 15.6 | 0 |
| Total | 198 | 186 | 60 (12) | 174 | 120 (24) | 162 | 180 (36) | 146 | 240 (48) | 138 | 300 (60) |

LCT decreases



Example of a daily meal plan for Harry incorporating 300ml betaquik into a 3 to 1 CKD.

Table 8 illustrates Harry's new daily meal plan once the MCT was incorporated into his meals and snacks.

- **Betaquik** has a more fluid consistency compared to LCT food sources such as double (heavy) cream, oil, butter. If any recipes* Harry previously had on his 3 to 1 CKD were too liquid, he took **betaquik** as a drink (unflavoured or flavoured using a permitted flavouring) as part of his meal or snack instead.

Table 8: Harry's daily meal plan (3 to 1 CKD with MCT), showing grams of macronutrients at each meal and snack.

| Meal or snack | Macronutrients | | | | |
|-----------------------|----------------|------------|-----------|----------------|-------------|
| | MCT g | LCT g | Protein g | Carbohydrate g | Energy kcal |
| Breakfast | 15 | 35.4 | 7.6 | 9.2 | 521 |
| Mid-am | 0 | 15.6 | 2.4 | 2.8 | 161 |
| Lunch | 15 | 35.4 | 7.6 | 9.2 | 521 |
| Mid-pm | 15 | 0.6 | 2.4 | 2.8 | 161 |
| Evening meal | 15 | 35.4 | 7.6 | 9.2 | 521 |
| Supper | 0 | 15.6 | 2.4 | 2.8 | 161 |
| Totals per day | 60 | 138 | 30 | 36 | 2046 |

* Recipes, with inclusion of **betaquik**, adapted for Harry from www.myketogenicdiet.co.uk/ using the EKM³⁹. LCT contribution from **betaquik** included as part of total fat content.



Summary

Harry tolerated the introduction of 60g MCT as 300ml **betaquik** in exchange for 60g of LCT over 5 days well. His urinary ketone levels improved and he had more energy for football. At a follow-up clinic review 3 months later with the **keto-team**, Harry's weight was stable and the family were advised to continue with the addition of MCT into his CKD.



Case Scenario 2 - CKD

This example uses **betaquik** as a source of MCT in the CKD, in two ways:

1. To improve ketosis as an alternative to increasing the ketogenic ratio.
2. Addition of a specific amount of MCT into the CKD to **increase** daily energy intake.

Samir was 5 years old and had Dravet syndrome. He was on a 3 to 1 CKD, calculated to meet his unique dietary needs³⁷, as shown in **Table 9**. When he started on the KD, he weighed 20kg and his daily energy requirement was estimated to be lower than expected for his age due to reduced activity levels³⁸.

Table 9: Samir's 3 to 1 CKD.

| | | |
|--------------|---------------------|-----------------|
| Daily | Protein | 20g (1g per kg) |
| | Carbohydrate | 20.5g |
| | Fat | 121g |
| | Energy | 1250kcal |

After 3 months, Samir's seizure frequency had significantly reduced and he was more mobile and active. He was taking all his meals and snacks well, and his quality of life had improved. Therefore, it was decided to continue with his CKD.

However, at a clinic review after 6 months on the CKD it was found that Samir:

1. Was complaining of hunger and asking for food.
2. Was having more seizures, especially early in the morning.
3. Had low ketone levels.
4. Had lost weight (**Table 10**).

Table 10: Samir's weight and height³⁶.

| | Weight, kg (centile) | Height, cm (centile) |
|----------------|----------------------|----------------------|
| Pre CKD | 20 (75th) | 113 (75th) |
| 6 month review | 19 (25 - 50th) | 116 (75th) |

To provide additional energy to prevent further weight loss and to try to optimise ketosis as an alternative to increasing to a 4 to 1 ketogenic ratio, the **keto-team** decided to add **betaquik** into Samir's original 3 to 1 CKD diet. He would have this as measured amounts with each of his three meals and at a pre-bedtime snack, to optimise ketosis overnight and hopefully reduce the early morning seizures.

Target volume of betaquik for Samir:

- 110ml (110g) **betaquik** (22g MCT, 1.1g LCT) per day, providing 208kcal, to increase his energy intake up to 1458kcal (13.6% from MCT).
- This quantity is approximately ½ a bottle of **betaquik**. However, all foods and liquids used in the CKD need to be precisely weighed or measured in grams.
- **Betaquik** was to be measured out in a graduated container, e.g. a measuring cup, or syringe, or, alternatively, weighed out on a digital electronic scales (10ml = 10g).



Case Scenario 2 - CKD, continued

Samir's parents were advised to:

- Follow a written schedule for introducing **betaquik** to Samir over 7 days, as per **Table 11**. This was calculated using the method previously described in **Tables 5** and **6** in Case Scenario 1.
- Accurately weigh or measure out the required amounts of **betaquik**, and give to Samir orally, along with food, as part of a meal or snack.
- Give the **betaquik** as it was, or to add a permitted flavouring suitable for the KD.
- Keep to the same meals and snacks calculated for the original 3 to 1 CKD meal plan.
- Measure his ketone levels regularly, as per their local **keto-team** protocol.
- Weigh Samir at home weekly and inform the **keto-team** of any changes, so that his energy intake could be amended if necessary.

Table 11: Introduction of 110ml **betaquik**, (22g MCT) per day into Samir's 3 to 1 CKD.

| Meal | ml betaquik (g MCT) | | | | | | |
|--------------|---------------------|---------------|----------------|----------------|----------------|-----------------|-----------------|
| | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 |
| Breakfast | 5 (1) | 10 (2) | 15 (3) | 20 (4) | 20 (4) | 25 (5) | 25 (5) |
| Lunch | 5 (1) | 10 (2) | 15 (3) | 20 (4) | 20 (4) | 25 (5) | 25 (5) |
| Dinner | 5 (1) | 10 (2) | 15 (3) | 20 (4) | 20 (4) | 25 (5) | 30 (6) |
| Supper | 5 (1) | 10 (2) | 15 (3) | 20 (4) | 20 (4) | 25 (5) | 30 (6) |
| Total | 20 (4) | 40 (8) | 60 (12) | 80 (16) | 90 (18) | 100 (20) | 110 (22) |

One month later...

Samir tolerated the **betaquik** as a flavoured drink at his meals and supper. However, his ketone levels remained low and his weight static. It was decided to try to further increase the quantity of **betaquik** he was taking, aiming for 225ml (one bottle), **betaquik** per day. Samir's introduction schedule is shown in **Table 12**. The **betaquik** was always weighed or measured out for accuracy.

This additional **betaquik** gave Samir a total energy intake of 1676kcal per day (24.2% from MCT).

Table 12: Further increase of **betaquik**, up to one bottle daily (225ml, providing 45g MCT).

| Meal | ml betaquik (g MCT) | | | | | | |
|--------------|---------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 |
| Breakfast | 30 (6) | 30 (6) | 35 (7) | 40 (8) | 45 (9) | 50 (10) | 55 (11) |
| Lunch | 30 (6) | 30 (6) | 35 (7) | 40 (8) | 45 (9) | 50 (10) | 55 (11) |
| Dinner | 30 (6) | 35 (7) | 40 (8) | 45 (9) | 50 (10) | 55 (11) | 55 (11) |
| Supper | 30 (6) | 35 (7) | 40 (8) | 45 (9) | 50 (10) | 55 (11) | 60 (12) |
| Total | 120 (24) | 130 (26) | 150 (30) | 170 (34) | 190 (38) | 210 (42) | 225 (45) |

*Note: 1g MCT providing 9kcal¹

Two months later...

Samir was continuing with his original 3 to 1 CKD meals and supper, and tolerating one bottle of **betaquik** daily. His seizure control had improved. He had gained weight and was trending back towards his original 75th centile (**Table 10**).



This example illustrates the use of **betaquik** as a source of MCT in a MKD to enhance ketosis and increase the overall quantity of fat consumed daily. The principles of incorporating MCT described here can apply to any one of the modified KD's.

Ruby was 16 years old and had developed epilepsy a few years previously that was not fully controlled by medication. She was referred for a KD and seen by the **keto-team**, who advised a MKD, and Ruby and her family were taught how to utilise a food choices system for foods providing carbohydrate and fat⁴¹. Her anthropometry, estimated daily energy needs and MKD diet plan are shown in **Table 13**.

Table 13:

| | |
|---|--|
| Anthropometry ³⁶ | Weight 56kg (50th centile) Height 163cm (50th centile) |
| Estimated daily energy requirements ³⁸ | 1800kcal per day (approximately 80% of the Average Requirement (AR) for energy for her age, at PAL 1.6) |
| Daily diet plan (MKD) | 150g fat (15 x 10g fat exchanges providing 1350kcal per day; 75% of daily energy needs) Moderate-sized portions of protein foods 20g carbohydrate (20 x 1g carbohydrate choices per day) |

Although she started off well, after three months on the MKD Ruby started to struggle. At her clinic review, it was noted she was only managing 10-12 fat choices daily out of the 15 she had been recommended. She was having larger portions of protein foods than advised but keeping to her carbohydrate allowance of 20g per day.

Urine testing showed trace ketones. Ruby was continuing to have daily seizures, although compared to those she experienced pre-diet, they were of a shorter duration and her recovery time had improved. In addition, she was sleeping better and more socially interactive and energetic.

Despite the problems with adherence, both Ruby and her family were keen to continue with the diet. They agreed to try and make some changes to see if the positive benefits they were beginning to see could be improved upon further.

Ruby and her parents were advised to do the following:

- Aim to add one bottle (225ml) of **betaquik** daily as a source of 45g of MCT to enhance ketosis and increase the amount of fat in her diet.
 - To start by introducing **betaquik** slowly and incrementally over several days to promote GI tolerance, following the plan shown in **Table 14**. This introduction schedule was calculated using Steps 1 to 7 for guidance (**Table 5**).
 - Incorporate **betaquik** so she had it regularly throughout the day, as part of her meals and snacks
- In addition:
- Have at least 10 x 10g fat choices daily.
 - Reduce the amount of protein eaten by keeping to moderate sized portions.
 - Maintain her carbohydrate intake at a maximum of 20g per day.

During the introduction of betaquik

Ruby's urinary ketones were checked regularly (as per her local **keto-team** guidelines). If her ketones had become too high, her parents had been advised to reduce the amount of **betaquik** down to 110ml (½ a bottle; 22g MCT) daily. Once settled, the aim would be to gradually build back up again to the target volume, or to a daily amount that she both tolerated and that improved her ketosis.



Case Scenario 3 - MKD, continued

Outcome

A few weeks later, Ruby and her parents reported she was tolerating 225ml (one bottle) of **betaquik** daily. She was finding it easy to have as three portions of 75mls; one at breakfast, one mid-afternoon (when she got home from school), and one before going to bed. **Ruby was taking the betaquik in a variety of ways (but always with food) - as a chilled drink flavoured with a few drops of sugar-free vanilla or fruit flavouring; semi-frozen into a 'slush' consistency, or served as a warm drink.** Alternatively, the **betaquik** was mixed with yogurt, or made into a 'milkshake' with unsweetened almond milk and fresh fruit.

In summary, Ruby was also eating less protein. Her carbohydrate intake was still 20g daily. As a result of including the **betaquik**, her daily fat intake had increased back up to around 150g per day. This was from the 45g of MCT in conjunction with 10 - 11g fat exchanges. An example of her daily meal plan is shown in **Table 15**. Ruby's urine ketone levels had increased from trace to moderate, her daily seizure frequency had reduced and her weight remained on the 50th centile.

Table 14: Introduction of 225ml of **betaquik** into Ruby's MKD, as part of meals and snacks, over 5 days.

| Day | Target volume of betaquik ml (g of MCT) | Daily frequency | Taken with food at: |
|---------------|--|-----------------|--------------------------------------|
| Day 1 | 50 (10) | 1 x 50ml | Breakfast |
| Day 2 | 100 (20) | 2 x 50ml | Breakfast Supper |
| Day 3 | 150 (30) | 3 x 50ml | Breakfast Mid afternoon Supper |
| Day 4 | 180 (36) | 3 x 60ml | Breakfast Mid afternoon Supper |
| Day 5 onwards | 225 (45)  | 3 x 75ml | Breakfast Mid afternoon Supper |

Case Scenario 3 - MKD, continued

Table 15: Example MKD meal plan for Ruby, including one bottle **betaquik** per day (45g MCT).

| Meal or snack | Food and quantity, g | Carbohydrate choices ⁴¹ | Fat choices [#] (10g of fat per choice ⁴¹) and g MCT |
|---|--|------------------------------------|---|
| Breakfast Betaquik yogurt drink* Scrambled eggs with tomatoes and mushrooms | Betaquik , 75ml, blended with diet-type, virtually fat free yogurt, 25g* Butter, 18g Double cream (50% fat), 21g Eggs, two large Mushrooms, 125g Tomatoes, 64g | 2 ½ x 1g ½ x 1g 2 x 1g | 15g MCT 1 ½ 1 |
| Lunch Cheese salad and berry fruit cream | Cheddar cheese, grated, two or three heaped tablespoons Ham, two – three slices Mayonnaise, 26g Lettuce, 71g Cucumber, 67g Double cream (50% fat), 42g Berry fruit, e.g. blackberries, 60g | 1 x 1g 1 x 1g 3 x 1g | 2 2 |
| Mid-afternoon Raspberry Betaquik 'slush' drink* | <i>Blended together, semi frozen:</i> Almond milk, unsweetened, 75-100ml Raspberries, 55g Betaquik , 75ml | 2 ½ x 1g | 15g MCT |
| Evening meal Creamy chicken, cauliflower rice and buttered spinach | <i>Fried together:</i> Chicken breast, medium sized portion Cream cheese, full fat, 47g Cauliflower, 92g Olive oil, 20g Spinach, 63g Butter, 12g | 4 x 1g 1 x 1g | 1 2 1 |
| Supper Betaquik yogurt drink* | <i>Blended together, semi frozen:</i> Diet-type, virtually fat free yogurt, 25g Betaquik , 75ml | 2 ½ x 1g | 15g MCT |
| Totals | | 20 x 1g | 10 ½ x 10g 45g MCT |

Fat inherent in protein foods not counted towards daily fat intake,

* Optional – addition of sweetener and/or sugar-free flavouring.

3.2 Using betaquik as a source of MCT in the MCTKD

3.2.1 Introduction and practical guidance

In this version of the KD, the proportion of each macronutrient (MCT, protein, carbohydrate and LCT) is calculated and expressed as a percentage of total daily energy requirements^{37,40,42,43}.

Typically, in a MCTKD, provision of 45 – 50% of daily energy requirements from MCT achieves a satisfactory ketosis and clinical efficacy⁴⁰.

- However, depending on individual efficacy and tolerance, the MCT content used in a MCTKD ranges from 30 – 60%, with higher intakes up to 70% reported^{8,40, 42, 43}.
- The grams of MCT required per 1000kcal to provide a specific percentage of energy* is shown in **Table 16**, as is the amount of **betaquik** that contains this quantity of MCT.

Note: 100ml of **betaquik** contains 20g of MCT.

Table 16: Percentages of energy from MCT used in the MCTKD; grams of MCT per 1000kcal and equivalent amount of **betaquik** (ml).

| MCTKD - % of energy from MCT per day | MCT, g per 1000kcal * | Quantity of betaquik (ml) containing this amount of MCT (g) |
|--------------------------------------|-----------------------|--|
| 30 | 33 | 165 |
| 35 | 39 | 195 |
| 40 | 45 | 225 (One bottle)  |
| 45 | 50 | 250 |
| 50 | 55 | 275 |
| 55 | 61 | 305 |
| 60 | 67 | 335 |
| 65 | 72 | 360 |
| 70 | 78 | 390 |

* Energy value of MCT = 9kcal per gram¹.



This example illustrates the use of **betaquik** as a source of MCT during the implementation of a MCTKD.

Jasmine was 13 years old when she was referred for a KD for the dietary management of epilepsy. She had some mobility problems which reduced her daily activity levels. Growth measurements indicated she was overweight for her height and from a dietary assessment, it was estimated that her usual daily energy intake was lower than expected for her age³⁸ (**Table 17**). Jasmine's parents reported she preferred carbohydrate foods, and liked to have cereal for breakfast and a drink of milk at supper. The MCTKD was a good option for Jasmine as it contains more carbohydrate than the CKD or a modified KD, so she could have some milk included in her daily meal plan.

Table 17: Jasmine's growth and dietary assessment before starting the MCTKD.

| | |
|--|--|
| Anthropometry ³⁶ | Weight 42kg (25th - 50th centile) BMI - 75th centile Height 143cm (2nd - 9th centile) |
| Estimated daily energy intake ³⁸ | 1800kcal per day approximately 76% AR (PAL 1.8) ³⁸ |



Planning Jasmine's MCTKD

- It was noted from historical growth data that Jasmine's BMI had been increasing over the past year, from the 50th to the 75th centile. Therefore, it was decided to reduce her estimated current daily energy intake of 1800kcal by approximately 10%, i.e. by 180 - 200 kcal per day to 1600kcal (68% of the AR for energy intake for her age³⁸).
- As a starting point for establishing GI of MCT and achieving dietary acceptance and efficacy, the macronutrient distribution chosen was 45% of estimated daily energy requirements from MCT, 10% from protein, 15% from carbohydrate, with the remainder 30% from LCT⁴⁰.
- **Betaquik** was chosen as a source of MCT, taken four times daily, at each of three meals and at supper.
- 200ml semi-skimmed milk was incorporated into Jasmine's daily meal plan. Milk is a useful vehicle for MCT, and **betaquik** mixes in easily.
- A 7-day transition schedule was devised for the introduction of the MCTKD and **betaquik** to Jasmine. There was an option to increase this to over 10 days depending on how well she tolerated the MCT and accepted the changes to her normal diet.

Tables 18, 19, 20 and **21** illustrate the process of calculating and planning Jasmine's MCTKD.

Table 18: Calculation of macronutrients (g per day).

| Macronutrient | Chosen % of daily energy requirement | Energy kcal per day | g per day |
|---------------------|--------------------------------------|---------------------|-------------|
| MCT | 45 | 720 | 80 |
| Protein | 10 | 160 | 40 |
| Carbohydrate | 15 | 240 | 60 |
| Fat (LCT) | 30 | 480 | 53.3 |
| Totals | 100 | 1600 | |



Case Scenario 4 - MCTKD, continued

Table 19: Inclusion of 200mls per day semi-skimmed milk into Jasmine's MCTKD.

| | Protein (g) | Carbohydrate (g) | Fat LCT (g) |
|--|-------------|----------------------------|----------------------------|
| Daily macronutrient totals (from Table 14) | 40 | 60 | 53.5 |
| 200ml semi skimmed milk provides | 7 | 9.4 | 3.4 |
| Daily macronutrient totals minus contribution from milk | 33 | 50.6 (round to 50g) | 50.1 (round to 50g) |

Table 20: Conversion to macronutrient food choices for the MCTKD⁴⁰.

| | g per day | Choices per day |
|-----------------------|---|-----------------|
| MCT (betaquik) | 80 (400ml) | Not applicable |
| Protein* | 33 | 5.5 x 6g* |
| Carbohydrate | 50 | 10 x 5g |
| Fat (LCT) | 50 – 16.5** - 4*** = 29.5 (round to 30) | 6 x 5g |

* Fat adjusted protein choice. To ensure these each contain 3g of fat, additional fat, e.g. butter, oil, may need adding.

** Minus 3g of fat per protein choice from total fat.

*** Minus 4g LCT daily from **betaquik** (this contains 1g LCT per 100ml).

Table 21: Example of a target daily distribution of **betaquik**, semi-skimmed milk (SSM) and food choices in three meals and one snack daily for Jasmine.

| Meal or snack | MCT g (Betaquik, ml) |  SSM, ml | Protein Choices, 6g, fat adjusted* | Carbohydrate Choices (5g) | Fat (LCT) Choices 5g | Energy kcal |
|---------------------|----------------------|---|------------------------------------|---------------------------|----------------------|-------------|
| Breakfast | 20 (100) | 100 | 1.5 | 3 | 2 | 464 |
| Lunch | 20 (100) | x | 2 | 3 | 2 | 441 |
| Evening meal | 20 (100) | x | 2 | 3 | 2 | 441 |
| Supper | 20 (100) | 100 | 0 | 1 | 0 | 257 |
| Totals | 80 (400) | 200 | 5.5 x 6g | 10 x 5g | 6 x 5g | 1603 |

* Energy content per protein choice = 51kcal (from 6g protein + 3g fat).

Implementation of Jasmine's MCTKD

For a week beforehand, Jasmine's parents made some pre-KD changes to her normal diet - reducing foods and drinks high in sugar and increasing her fat intake.

Diet initiation took place at home, as per policy of the local **keto-team**. They kept in close contact with Jasmine's carers, to monitor her dietary intake, tolerance of MCT, ketone levels, and seizures.

A careful, 7-day introduction plan helped ensure an adequate energy intake by substitution of normal meals to MCTKD meals, in combination with the gradual introduction of **betaquik**, up to the daily target amount, and mixed into semi-skimmed milk as a drink (**Tables 22 and 23**).



Case Scenario 4 - MCTKD, continued

Table 22: MCTKD meal, snack and **betaquik** introduction schedule for Jasmine.

■ = normal meal or snack ■ = keto meal or snack **SSM** = semi skimmed milk **BQ** = **betaquik**.

| Day | Breakfast | Lunch | Evening meal | Supper | Total BQ ml + 200ml SSM |
|-----|-----------------------------|-------|--------------|-----------------------------|-------------------------------|
| | ml of BQ added to 100ml SSM | BQ ml | BQ ml | ml of BQ added to 100ml SSM | |
| 1 | 15 | 15 | 15 | 15 | 60 |
| 2 | 30 | 30 | 30 | 30 | 120 |
| 3 | 45 | 45 | 45 | 45 | 180 |
| 4 | 60 | 60 | 60 | 60 | 240 |
| 5 | 75 | 75 | 75 | 75 | 300 |
| 6 | 90 | 90 | 90 | 90 | 360 |
| 7 | 100 | 100 | 100 | 100 | 400 |



Table 23: Example of a target daily meal plan, incorporating 200ml semi skimmed milk (2 x 100ml) and 80g MCT from 400ml **betaquik** (4 x 100ml)

| Meal or snack | Foods | MCT g | Protein choices, fat adjusted (6g) | Carbohydrate choices (1g and 5g) | Fat (LCT) choices (5g) |
|---------------------|---|-----------|------------------------------------|----------------------------------|------------------------|
| Breakfast | Betaquik, 100ml, mixed with Milk, semi skimmed 100ml Weetabix, 21g Eggs, 75g, scrambled with 9g butter | 20 | 1 ½ | 3 x 5g | 1 ½ |
| Lunch | Betaquik, 100ml, (sugar free flavouring optional) Cheddar cheese, 36g Bread, wholemeal, 24g Butter 12g Strawberries, 83g | 20 | 1 ½ | 2 x 5g 1 x 5g | 2 |
| Evening meal | Chicken, vegetable and coconut curry* (including betaquik, 100ml) Peaches, 50g | 20 | 2 ½ | 2 x 5g 1 x 5g | 2 ½ |
| Supper | Betaquik, 100ml, mixed with Milk, semi skimmed 100ml Digestive biscuit, 7g | 20 | | 1 x 5g | |
| Totals | | 80 | 5.5 x 6g | 10 x 5g | 6 x 5g |

* For recipes, visit www.myketogenicdiet.co.uk

Summary

During the first few days on the introduction schedule, Jasmine experienced some symptoms of GI intolerance to the MCT, although she readily took the milk with **betaquik** mixed into it. She was also sometimes reluctant to take the ketogenic meals. However, these issues were resolved by making the dietary changes more slowly, every two days instead of daily. After two weeks, Jasmine was fully established on her diet plan and her seizure frequency had reduced by more than 50%.

4.0 References

1. Regulation (European Union) No. 1169/2011 of The European Parliament and of the Council of 25 October 2011 on the provision of food information to consumers. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02011R1169-20180101>
2. Wilder, R. M. 1921. Effects of ketonuria on the cause of epilepsy. *Mayo Clinic Proc.* 2, pp. 307-8.
3. Talbot, F.B., Metcalf, K.M., Moriarty, M.E. 1927. A clinical study of epileptic children treated by the ketogenic diet. *Boston Medical and Surgical Journal.* 196, pp. 89-96.
4. Talbot, F.B. 1930. *Treatment of epilepsy.* New York; Macmillian.
5. Neal, E. Introduction to the ketogenic diet and other dietary treatments. Chapter 1, pp. 3-10. Neal E, editor. *Dietary treatment of epilepsy: practical implementation of ketogenic therapy.* John Wiley & Sons; 2012 Jul 3.
6. Bergen, S.S., Hashim, S.A., Van Itallie, T.B. 1966. Hyperketonemia induced in man by medium-chain triglyceride. *Diabetes.* 15 (10), pp. 723-25.
7. Freund, G., Si Weinsier, R. L. 1966. Standardized ketosis in man following medium chain triglyceride ingestion. 1966. *Metabolism.* 15, pp. 980-991.
8. Huttenlocher, P. R., Wilbourn, A. J., Signore, J. M. 1971. Medium-chain triglycerides as a therapy for intractable childhood epilepsy. *Neurology.* 21 (11), pp. 1097-1103.
9. Huttenlocher P. R. 1976. Ketonemia and seizures: metabolic and anticonvulsant effects of two ketogenic diets in childhood epilepsy. *Pediatr. Res.* 10, pp. 536-540.
10. Neal, E. G., Chaffe, H., Schwartz, R. H., Lawson, M. S., Edwards, N., Fitzsimmons, G., Whitney, A., Cross J. H. 2009. A randomized trial of classical and medium-chain triglyceride ketogenic diets in the treatment of childhood epilepsy. *Epilepsia.* 50, pp. 1109-1117.
11. Sills, M.A., Forsythe, W.I., Haidukewych, D., MacDonald, A., Robinson, M. 1986. The medium chain triglyceride diet and intractable epilepsy. *Arch. Dis. Child.* 61, pp. 1168-1172.
12. Sills, M.A., Forsythe, W.I., Haidukewych, D. 1986. Role of octanoic and decanoic acids in the control of seizures. *Arch. Dis. Child.* 61, pp. 1173-1177.
13. Chang, P., Terbach, N., Plant, N., Chen, P., Walker, M.C., Williams, R.S.B. 2013. Seizure control by ketogenic diet associated medium chain fatty acids. *Neuropharmacology.* 69, pp. 105-114.
14. Hughes, S.D., Kanabus, M., Anderson, G., Hargreaves, I.P., Rutherford, T., Donnell, M.O., Cross, J.H., Rahman, S., Eaton, S. and Heales, S.J. 2014. The ketogenic diet component decanoic acid increases mitochondrial citrate synthase and complex I activity in neuronal cells. *Journal of Neurochemistry.* 129(3), pp. 426-433.
15. Marten, B., Maria Pfeuffer, M., Schrezenmeir, J. 2006. Medium-chain triglycerides. *International Dairy Journal.* 16, pp. 1374-1382.
16. Bach, A.C., Babayan, V.K. 1982. Medium chain triglycerides: an update. *Am J Clin Nutr.* 36, pp. 950-962.
17. Bach, A.C., Zngenbleek, Y., Frey, A. 1996. The usefulness of dietary medium-chain triglycerides in body weight control - fact or fancy? *Journal of Lipid Research.* 37, pp. 708-726.
18. Fukao, T., Lopaschuk, G.D., Mitchell, G.A. 2004. Pathways and control of ketone body metabolism: on the fringe of lipid biochemistry. *Prostaglandins, Leukotrienes and Essential Fatty Acids.* 70, (3), pp. 243-251.
19. Courchesne-Loyer, A., Fortier, M., Tremblay-Mercier, J., Chouinard-Watkins, R., Roy, M., Nugent, S., Castellano, C-A., Cunnane, S.C. 2013. Stimulation of mild, sustained ketonemia by medium-chain triacylglycerols in healthy humans: estimated potential contribution to brain energy metabolism. *Nutrition.* 29, pp. 635-640.
20. Pi-Sunyer, F. X., Hashim, S.A., Van Itallie, T.B. 1969. Insulin and ketone responses to ingestion of medium and long-chain triglycerides in man. *Diabetes.* 18,(2), pp. 96-100.
21. Hartman, A.L., Rho, J.M. The biochemical basis of dietary therapies for neurological disorders. Chapter 5, pp. 34-44. Neal E, editor. *Dietary treatment of epilepsy: practical implementation of ketogenic therapy.* John Wiley & Sons; 2012 Jul 3.
22. Thavendiranathan P, Mendonca A., Dell C., Likhodii S. S., Musa K., Iracleous C., Cunnane S. C., Burnham, W. M. 2000. The MCT ketogenic diet: effects on animal seizure models. *Exp. Neurol.* 161, pp. 696-703.

23. McNally, M.A., Hartman, A.L. 2012. Ketone Bodies in Epilepsy. *J Neurochem.* 121 (1), pp. 28–35. doi:10.1111/j.1471-4159.2012.07670.x
24. Właż, P., Socąła, K., Nieoczym, D., Łuszczki, J.J., Żarnowska, I., Żarnowski, T., Czuczwar, S.J. and Gasior, M., 2012. Anticonvulsant profile of caprylic acid, a main constituent of the medium-chain triglyceride (MCT) ketogenic diet, in mice. *Neuropharmacology.* 62(4), pp.1882-1889.
25. Właż, P., Socąła, K., Nieoczym, D., Żarnowski, T., Żarnowska, I., Czuczwar, S.J. and Gasior, M., 2015. Acute anticonvulsant effects of capric acid in seizure tests in mice. *Progress in Neuro-Psychopharmacology and Biological Psychiatry.* 57, pp.110-116.
26. Maciejak, P., Szyndler, J., Turzyńska, D., Sobolewska, A., Kołosowska, K., Krząścik, P. and Płażnik, A., 2016. Is the interaction between fatty acids and tryptophan responsible for the efficacy of a ketogenic diet in epilepsy? The new hypothesis of action. *Neuroscience.* 313, pp.130-148.
27. Magrath, G. Fine tuning. Chapter 17, pp. 142-148. Neal E, editor. *Dietary treatment of epilepsy: practical implementation of ketogenic therapy.* John Wiley & Sons; 2012 Jul 3.
28. Zupiec-Kania, B. 2015. Ketogenic diet for glut-1 ds summary of 2015 family conference presentation. The Charlie Foundation for Ketogenic Therapies. [www.charlifoundation.org](http://www.gldfoundation.org/wp-content/uploads/2015/10/KETO-DIET-FOR-GLUT1-3.pdf) Available from: <http://www.gldfoundation.org/wp-content/uploads/2015/10/KETO-DIET-FOR-GLUT1-3.pdf>.
29. Bhavsar, N. and St-Onge, M.P. 2016. The diverse nature of saturated fats and the case of medium-chain triglycerides: how one recommendation may not fit all. *Current Opinion in Clinical Nutrition and Metabolic Care.* 19(2), pp. 81-87.
30. Kwiterovich, P.O., Vining, E.P.G., Pyzik, P., Skolasky Jr, R., Freeman, J.M. 2007. Effect of a high-fat ketogenic diet on plasma levels of lipids, lipoproteins, and apolipoproteins in children. *JAMA.* 290, pp. 912-920.
31. Freeman, J.M., Kossoff, E.H. and Hartman, A.L. 2007. The ketogenic diet: one decade later. *Pediatrics.* 119(3), pp. 535-543.
32. Liu, Y.M.C., Lowe, H., Zak, M.M., Kobayashi, J., Chan, V.W. and Donner, E.J. 2013. Can children with hyperlipidemia receive ketogenic diet for medication-resistant epilepsy? *Journal of Child Neurology.* 28(4), pp. 479-483.
33. Codex Standard for named vegetable oils. CODEX-STAN 210-1999. www.FAO.org. Accessed April 2018.
34. Schwartz RH, Eaton J, Bower BD, Aynsley Green A. 1989. Ketogenic diets in the treatment of epilepsy: short-term clinical effects. *Developmental Medicine & Child Neurology.* 31(2), pp. 145-51.
35. Personal communication 2016. Department of Nutrition and Dietetics, National Hospital for Neurology and Neurosurgery, London, UK.
36. UK-WHO. World Health Organisation (WHO) Child Growth Standards. 2013. Available at: <http://www.rcpch.ac.uk/child-health/research-projects/uk-who-growth-charts/>
37. Fitzsimmons, G. and Sewell, M. Ketogenic diets. Chapter 16, p. 354. *Clinical Paediatric Dietetics.* 4th Edition. Editor: Vanessa Shaw. John Wiley and Sons Ltd, 2015.
38. European Food Safety Authority (EFSA). 2017. Dietary Reference Values for nutrients. Summary report. doi: 10.2903/sp.efsa.e15121. <https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/sp.efsa.2017.e15121>
39. EKM (Electronic Ketogenic Manager). Available at: <http://www.matthewsfriends.org/keto-kitchen/ketorecipes/ketogenic-mealplanner-electronic-ketogenic-manager-ekm/>
40. Neal, E. The medium chain triglyceride diet. Chapter 9, pp. 78-88. Neal E, editor. *Dietary treatment of epilepsy: practical implementation of ketogenic therapy.* John Wiley & Sons; 2012 Jul 3.
41. Magrath, G., Leung, M-A, Randell, T. The modified Atkins diet. Chapter 10, pp. 89-99. Neal E, editor. *Dietary treatment of epilepsy: practical implementation of ketogenic therapy.* John Wiley & Sons; 2012 Jul 3.
42. Liu, Y-M.C. 2008. Medium chain triglyceride (MCT) ketogenic therapy. *Epilepsia.* 49, suppl 8, pp. 33-6.
43. Liu, Y-M.C., Wang, H.S. 2013. Medium chain triglyceride ketogenic diets, an effective treatment for drug resistant epilepsy and a comparison with other ketogenic diets. *Biomed. J.* 36, pp. 9-15.

Appendix 1

Energy values, calculation symbols and measurement units.

Energy values used in calculations(as per EU Regulation No 1169/2011)¹

| per g | kcal |
|--------------|-------------|
| Fat LCT | 9 |
| MCT | 9 |
| Protein | 4 |
| Carbohydrate | 4 |

| Calculation | Symbol |
|--------------------|---------------|
| Plus (or addition) | + |
| Minus | - |
| Divide | ÷ |
| Multiply | x |
| Percentage | % |
| Equals (or result) | = |

| Measurement | Unit |
|----------------------|-------------|
| Kilocalorie (energy) | kcal |
| Gram | g |
| Kilogram | kg |
| Milliliter | ml |
| Metre | m |
| Centimetre | cm |



Innovation in Nutrition

A Nestlé Health Science Company

VitaFlo International Ltd,
Suite 1.11, South Harrington Building,
182 Sefton Street, Brunswick Business Park,
Liverpool L3 4BQ, UK

+44 (0)151 709 9020

www.vitaFlo-VIA.com

 **Follow VitaFlo Dietitians on Twitter: [@VitaFloRDs](https://twitter.com/VitaFloRDs)**

® Reg. Trademarks of Société des Produits Nestlé S.A.

© Société des Produits Nestlé S.A.