



Guidelines for using **keyo**® in the ketogenic diet



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Disclaimer

These guidelines are for the use of keyo in the ketogenic diet (KD) for the dietary management of drug resistant epilepsy and neurometabolic disease, e.g. Glut-1 deficiency syndrome (Glut-1 DS).

They should be utilised in conjunction with local and national protocols and general recommendations for the use of the KD in these conditions.

These guidelines are:

- Only to be used by qualified healthcare professionals.
- Not for use by patients or their parents or carers.
- For general information only and must not be used as a substitute for professional medical advice or treatment.

The information in these guidelines, although accurate and based on current best practice in the UK at the time of publication, is subject to change as use of the KD evolves.

It is the responsibility of the multidisciplinary clinical team (i.e. a dedicated '**keto-team**'*) to ensure patients managed on the KD are suitable to undergo this form of diet therapy, and they undertake and implement all required assessments, procedures, investigations and monitoring in accordance with locally agreed procedures specific to the intervention.

* N.B. The term **keto-team** is a generic description for those healthcare professionals (e.g. dietitians, clinicians, nurses) involved in the implementation, follow-up and care of patients on a KD.

The keyo product information presented in these guidelines, although correct at the date of publication, is subject to change. To ensure accuracy, please refer to product labels.

Keyo is a food for special medical purposes (FSMP) and must only be used under medical supervision

- Keyo is suitable for use as a supplementary source of nutrition in the KD from 3 years of age.
- Keyo is nutritionally complete and could be used in the KD as a sole source of nutrition from 3 to 10 years of age.

The quantity of keyo required to meet individual nutritional requirements must be determined by a clinician or dietitian only, as this is dependent on age, body weight, medical condition and local dietary guidelines and recommendations.

Collaborators

Vitaflo dietitians in collaboration with Rachel Meskell and Kathryn Lightfoot, Senior Specialist Paediatric Ketogenic Dietitians, Leeds Children's Hospital, Leeds Teaching Hospitals NHS Trust, Leeds, UK.

Abbreviations

CKD	Classical ketogenic diet
KD	Ketogenic diet
LCFA	Long chain fatty acid
LCT	Long chain triglyceride
LGIT	Low glycaemic index treatment
MAD	Modified Atkins diet
MCFA	Medium chain fatty acid
MCT	Medium chain triglyceride
MCTKD	Medium chain triglyceride ketogenic diet
MKD	Modified ketogenic diet

For term definitions see Section 6



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A food for special medical purposes

Keyo is a chocolate flavoured, nutritionally complete, very high fat, low carbohydrate ready to eat, semi-solid food with a 3 to 1 ratio of fat to carbohydrate and protein. Keyo contains fat, protein, carbohydrate, vitamins, minerals, trace elements and arachidonic acid and docosahexanoic acid. With sugar and sweetener.

For information on the ketogenic diet and keyo visit the VitaFlo websites
www.nestlehealthscience.com/vitaflo/via
www.vitafloweb.com
www.myketogenicdiet.com

There are many clinical and dietetic challenges, both day-to-day and long term, associated with the implementation and use of the ketogenic diet in the dietary management of drug resistant epilepsy and neurometabolic disease. From the dietitians' perspective, ensuring patients are achieving an appropriate dietary intake that meets individual nutritional requirements, and consuming enough fat to maintain ketosis, is of utmost importance. Meals and snacks need to be appetising and relatively easy to prepare, and preferred foods, tastes, and flavours included and accommodated as much as possible. These considerations can all help promote dietary acceptance and adherence.

Another vital aspect of dietetic care required on a ketogenic diet concerns giving attention to the correct food texture for those with feeding problems related to oro-motor impairment, dysphagia and gastrointestinal dysfunction. Under the guidance of a qualified feeding specialist (e.g. a speech and language therapist), for many individuals, the modification of meals, (e.g. mashing, blending or pureeing), will facilitate a sufficiently safe and adequate dietary consumption. However, even those who are solely tube fed the ketogenic diet may, under relevant healthcare professional direction, be able to take tiny amounts of food orally, for the simple pleasure of taste and flavour. The smooth, semi-solid texture of keyo has potential application for those on the ketogenic diet with feeding difficulties requiring texture modification both with and without a feeding tube in situ.

We were involved with the clinical evaluation of keyo with a group of our patients and found it was a palatable and acceptable food to include as part of their ketogenic diets. The fact it has a chocolate flavour means a universally popular food taste can be enjoyed whilst on the ketogenic diet - even if the real thing has to be excluded! This attribute, along with its convenient, ready to use presentation, lends keyo for use as a source of fat (with a favourable fatty acid profile) for contributing toward adequate intakes in the ketogenic diet, either on a regular or ad hoc basis or during illness and periods when appetite is poor.

Nutritionally, keyo also serves as an excellent source of high quality protein and micronutrients, easily factored into the ketogenic diet thus making a valuable contribution, in varying degrees, toward meeting dietary requirements and improving intakes of these nutrients.

As experienced paediatric dietitians, our observations are that the design of this product offers flexible solutions to dietetic issues commonly encountered during the implementation and use of the ketogenic diet, and that it can potentially contribute toward its success. Keyo is an innovative new addition to the range of currently available nutritionally complete proprietary products for the ketogenic diet.

Finally, both patients and their caregivers benefit from regular support and provision of user-friendly guidance and instructions to help them with the demands of the ketogenic diet. With this in mind, VitaFlo have developed these guidelines for the use of keyo in the ketogenic diet to highlight and illustrate how dietitians and clinicians can incorporate this product into each specific version in easy, varied, acceptable and enjoyable ways, and to help them advise on its use accordingly.

**Rachel Meskell and Kathryn Lightfoot,
Senior Specialist Paediatric Ketogenic Dietitians.**

**Leeds Children's Hospital,
Leeds Teaching Hospitals NHS Trust,
Leeds
UK.**



1.0

What is keyo?

1.0 What is keyo?

Keyo:

- **A chocolate flavoured, nutritionally complete, very high fat (LCT), low carbohydrate, ready to eat, semi-solid food with a 3 to 1 ratio of fat to carbohydrate and protein.**
- **Contains fat, protein, carbohydrate, vitamins, minerals, trace elements, arachidonic acid (ARA) and docosahexaenoic acid (DHA). With sugar and sweetener.**
- **For use in the dietary management of epilepsy in a ketogenic diet; Glut 1 deficiency syndrome or other conditions requiring a ketogenic diet.**

- Suitable from 3 years of age onwards.
- Recommended daily intake and administration to be determined by a clinician or dietitian and is dependent on the age, body weight and medical condition of the patient. For enteral use only.
- Ensure an adequate intake of permitted fluids when using keyo as part of a ketogenic diet.

Nutritional information

Table 1

	Unit	Per 100g (one pot)	Per 100kcal
Energy	kJ kcal	1280 310	420 100
Fat	g	30	9.7
Of which saturates	g	2.2	0.7
monounsaturates	g	18.6	6.0
polyunsaturates	g	8.6	2.8
Carbohydrate	g	2.0	0.65
Of which sugars	g	1.5	0.48
Protein	g	8.0	2.6

Product Overview

Keyo can be consumed on its own, in combination with suitable foods and drinks or used as an ingredient in ketogenic recipes.

Keyo can be used on a regular or ad hoc basis in those versions of the KD primarily based on LCT, i.e.,

- Classical ketogenic diet (CKD)
- Modified Atkins diet (MAD)
- Low glycaemic index treatment (LGIT)
- Modified ketogenic diet (MKD)

Keyo can be included in the medium chain triglyceride ketogenic diet (MCTKD) in small measured quantities only due to its LCT content.



2.0

Overview of the KD

2.0

2.0 Overview of the KD

The KD is a very high fat, low carbohydrate, adequate protein diet that replicates the metabolic effects of starvation and fasting. Provided carbohydrate is restricted, adequate dietary protein for growth, development and tissue repair included and sufficient fat consumed to meet individual energy requirements, the release of glucose from the breakdown of muscles and organs is minimised in favour of ketone production from the breakdown of fatty acids¹. With its requisite high fat intake (at least two thirds of daily energy requirements), the KD is designed to be 'keto-genic' – ketone generating.

The KD has proven success in the dietary management of drug resistant epilepsy, which affects 25 – 30% of individuals with epilepsy², although the mode of action remains to be fully established³. Studies of efficacy have shown that approximately 50% who start the KD have a greater than 50% reduction in seizures (i.e., frequency, clustering and severity) during an initial 3-month trial period. About one third will have a 90% decrease and 10-15% will achieve seizure freedom, comparable to the results achieved with successful use of medication⁴⁻⁶. Some can reduce or discontinue anti-epileptic drugs. In addition to improved seizure management, many patients and their families gain positive improvements in quality of life. Provided a favourable response is experienced, the KD can be continued for up to two years, then a normal diet resumed. Typically, benefits experienced whilst on the KD continue and may be sustainable without requirement for further medical or dietary intervention^{7,8}.

The KD is also central to the effective management of neurometabolic diseases such as Glut-1 DS and pyruvate dehydrogenase deficiency (PDHD). Glut-1 DS, a genetic defect in primary glucose transport via the Glut-1 transporter enzyme across the blood brain barrier, reduces the availability of glucose as a fuel source within the brain, resulting in seizures, complex disorders of movement and global developmental delay. A range of phenotypes from mild to severe are exhibited and a diagnosis can be made from infancy through to adulthood⁹. Use of the KD on a long-term basis to provide ketones as an alternative energy source to glucose promotes brain growth and development in infancy and early childhood, and can help facilitate a more normal neuronal function and hence symptom control¹⁰.

Efficacy aside, being on a KD is very different from eating a regular diet. In comparison with the wide range and choice of foods, and variety of flavours and textures typically consumed and readily available, the KD is extremely restrictive. Although with effort and imagination it is possible to prepare tasty, appetising meals and snacks, this is challenging, and can make the diet daunting to undertake and maintain as part of everyday life¹¹.

Fundamental to attaining success or not is the ability to cope with issues around the acceptability and complexity of the KD. A review of studies on its use reports that despite achieving an initial beneficial effect on seizure control, there tends to be an early discontinuation rate, especially amongst adolescents and adults¹². This is predominantly due to the realities of keeping to such a strict dietary regime. In addition, many carers, and those who are undertaking the KD on their own, struggle with food preparation and meal planning. All these factors, plus the stigma of eating differently with others in social situations can significantly contribute toward non-adherence¹³.

Keyo has been developed to try and help overcome these challenges and make a contribution toward improving and widening the acceptability and application of the KD.

Renewed interest and use of the KD, together with associated clinical and scientific research, has been gathering momentum up to the present day and looks set to continue into the future¹⁴. It has further established the efficacy of the KD in the dietary management of drug resistant epilepsy and neurometabolic diseases and revealed its potential application in cancer and other neurological conditions^{15,16}.

There are five versions of the KD in clinical use worldwide. For a brief overview of each, refer to Section 6.2 of these guidelines.



For further information, refer to the Vitaflo publication 'Guidelines for the practical implementation of the ketogenic diet in the dietary management of drug resistant epilepsy and neurometabolic disease'.



3.0

Attributes and uses of keyo in the KD

Chart 1 - Attributes of keyo in the KD

Chart 2 - Using keyo in the KD

3.1 A palatable source of fat

3.2 Modified texture

3.3 Dietary contribution

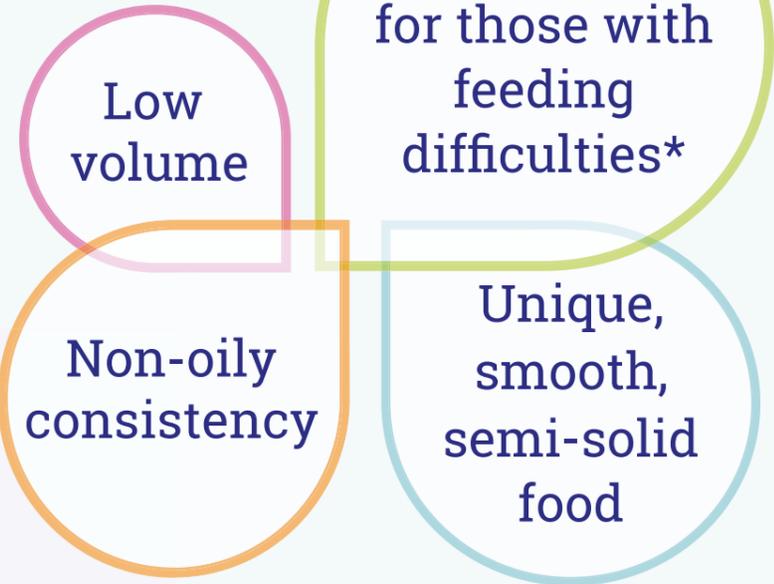
3.4 Ready to eat

3.0

A Palatable Source of Fat

- ✓ Can make a significant contribution to fat intake
- ✓ Appetising chocolate flavour
- ✓ May aid dietary acceptance and adherence
- ✓ Optimal fatty acid profile

Modified Texture

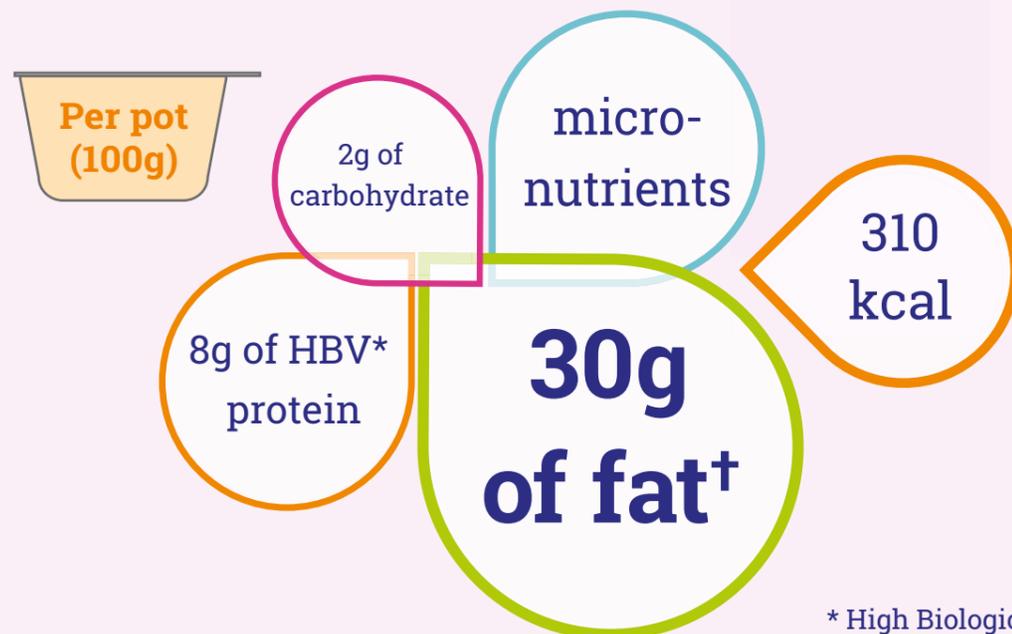


* under guidance from qualified health care professionals experienced in feeding difficulties



Dietary Contribution

Keyo is nutrient dense



* High Biological Value
† Long Chain Triglycerides

Ready to Eat

- ✓ Portable
- ✓ Convenient
- ✓ Versatile and flexible
- ✓ No preparation required

A Palatable Source of Fat

Achieving the high intake of fat required in the ketogenic diet can be challenging.

The restrictiveness of the diet can make it difficult to achieve an adequate nutritional intake or the required balance of energy to maintain ketosis.

Keyo is an oral nutritional supplement for use in all versions of the ketogenic diet to help make this more achievable.



Modified Texture



Nutrient dense, low volume formulation potentially benefits slow or inadequate feeders.*

Modified texture may be suitable for facilitating oral feeding and intake in those with oro-motor impairment or dysphagia.*

Presentation as a uniform and consistently smooth food provides reassurance with feeding.*

Can complement an enteral feeding regime.*

* Under guidance from qualified health care professionals experienced in feeding difficulties

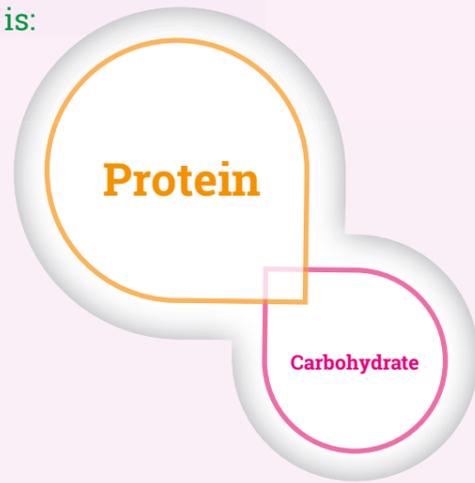
Dietary Contribution

Micronutrients

Per 100kcal, the micronutrients in keyo and proprietary ketogenic feeds are comparable.

The micronutrient content of keyo reflects global and country specific dietary recommendations and guidelines for daily intakes¹⁻⁴. Keyo can contribute toward meeting these.

E.g. for ages 4 to 6 years, number of pots of keyo providing approximate minimum percentage of daily requirements* is:



Ready to eat

Keyo can be used:

- ✓ As an oral nutrition supplement on a regular or ad hoc basis
- ✓ As a replacement for meals or snacks during illness or if appetite is poor
- ✓ As part of a meal or snack
- ✓ On its own, straight from the pot or weighed out
- ✓ In combination with other permitted foods

For simple and easy ways to incorporate keyo into meals, snacks and recipes, visit www.myketogenicdiet.com

* Excluding sodium, potassium, and chloride.
 1 Dietary reference values for food energy and nutrients for the United Kingdom (1991).
 2 Institute of Medicine (1997 - 2010). Dietary Reference Intakes for the USA.
 3 World Health Organisation (2004). Vitamin and mineral requirements in human nutrition.
 4 European Food Safety Authority (2006 - 15). Scientific Opinion on Dietary Intakes.

3.0 Attributes and use of keyo in the KD

3.1 A palatable high fat food

30g
of fat

3.1.1 How can keyo contribute towards dietary fat intake?

Adherence to the KD is critical to its success. Factors such as palatability are therefore crucial to implementation and acceptance.

Fat is a vital and integral part of the KD, and needs to provide at least two thirds of daily energy requirements for ketosis¹⁷. However, consumption of the large amount required, combined with a limited carbohydrate intake is often problematic¹⁸. In comparison with the wide range and choice of foods, and variety of flavours and textures consumed as part of a regular human diet, the KD is extremely restrictive.

The high fat, low carbohydrate content of the KD influences dietary acceptability, palatability and enjoyment of food in several ways¹⁹⁻²².

Generally high fat foods are considered to be:

Too oily in consistency - fats in food provide texture, flavour, aroma, and taste. However, if fat content is very high, food becomes unappetising, and can feel slimy and greasy during eating and swallowing.

Low in taste - Foods with a combined high fat and high carbohydrate content, such as chocolate and ice cream, are avoided in the KD. These are much tastier and easier to eat, especially in large amounts, than foods consisting solely or mostly of fat (e.g. oil, butter and cream), which are included in the KD.

Unappealing and uninspiring - meals and snacks with high fat, low carbohydrate content can tend to be unsatisfying and boring.

These can all potentially reduce food consumption and consequently lower energy and nutrient intakes.

3.1.2 Keyo has an appetising chocolate flavour

Chocolate is universally popular due to its unique sensory properties, which include aroma, taste and texture²³, but is typically excluded from the KD due to its high carbohydrate content. However, sweetness, as a taste, can very effectively conceal a high fat content within a food, making it more appetising and acceptable to eat¹⁹. The combined sweet, chocolate flavour of keyo is intended to impart desirability and tastiness, so enhancing its appeal and agreeableness.

With regard to promoting fat intakes in the KD, this feature of keyo may aid dietary acceptance, which is facilitated and maintained when an oral nutrition product is perceived as being highly palatable²⁴.

3.1.3 Keyo can contribute toward dietary fat intakes in all versions of the KD.



For case scenarios of the use of keyo in the specific versions of the KD see Section 4.0.

Under the direction of a dietitian or clinician, keyo can be used in the KD on an individual patient basis to optimise fat intakes.

Keyo can be introduced and used during initiation of a KD or once it is established.

* Due to the LCT content of keyo, only small quantities can be incorporated into an MCTKD.

CKD

Keyo is formulated with a ratio of fat to protein and carbohydrate combined of 3 to 1. However, it can be incorporated into a CKD of any ratio in conjunction with other foods and the patients individual macronutrient requirements.

The ketogenic ratio of keyo can be increased or decreased by the addition of permitted foods, as calculated and advised by a dietitian or clinician (see Section 4.1).

MCTKD

In comparison with the CKD, the MCTKD allows more protein and carbohydrate. Use of the 'Choices' system, which takes into consideration the LCT, protein and carbohydrate content of foods, enables inclusion of keyo into the MCTKD.

Due to the high LCT content of keyo, typically only small, measured quantities can be incorporated into an MCTKD. This amount will be dependent on the individual dietary prescription, in particular the percentage of daily energy requirements derived from MCT and LCT.

MCT products (oil, emulsions, and powders) can be mixed into keyo. It can act as a palatable vehicle for the delivery of MCT to the patient. MCT is best consumed in combination with food as a meal or snack as this helps with gastro intestinal tolerance²⁵.

Modified versions of the KD: LGIT, MAD, and MKD

Very high fat, moderate protein and minimal carbohydrate intakes are required in all of the modified versions of the KD. This is mirrored by the macronutrient content of keyo, meaning it fits easily into meal plans. The composition of keyo means the glycaemic index (GI) is likely to be low.

3.1.4 Fatty acids in keyo

The high fat consumption required on the LCT versions of the KD (CKD and modified), can result in high intakes of saturated fatty acids (SFA) due to the use of products like butter and double cream.

Although raised lipid levels are a common finding in patients on a KD, the long-term effects are uncertain in terms of cardiovascular health^{26,27}. There is evidence that levels tend to revert to normal over time²⁸, and that dietary manipulation of fatty acid content of the KD may or may not be beneficial^{29,30}.

However, generally the advice is to aim for inclusion of fat sources from both animals and plants to provide a mixture of saturated, monounsaturated and polyunsaturated fatty acids¹⁸.

When used in the KD as a source of fat, keyo can help toward a more balanced intake of saturates, monounsaturates and polyunsaturates overall. Table 2 illustrates the fatty acid composition of keyo in comparison to other high fat foods commonly used in the KD.

Table 2 Comparison of fatty acid profiles of keyo and foods commonly used in the KD, each providing 30g of fat³¹.

Food	Unit	Keyo	Butter	Double cream (53.7% fat)	Olive oil	Sunflower oil
Quantity	g	100g (one pot)	36.5g	56g	30g	30
Fat	g	30	30	30	30	30
of which saturates	g	2.2	19	18.7	4.3	3.6
of which monounsaturates	g	18.6	7.6	7.7	21.9	6.2
of which polyunsaturates	g	8.6	1.0	1.1	2.5	19

Keyo is a source of the essential fatty acids linoleic and alpha linolenic and longer chain polyunsaturated fatty acids: arachidonic acid and docosahexaenoic acid.

3.2 Modified Texture

3.2.1 Keyo is a food, with a unique, smooth, semi-solid consistency

This feature offers potential benefits within the KD in two ways:

⊗ Helps with the acceptability and palatability of fat.

Eating a high fat food with a uniform, non-gritty, lump-free texture is both easy and very enjoyable²⁰.

When on a KD, this feature, in combination with its appealing sweet chocolate flavour, may contribute towards improving fat intakes and promote dietary acceptance.

Despite consisting predominantly of fat, keyo maintains its structure and appearance. It does not separate out on standing or storage, and has a non-oily mouth feel.

⊗ The modified texture of keyo may be ideal for those who have difficulties with eating and swallowing associated with epilepsy and neurological disorders.

However, its suitability should always be determined on an individual patient basis by assessment from a health care professional (HCP) specialised in the management of feeding problems, e.g. a speech and language therapist (SALT)³².

3.2.2 Brief overview of the relationship between neurological disorders, epilepsy, and feeding difficulties

Neurological disorders, e.g. cerebral palsy (CP), cause damage to the normal functioning and development of the central nervous system, impacting sensory and motor control and making the activities of daily living such as eating and drinking more challenging³³.

Approximately 25% of all those with CP have feeding problems due to oro-motor impairment, dysphagia, and gastrointestinal dysfunction, with the incidence rising with greater severity of immobility and cognitive deficit^{33,34}.

In addition, poor swallowing is a significant concern amongst adults with any type of neurological disability³⁵.

Epilepsy is strongly associated with neurological impairment. It can be its origin or a symptom. For example, CP is present in approximately one third of all cases of epilepsy in children and adults³⁶⁻³⁸.

In turn, the estimated prevalence of epilepsy existing in combination with both CP and feeding problems in children and adults ranges from 40 - 60%³⁹⁻⁴¹.

Challenges with feeding, both physical and behavioural, are known to contribute toward inadequate consumption of food and fluids, and can ultimately affect nutritional status and health in those with neurological impairment and epilepsy⁴²⁻⁴⁵.

To try to overcome difficulties with self-feeding, chewing, biting or swallowing, adjustments can be made to the textures of foods and fluids e.g. by chopping, mashing, blending, pureeing, or thickening, to help facilitate more effective oral intakes. Alternatively, enteral tube feeding may be indicated³³.

However, many carers of those with feeding problems report food preparation is time consuming and messy. Meals can be prolonged, stressful situations³⁹.

3.2.3 What are the key features of a nutritious food for those with feeding difficulties?

- Suitable texture, assessed on an individual basis by a qualified HCP specialising in feeding difficulties³².
- Nutrient dense in a low volume.
- Appealing and tasty to eat.
- Available in a convenient, practical format requiring minimal preparation.

3.3.3 The KD and feeding difficulties

Due to the association of epilepsy, neurological disability and feeding problems, a proportion of those on a KD or newly referred to start one are likely to have a compromised ability to eat and drink safely and competently. Oral feeders may have mild, moderate or severe feeding problems that require texture modification.

Some will have an enteral tube in situ and require a proprietary ketogenic feed to provide all, or a proportion of their nutritional intake.

As feeding difficulties may potentially affect adherence to a KD and its efficacy, it is recommended that:

- Feeding ability and anthropometry be assessed before a KD is started, and then monitored regularly⁴⁵.
- Specialist HCP's help identify and manage any pre-existing or evolving problems³².

The KD has two inherent features that potentially make it suitable for those with feeding difficulties:

- **Predominantly soft, sloppy texture** - this is due to the inherent high fat content of foods permitted on the KD, which can mean the diet is potentially suitable for those who cannot chew or bite well, or safely manage lumps.

Meals and snacks can be further modified to help ensure they are of the correct consistency. Conversely, however, because of the requisite high fat content, the results can be greasy and unappetising.

- **High energy to volume ratio** - an advantage of the high fat content is that the KD is energy dense. Relative to a normal diet, sizes of ketogenic meals and snacks are much smaller.

This reduction in food volume can be helpful for those with feeding problems and are slow to eat. Extended meal durations are common in this group, and many physically struggle to consume an adequate nutritional intake within a reasonable timeframe³⁹.

3.3.4 Keyo may help facilitate oral feeding and nutritional intake in those with feeding difficulties on the KD*

Keyo has a:

- Unique, smooth, semi-solid consistency; a uniform, even presentation in a standardised format. This can provide reassurance and confidence with feeding. There are no solid lumps and it is non-gritty.
- Nutrient dense formulation in a low volume. This will help ensure dietary intakes and requirements are more efficiently and appropriately met, particularly in those who are inadequate and/or slow feeders (see Section 3 'Dietary Contribution' for nutritional information).
- Sweet, chocolate flavour and non-oily mouth-feel making it desirable and acceptable to eat.
- Ready to use presentation requiring little or no preparation beforehand.

3.3.5 Keyo can potentially complement an enteral feeding regime*

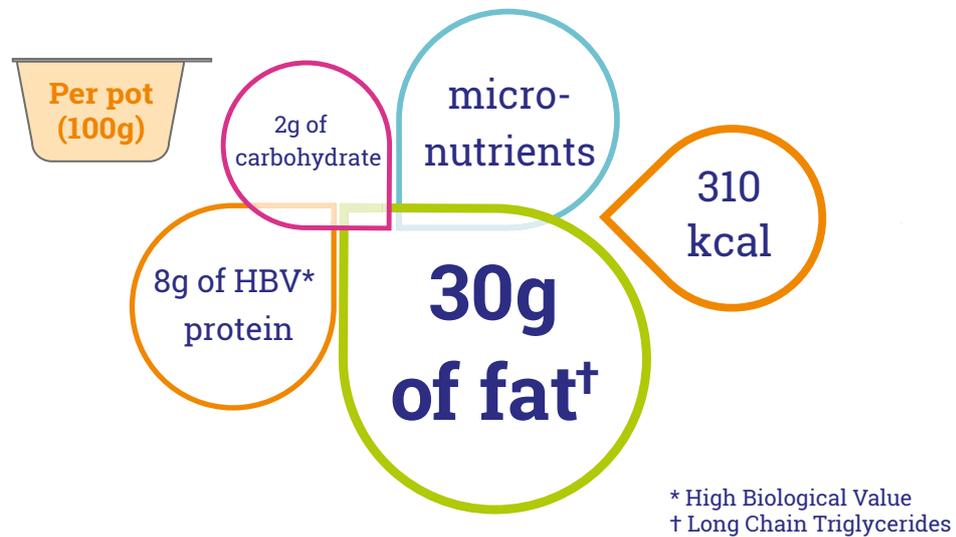
Those on the KD who are tube fed may still be able to be given small amounts of permitted foods orally for the simple pleasure of taste and flavour, provided they are of a suitable consistency and in appropriate quantities, even if these are tiny.

Keyo, as part of a KD, may complement an enteral feeding regime by offering an alternative consistency to enteral ketogenic feeds for those who are able to take some of their diet orally.

***This should always be determined on an individual basis by a qualified HCP specialising in feeding difficulties³².**

3.3 Dietary contribution

3.3.1 keyo is nutrient dense in a low volume



3.3.2 Keyo is suitable as:

- **A sole source of nutrition from 3 to 10 years of age**
- **An oral nutritional supplement from 3 years of age.**

The quantity of keyo required daily must be determined by a clinician or dietitian and will be dependent on:

- Age
- Body weight
- Medical condition
- Individual nutritional requirements for energy, fat, protein, carbohydrate, micronutrients and fluid
- Version of the KD

For case scenarios of the use of keyo in the specific versions of the KD see Section 4.0.

Keyo can be introduced and used during initiation of a KD, or once it is established.

3.3.3 FAT

Keyo can contribute toward dietary fat intakes, which are integral to all versions of the KD, on a regular or ad hoc basis.

See Sections 3.0 and 4.0 for more details.

3.3.4 MICRONUTRIENTS

Due to its high fat, low carbohydrate content, and restrictive nature, the micronutrient content of the KD is inherently low. Therefore, when compared to dietary recommendations, daily intakes are inadequate or inappropriate⁴⁶.

Inclusion of a micronutrient supplement is necessary, taken on a daily basis, to ensure requirements are met^{46,48}.

Keyo contains vitamins, minerals, and trace elements. It complies with EU legislation regarding the nutritional composition of foods for special medical purposes⁴⁹.

Per 100 kcal the micronutrient content of keyo is comparable to proprietary ketogenic feeds.

The micronutrient content of keyo reflects dietary recommendations and guidelines for daily intakes on a global and country specific basis, e.g. the World Health Organisation⁵⁰, the USA⁵¹, Europe⁵² and the UK⁵³. Although these are intended for general, healthy populations, and not directly applicable to those with epilepsy or Glut-1 DS, they are useful as references in the absence of disease specific standards.

When using keyo as an oral nutritional supplement in the KD on a regular basis, e.g. as a whole or part of a meal or as a snack, the contribution it makes towards daily micronutrient intakes should be taken into account (see examples in Table 3).

If keyo is used to provide a source of micronutrients in a KD, individual intakes should be checked and monitored on a regular basis. Compare with local and/or national recommendations to ensure nutritional adequacy is being achieved.

This is especially important if daily energy needs are lower than expected for age, e.g. in those with impaired mobility due to neurological impairment. In this situation, intakes required to meet individual activity levels may be reduced in comparison^{43,54}.

Table 3 Examples of approximate MINIMUM contribution of micronutrients* from pots of keyo, as a percentage of dietary recommendations⁵⁰⁻⁵³.

Age, years	Number of pots of keyo per day	Approximate minimum contribution to daily micronutrient intakes, %
4 to 6	1	30
	2	50
	3	100

* Excluding electrolytes: sodium, potassium, and chloride.

N.B. As age bands and micronutrient recommendations differ between countries, always use local guidelines when assessing intakes.

3.3.5 PROTEIN

Alongside the very high fat consumption required for ketosis, it is essential that adequate protein for growth and tissue repair is included in the KD.

It is important that this protein is 'complete' and of high biological value (HBV) (e.g. from eggs, dairy foods, meat or fish) to provide a source of all nine essential amino acids in adequate proportions.

Achieving an adequate protein intake is relatively easy from the MCT and modified versions of the KD as these include more protein. In comparison, protein is strictly controlled in the CKD yet it is vital individual requirements are met⁵⁵.

Keyo can make a useful contribution of HBV protein (from milk) into the KD.

It can help meet daily adequate levels of protein intake on a g per kg, or g per day basis, especially in the CKD, as per the recommended requirements for human nutrition^{56,57} (Table 4).

Table 4 Examples of protein contribution from pots of keyo, as an approximate percentage of recommended daily adequate levels of protein intake^{56,57}.

Age, years	Number of pots of keyo per day	Approximate daily %
3 - 6	1	50
	2	100
7 - 10	2	50
	3	100

3.3.6 CARBOHYDRATE

The relatively small amount of carbohydrate, 2g per pot, facilitates easy integration of keyo into all versions of the KD to take advantage of its dietary, nutritional and practical attributes.

3.4 Ready to eat

The KD can be challenging to undertake and a source of anxiety for those on it and their carers.

Whilst all versions of the KD require considerable planning and preparation, the CKD and MCTKD are particularly complex, labour intensive and involve precise weighing and measuring.

For many patients, their families and carers, these aspects can be overwhelming, especially at first. It can also mean that eating outside of the home environment is problematic and only those carers specifically trained in its provision can accurately make up meals and snacks in the correct proportions and quantities for patients¹¹⁻¹³.

3.4.1 How can keyo help make the KD easier and simpler?

Convenient

- Portable - can be taken anywhere.
- Presented in a lightweight pot, with a foil lid that peels off easily.
- Ready to eat, straight from the pot.
- Manageable serving size of 100g = 310kcal.
- Alternatively, the required amount of keyo can be weighed out, or measured into, an alternative feeding container.
- A keyo spoon and pot lid cover are available on request.

Having a product that is ready to use and easily transported can be invaluable and help make the diet more manageable on a daily basis.

This can be particularly advantageous when eating out, for example, at school/work or a respite care facility, or when visiting relatives or travelling.

Time saving

No additional preparation of keyo is required beforehand (unless modification advised and directed by a dietitian on an individual patient basis).

3.4.2 When using keyo in the KD it can be:

- Eaten on its own or in combination with other permitted foods.
- It can be calculated or fitted into all versions of the KD (see Section 4).
- Recipes are available - please visit the VitaFlo patient resource website www.myketogenicdiet.com

3.4.3 Storage

- Store keyo in a cool dry place.
- Once opened, tightly cover, keep refrigerated and use within 24 hours.



4.0

Use of keyo in the specific versions of the KD

4.1

CKD

Case scenario 1
Case scenario 2

4.2

MCTKD

Case scenario 3

4.3

Modified versions

Case scenario 4 - MKD
Case scenario 5 - MKD

4.0 Use of keyo in the specific versions of the KD

4.1 Use of keyo in the CKD

The calculation of a CKD is on an individual patient basis. The exact amounts (in grams) of fat, protein and carbohydrate required daily are determined according to their unique dietary needs and the chosen ketogenic ratio.

A daily meal plan is constructed specifically for them. To maintain the ketogenic ratio throughout the day, the quantities of macronutrients calculated are evenly distributed into meals and snacks, so each one contains fat, protein and carbohydrate.

Keyo can be used in a CKD of any ketogenic ratio, as it can be used in combination with permitted foods in weighed quantities achieve the amounts of fat, protein and carbohydrate required in a meal or snack.

N.B. Although keyo has a 3 to 1 ketogenic ratio it may not be appropriate to automatically include it in a 3 to 1 CKD. It is important to calculate the amount to be given carefully and on an individual patient basis. This is to ensure intakes of fat, protein and carbohydrate remain appropriate within their unique dietary requirements and daily meal plan.

4.1.1 Changing the ketogenic ratio of keyo

If required, the ketogenic ratio of keyo can be altered, either **increased (Table 5)** or **decreased (Table 6)**, to suit individual dietary requirements.

N.B. **Addition** of an ingredient to keyo will **reduce the micronutrient content** per 100kcal.

Table 5 - To INCREASE the ketogenic ratio of keyo to 4 to 1

To one pot of keyo (100g) mix in ONE of these ingredients	Amount g	Macronutrient and energy content (100g keyo + added ingredient)			
		Fat g	Protein g	Carbohydrate g	Energy kcal
Oil (e.g. olive, sunflower) [^]	10	40	8.0	2.0	400
or					
Double cream (approximately 50% fat) [^]	33	46	8.6	2.9	460

N.B. Addition of any of the ingredients listed in Table 5 to keyo will change the consistency from semi-solid to more liquid. This might be an issue with those with swallowing problems. Always check with a HCP specialising in feeding difficulties when altering the ratio of keyo that the texture remains suitable.

Table 6 - To DECREASE the ketogenic ratio of keyo to 2 to 1

To one pot of keyo (100g) mix in ONE of these ingredients	Amount g	Macronutrient and energy content (100g keyo + added ingredient)			
		Fat g	Protein g	Carbohydrate g	Energy kcal
Vitajoule (VitaFlo (International) Ltd) [*] or alternative carbohydrate source	5.0	30	8.0	7.0	330
or					
Skimmed milk powder [^]	5.0	30	9.8	4.6	328

[^] Nutritional information³¹

^{*} Vitajoule is a food for special medical purposes to be used under medical supervision.

4.1.2. Case Scenario 1 - CKD

Illustrating the use of keyo as:

- An oral nutritional supplement on a regular or daily basis
- A short term replacement for meals and snacks during a period of illness and loss of appetite

Amy was 4 years old and had Dravet syndrome. She had been on a 3 to 1 CKD for a year, experiencing a beneficial reduction in seizure number and severity. The calculation of her diet is shown in Table 7 and individual daily meal plan in Table 8.

Amy was given keyo to try and really liked it. Her dietitian calculated some into her meals and snacks as part of her daily meal plan (Table 9). An adjustment was made to the amount of micronutrient supplement that Amy was given to take into account the contribution from keyo.

Amy's growth was in proportion on the 50th centile (weight 16kg, height 106cm)⁶⁰.

Table 7 - Calculation of a 3 to 1 CKD for Amy⁵⁸

Current weight	16kg
Estimated daily energy requirement	1240kcal per day
Protein requirement 1.5g per kg*	24g per day
1240kcal x 0.87**	= 1080kcal from fat per day
1080kcal / 9***	= 120g fat per day
1240kcal x 0.13**	= 160kcal from protein and carbohydrate combined, per day
160kcal / 4	= 40g combined protein and carbohydrate per day
40g – 24g (daily protein requirement)	= 16g carbohydrate per day
Per day	Fat 120g Protein 24g Carbohydrate 16g Energy 1240kcal
Ratio = g fat / (g protein + carbohydrate), i.e. 120 / (24 + 16) = 3 to 1	

*Amy was growing rapidly so was given 1.5g protein per kg. Alternatively, daily protein requirements can be calculated as per WHO⁵⁶ and EFSA⁵⁷.

**The 3 to 1 ratio CKD has a fat content of 87% and a combined protein and carbohydrate content of 13%⁵⁸.

*** Energy provided: Fat = 9kcal per g
Carbohydrate and protein = 4kcal per g

Table 8 Amy's individual daily meal plan

Meal or snack	Fat g	Protein g	Carbohydrate g	Energy kcal	Ratio 3 to 1
Breakfast	30	6	4	310	Yes
Mid-morning	15	3	2	155	Yes
Lunch	30	6	4	310	Yes
Dinner	30	6	2	310	Yes
Supper	15	3	2	155	Yes
Totals	120	24	16	1240	Yes

Table 9 Example of a daily meal plan for Amy (3 meals and 2 snacks), 3 to 1 ratio CKD*

Meal or snack	Example foods, and quantity*	Fat g	Protein g	Carbohydrate g	Energy kcal
Breakfast	Mixed together: keyo 70g Double cream (50% fat), 18g Banana, mashed, 10g	30	6.0	4	310
Mid-morning	Greek yogurt (10% fat), 42g Double cream (50% fat), 22g	15.3	2.8	2.2	158
Lunch	Mixed together: Tuna (in brine), 11g Cucumber, grated, 20g Mayonnaise, 28g keyo 25g Raspberries 60g	29.9	5.9	3.9	308
Evening meal	Fried together: Chicken breast, 20g Olive oil, 12g Mixed with: Cream cheese (10% fat), 20g Spinach, 25g Carrots, boiled, 40g Butter, 10g	30.2	6.0	3.6	310
Supper	keyo 35g Double cream (50% fat), 9g Banana, mashed, 5g	15	3.0	2.0	155
Totals g		120.4	23.7	15.7	1241

*Ketogenic meal planner based on nutritional values for UK foods (EKM⁵⁹) used to calculate this meal plan.

Using keyo as a short term replacement for meals and snacks during illness of loss of appetite.

Amy became unwell and her parents struggled to feed her. Apart from eating keyo she refused her usual meals and snacks. The dietitian adapted Amy's usual meals and snacks to incorporate more keyo according to her individual meal plan. This meant her macronutrient intakes were kept the same as usual throughout the day (Tables 8 and 10).

N.B. When using keyo on its own as a meal or snack replacement on a CKD, ensure dietary requirements for macronutrient intakes, particularly for carbohydrate, are met. If necessary, modify by the addition of permitted ingredients calculated on an individual basis.

Table 10 - Adapted daily meal plan incorporating keyo

Meal or snack	Keyo g	Fat g	Protein g	Carbohydrate g	Energy kcal
Breakfast	Keyo, 70g Double cream (50% fat), 18g Banana, mashed, 10g	30	6.0	4.0	310
Mid-morning	Keyo, 35g Double cream (50% fat), 9g Banana, mashed, 5g	15	3.0	2.0	155
Lunch	Keyo, 70g Double cream (50% fat), 18g Banana, mashed, 10g	30	6.0	4.0	310
Evening meal	Keyo, 70g Double cream (50% fat), 18g Banana, mashed, 10g	30	6.0	4.0	310
Supper	Keyo, 35g Double cream (50% fat), 9g Banana, mashed, 5g	15	3.0	2.0	155
Totals		120	24	16	1240

Outcome

As Amy recovered her parents transitioned her back to her usual 3 to 1 meals and snacks over a couple of days.

4.1.3. Case Scenario 2 - CKD

This illustrates the daily use of keyo:

- In conjunction with a ketogenic enteral feed
- To provide experience of taste and texture to those with oro-motor difficulties, with a feeding tube in situ

Joe was 10. He had drug resistant epilepsy, cerebral palsy, and was gastrostomy fed because of severe feeding problems. Due to his limited mobility, Joe's energy requirements were approximately 75% of those expected for his age group⁶⁰.

Joe had four bolus feeds of 250ml of a proprietary 4 to 1 ketogenic feed (1.5kcal per ml), providing 1500kcal per day (Table 11).

Along with his feeds at lunchtime and in the evening, Joe was offered very small amounts of pureed foods in a 4 to 1 ratio and some tastes of keyo. The nutritional contribution from these was considered negligible. Joe seemed to really enjoy keyo and usually indicated he wanted more! There had been no adverse effect on Joe's ketone levels or seizure control from having small amounts of keyo in a 3 to 1 ratio.

Table 11 - Joe's enteral feeding regime

4 to 1 ketogenic feed at:	Volume ml	Energy (kcal)	Foods offered and example quantities
Breakfast	250	375	
Lunch	250	375	Half to one level teaspoon (up to 5g)
Evening meal	250	375	Half to one level teaspoon (up to 5g)
Supper	250	375	
Total	1000	1500	

Joe had his feeding ability reassessed by a SALT specialising in feeding problems. The evaluation indicated he could safely manage larger amounts of smooth, semi-solid and pureed foods, and recommended he had more opportunity to be fed by mouth to promote the development of his oro-motor skills.

Following on from a discussion, Joe's SALT, dietitian, mother, and school carers decided to try the following:

- Replace part of Joe's ready to use ketogenic feed with food at lunchtime.
- Keyo was chosen as it was convenient for school; the advantages were it was portable, ready to eat and the correct semi solid texture, plus Joe already liked it. Joe could also have keyo when at home at weekends.

This is what happened at lunchtimes:

- Over several days, the amount of keyo that Joe could regularly and comfortably manage within a maximum time frame of 15 minutes was established. This was to avoid a meal becoming prolonged or too tiring for him, so eating remained a pleasurable experience.
- As per specific advice from his SALT and dietitian, Joe was offered keyo via an appropriate feeding spoon directly from the 100g pot.
- After a maximum of 15 minutes, the amount of keyo remaining in the pot was weighed.
- The volume of ketogenic feed was then adjusted to take into account of amount of keyo eaten, to ensure his energy and nutritional intake remained the same.
- The required amount of feed was then given as usual (Table 11).

Joe was given additional fluid via his feeding tube as a flush to account for the reduction in intake from his liquid feed and to help ensure he remained adequately hydrated. The amount given was dependent on the quantity of keyo he consumed (Table 12).

- 100g keyo contains approximately 56g water.
- 100ml of a liquid ketogenic feed contains approximately 80 - 85ml water.
- Keyo contains 310kcal per 100g
- Joe's ketogenic feed provided 150kcal per 100ml.
- Therefore, 1g keyo = 2ml feed = 3 kcal
- Per 100kcal, the micronutrients in keyo and Joe's ketogenic feed were comparable. No additional supplementation was required.

Key Messages

If keyo is used by those with feeding problems to replace liquid ketogenic feeds:

- A suitably qualified health care professional must confirm the texture and presentation of keyo is appropriate on an individual basis³².
- Ensure nutritional requirements are met and individual diet plans followed with regard to macronutrient intake and timings of meals and feeds. Adjustments to the amounts of fat, protein and carbohydrate may be required to avoid impacting ketosis, seizure control or growth.
- Ensure fluid intakes remain adequate.

Table 12. Examples of adjustments made to the volume of ketogenic feeds given at lunchtime to Joe, taking into account the amount of keyo eaten, to ensure his daily energy and **nutritional** intake remained the same*.

Amount of keyo (g) remaining in the pot (to nearest 10g)	Energy (kcal) consumed by Joe from keyo (to nearest 5kcal)	Volume of ketogenic feed (1.5kcal per ml) still required to provide a total of 375kcal*	Additional water for flush, ml (to nearest 5ml)**
90	30	230	0 - 40
80	60	210	30 - 50
70	95	190	40 - 60
60	125	165	60 - 80
50	155	145	70 - 90
40	185	125	80 - 100
30	215	105	90 - 110
20	250	85	100 - 120
10	280	65	110 - 130
Less than 10	300	50	120 - 140

* N.B. Changes in macronutrient intakes, e.g. carbohydrate, protein, may result from using keyo interchangeably with ketogenic feeds. Ensure adjustments are made in line with individual diet calculations and plans.

**Additional fluid given via the feeding tube (e.g. as a flush) to account for the reduction in intake from the liquid feed. This is dependent on the quantity of keyo consumed; 100g keyo contains approximately 56g water.

Outcome

This approach proved successful. Joe enjoyed the keyo and he managed to take 50g (155kcal) consistently at lunchtime. Therefore, the volume of ketogenic feed given was reduced from 250 to 145mls to maintain an energy intake of 375kcal at this meal. The keyo was always weighed out to ensure an accurate portion size was given. The macronutrients provided were included as part of his individual CKD calculation.

To maintain his fluid intake, Joe was given an extra 70 - 90ml of water. This was either added to his feed, or given as part of his usual water flush afterwards.

In this example, although Joe's ketogenic feed was a 4 to 1 ratio, to ensure he was given food of the correct texture, the ketogenic ratio of keyo was kept at 3 to 1. Increasing to 4 to 1, by the addition of oil or double cream, for example, would have resulted in the consistency being too liquid for him.

Joe's ketone levels were monitored regularly to ensure this approach remained appropriate for him, and effective for the dietary management of his epilepsy with a view to using alternative foods in a 4 to 1 ratio if necessary.

4.2 Keyo in the MCTKD

For an overview of the MCTKD, see section 6.2.

For further details calculating the MCTKD and use of the choices (or exchange) system for the fat, protein and carbohydrate content of food portions, refer to Neal⁶¹, Fitzsimmons and Sewell⁵⁸ and Table 13.

The choices system enables incorporation of weighed amounts of keyo into the MCTKD (Table 14). However, due to the LCT content of keyo, quantities will be small, and dependent on individual dietary prescription, in particular, the percentage of daily energy requirements derived from MCT and LCT.

Table 13 Choices typically used on the MCTKD

Macronutrient	g per choice
Protein*	6
Carbohydrate	1, 5 or 10
Fat (LCT)	5

*Protein choices are adjusted to equalise fat content, e.g. by addition of oil or butter, to an average of 3g per 6g protein choice.

Table 14 Using the choices system for keyo

38g keyo provides approximately	Number of choices
3 g protein	half (fat adjusted)
1g carbohydrate	1 x 1g
10g fat (LCT)	2 x 5g

4.2.1. Case Scenario 3 - MCTKD

This illustrates how to incorporate small, weighed quantities of keyo using the choices food system into the MCTKD.

Jasmine was 8 years old and had Glut-1 DS. She had been on the MCTKD since her diagnosis when aged 2 years.

Her mum was always keen to make Jasmine's meals as tasty and 'normal' as possible. She was very keen for her to try some keyo, particularly as Jasmine asked for chocolate regularly, as she wanted to have similar food to her two sisters.

Although Jasmine had slightly reduced mobility due to the Glut-1 DS, her daily energy requirements were estimated to be the same as those for her peer group⁶⁰.

The calculation of Jasmine's MCTKD is given in Tables 15 - 18.

Table 15 - Macronutrient distribution of Jasmine's MCTKD

Energy requirement, kcal per day	1600
Chosen macronutrient distribution as a % of total daily energy requirement	MCT 45%
	Protein 12%
	Carbohydrate 13%
	LCT 30%

Table 16 - Calculation of macronutrients and conversion to food choices

Macronutrient	Chosen % of daily energy requirement	kcal per day	g per day	Number of choices	Energy, kcal
MCT [^]	45	720 [^]	80	0	720
Protein	12	192	48	8 x 6g ^{**}	408 ^{***}
Carbohydrate	13	208	52	e.g. 10 x 5g and 2 x 1g	208
Fat (LCT)	30	480	53.3 - 24* = 29.3	6 x 5g	270
Totals	100	1600			1606

[^]MCT - an energy value of 9kcal per g is assigned for MCT in accordance with labeling regulations⁴⁹.

*Minus 3g from total fat for each protein choice

**Fat adjusted protein choices

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

Table 17 Example daily distribution of MCT and macronutrient choices (3 meals and 1 snack)

Meal/snack	MCT g	Protein Choices 6g fat adjusted	Carbohydrate (1g and 5g)	Fat Choices 5g	Energy, kcal
Breakfast	20	2	2 x 5g	2	412
Lunch	20	3	3 x 5g & 1 x 1g	2	487
Evening meal	20	3	3 x 5g & 1 x 1g	2	487
Supper	20	0	2 x 5g	0	220
Totals	80	8	10 x 5g & 2 x 1g	6	1606

Table 18 Example of an MCTKD incorporating keyo, 3 meals and one snack per day

Meal or snack	Foods and quantities using the food choices system ^{58, 61*}	MCT g	Protein choices, 6g, fat adjusted	Carbohydrate choices, 5g and 1g	Fat (LCT) choices, 5g
Breakfast	Betaquik [^] , 100g Mushroom scrambled egg** and toast 24g + extra butter 6g	20	2	2 x 5g	2
Lunch	Betaquik, 100g Cheddar cheese, 24g Ham, 50g (+5g butter) Bread, wholemeal, 24g Keyo, 38g Strawberries, 83g	20	1 1 ½ ½	2 x 5g 1 x 1g 1 x 5g	2
Evening meal	Stir-fry: MCT oil, 10g Chicken, 54g (+ 6g oil) Vegetables, e.g. courgette, broccoli, green pepper, spring onions (200g) Tomato puree (for sauce), 70g Betaquik jelly** Keyo, 38g	10 10	2 ½ ½	5 x 1g 2 x 5g 1 x 1g	2
Supper	Betaquik, 100g Cereal, e.g. Oatibix, 15g or rice krispies, 11g	20		2 x 5g	
Totals		80	8	9 x 5g & 7 x 1g	6

[^] Betaquik (Vitaflor (International) Ltd) is a combined emulsion of 20% MCT and 1% LCT. Betaquik is a food for special medical purposes to be used under medical supervision.

*Nutritional information based on UK food values³¹.

**For recipes, visit the Vitaflor patient resource website dedicated to the ketogenic diet www.myketogenicdiet.com

Outcome

Jasmine loved keyo!

Although using keyo in an MCTKD means only small quantities can be eaten, it can still be enjoyed by those on this version of the KD.

4.3 Use of keyo in the modified versions of the KD

4.3.1. Case Scenario 4 - MKD

This illustrates the use of keyo as part of meals and snacks in a modified ketogenic diet for a person with energy requirements of approximately 2000kcal per day. The aim is for a minimum of two thirds of daily energy requirement from fat and a carbohydrate intake of 30g or less per day.

A brief overview of dietary advice for patients on a modified KD is given in Table 19. For further information see section 6.2 and references 17, 18, 58 and 61.

In this scenario only carbohydrate is counted (Table 20).

An alternative approach is for patients to use the choices system to help guide fat and carbohydrate intakes. This is illustrated in case scenario 5.

Table 19 Overview of dietary advice for macronutrient intake for a patient on a modified KD

Macronutrient	Quantity	Advice
Fat	Very liberal	Include generous amounts at each meal and snack (fat should provide at least two thirds of daily energy requirements).
Protein	Moderate	Normal sized portions at meals.
Carbohydrate	Strict control	Count intake in grams, up to a maximum amount each day. Use information from food lists and labels to calculate carbohydrate content of portions. Weigh food to ensure correct portion size (optional).

Table 20 – sample daily meal plan including keyo in a modified ketogenic diet

Meal or snack	Food	Quantity	Carbohydrate, to nearest g
Breakfast	keyo Raspberries	One pot 10 - 12 medium	2 6
Lunch	Keto egg fried rice* Green salad (lettuce, cucumber, green pepper) Mayonnaise Strawberries	One serving 2-3 tablespoons 1 tablespoon 7 - 8 medium	2 8
Evening meal	Meat, e.g, ham, bacon, chicken (fried) Broccoli Celeriac chips with mayonnaise*	3 - 4 florets 2 servings (12 chips)	5 5
Supper	keyo	One pot	2
Total**			30

* Household measures used in this example. All tablespoons are heaped.

*Recipes from www.myketogenicdiet.com

**Meal plan contains approximately 2000kcal; approximately 160g fat, providing 1440kcal (70% of energy).

4.3.2 Case Scenario 5 - MKD

This illustrates the use of keyo:

- **To help achieve a more adequate intake of fat to promote ketosis**
- **To balance out fatty acid intakes by reducing saturates in favour of more mono and polyunsaturates**

Jenny was 20 years old. She had started the MKD a year previously and did well at first, eating her recommended amount of fat (at least sixteen fat choices, 16 x 10g) every day. Jenny used a combination of weighing and household measures for making up her meals and snacks. Her seizure frequency reduced, her social life improved and she went out more for meals with her friends and family.

However, after 8 months on the MKD, Jenny was struggling to consume enough fat. Although keeping strictly to her agreed maximum carbohydrate intake of 30g per day, she was eating too much protein especially from cheese which she was having regularly as a snack.

Jenny's seizures had returned and she was disheartened. In addition, although wanting to continue with the MKD, Jenny was finding it difficult to prepare suitable meals and snacks and wanted something ready to eat that she could take with her to have away from home.

A routine monitoring blood test showed her blood lipid levels were elevated. A diet history revealed a high intake of saturated fatty acids, as predominantly her sources of fat were butter, double cream and cheese.

Following discussion with the keto-team, Jenny agreed to try the following:

- Incorporate up to two pots of keyo daily to increase the quantity of fat consumed (Table 21).
- To exchange at least one cheese snack with a pot of keyo daily to help reduce her intake of saturated fat
- Aim to include alternative high fat foods rich in mono and polyunsaturates e.g. olive oil and mayonnaise made from rapeseed oil, to help reduce her saturate intakes.

Outcome

A few weeks later, Jenny reported she was managing at least two pots of keyo each day, having fewer seizures and eating less cheese.

She found keyo very useful to take with her packed lunch every day and often mixed fresh fruit into it.

A dietary assessment revealed Jenny's intake of saturates had reduced, as her food choices, along with having keyo regularly, had altered in favour of those containing more mono and polyunsaturates.

Her overall intake of fat had increased, from around ten to up to twenty (20 x 10g) fat choices daily.

Jenny's carbohydrate intake remained below 30g per day.

Her daily energy intake was approximately 2000kcal, which met her estimated requirements adequately.

Table 21 Example of a daily MKD meal plan including keyo for Jenny

Meal or snack	Food	Quantity or weight*	Number of 10g fat choices	Number of 1g carbohydrate choices
Breakfast	Butter	Six teaspoons	2	4
	Eggs	Two large		
	Olive oil	Two dessert spoons	2	
	Mushrooms	125g		
	Tomatoes	100g		
Lunch	Tuna (tinned in oil)	Medium size tin		9
	Tomato	100g		
	Cucumber	66g		
	Lettuce	59g		
	Bread, wholemeal	Half a thin slice (15g)		
	Butter	3 teaspoons	1	
	Mayonnaise (rapeseed oil based)	One tablespoon	1	
keyo	One pot	3		
Strawberries	99g			
Evening meal	Chicken breast	One large portion	2	10
	Cream cheese, full fat	Two tablespoons		
	Cauliflower	165g		
	Olive oil	One dessert spoon	1	
	Spinach	55g		
	Butter	Three teaspoons	1	
	Raspberries	66g		
Double cream (50% fat)	Four dessert spoons	2		
Supper	keyo	One pot	3	2
Totals			19	25

*Quantities are weighed in grams or given in UK household measures. All spoons (tea, dessert and table) are level.



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Appendices

- 6.1 Glossary of terms
- 6.2 Overview of the specific versions of the KD
- 6.3 References

6.1 Glossary of terms

Ketogenic diet (KD) - The very high fat, low carbohydrate and adequate protein diet used in the dietary management of drug resistant epilepsy and neurometabolic disease, e.g. Glut-1 deficiency syndrome (Glut-1 DS)¹.

Further information is available in the Vitaflo publication 'Guidelines for the practical implementation of the ketogenic diet for the dietary management of drug resistant epilepsy and neurometabolic disease'.

Ketogenesis – ketones are produced by the liver via excess acetyl-CoA from the breakdown of fatty acids in response to the high fat, low carbohydrate content of the KD¹.

Ketosis – a physiological/metabolic state where the majority of energy for the body is supplied by ketones².

Fatty acids – molecules comprised of hydrocarbon chains with a carboxylic acid group (-COOH) at the end, derived from or contained in an esterified form in animal or vegetable fats, oils and waxes (Table 1). Most fatty acids occurring in nature have chains of even numbers of carbon atoms, from 4 to 28.

Fats – the soft, solid or semi-solid organic compounds existing naturally in the seeds, nuts and fruits of plants, and in cells and organs of animals (e.g. in brain and adipose tissues) (Table 2).

Table 1³⁻⁵

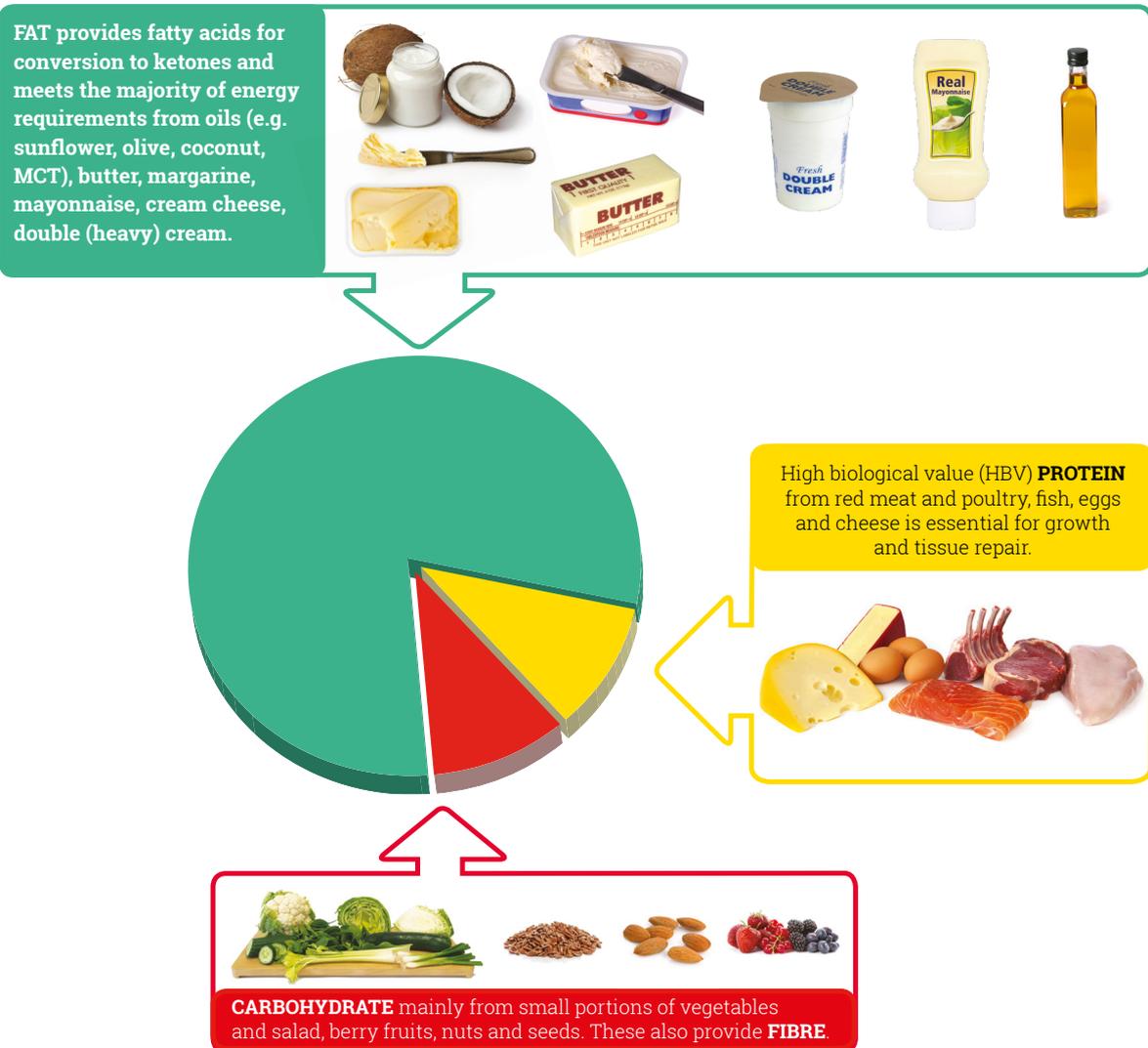
Number of carbon atoms in chain	Category of fatty acid by chain length	Notes
4 to 6	Short (SCFA)	
8 to 12	Medium (MCFA)	C8 and C10 are the ketogenic MCFA ³ . C12 is classified as a MCFA in these guidelines
14 – 20	Long (LCFA)	The most common fatty acids occurring in nature. C16 and C18 predominate in the human diet
22 plus	Very long (VLCFA)	

Table 2

Triglycerides	Three fatty acids esterified to a glycerol molecule backbone. The specific fatty acids they are composed of and their proportions influence their physical and chemical characteristics and health and nutritional effects.
Long chain triglyceride LCT	Triglycerides consisting of mixtures of long chain saturated or unsaturated fatty acids with carbon chain lengths of 14 to 20. LCT is the most common type of fat present in food and adipose tissue.
Medium chain triglyceride MCT	Triglycerides consisting of mixtures of medium chain saturated fatty acids with carbon chain lengths of 8 to 12. MCT oils and emulsions advised for used in the KD consist predominantly of triglycerides of the ketogenic MCFA C8 and C10, obtained from the hydrolysis, fractionation and re-esterification of coconut and palm kernel oils.

6.2 Overview of the specific versions of the KD

6.2.1 Foods typically used to supply macronutrients in all versions of the KD, and their relative proportions⁶



6.2.2 KD food notes (Always check local product availability, product ingredients, and keto-team policy)

Foods very high in carbohydrate are avoided on the KD

- Foods high in natural or added sugars e.g. sweets (candies) and chocolate, dried fruit, pure fruit juices, fizzy drinks and cordials containing sugars, jams, honey and ice cream.
- Foods high in starch, with or without natural or added sugars, e.g. potato chips (French fries) and crisps, cakes, biscuits, puddings, pies and pastry products.

Food items usually included freely in the KD

- Water, herbal teas and sugar-free carbonated drinks, cordials or squashes.
- Unsweetened soya, coconut, or almond milk (N.B. may be counted in the CKD and MCTKD).
- Fresh and dried herbs and spices (may be counted), salt, pepper, carbohydrate-free flavourings, stock and essences.
- Sweeteners, e.g. sucralose, saccharin or stevia, in liquid, powder or tablet form.

Incorporation of other foods into the KD in small, measured amounts

Using a choices system allows incorporation of foods such as bread, milk, yogurt, pasta, rice, fruit and vegetables into the KD, by calculation and weighing. This means that in addition to extending the range and choice of foods, favourite or familiar items can be included as part of meals, snacks and as ingredients in recipes. Although portion sizes will be much smaller than typically eaten in a normal diet, even tiny quantities can aid acceptability, palatability and long term compliance with a KD.

6.2.3 The 5 versions of the KD in clinical use worldwide



Although there are differences in the ways each version is calculated and prescribed, they are similar in terms of permitted foods.

CKD

This is the original version of the diet devised in the 1920's, and is based on the ratio of grams of fat to grams of carbohydrate and protein combined. For example, the ratio of 3 to 1 is 3 g of fat to 1 g of carbohydrate + protein combined. Typically 85-90% of energy comes from fat in foods such as double cream, butter, oils and mayonnaise. The diet is individually prescribed and foods precisely weighed in grams; carbohydrate is extremely limited, protein just adequate for growth is provided and energy intake carefully controlled⁷.

MCT KD

The MCT KD was introduced as a modified version of the Classical KD in the 1970's using MCTs as the alternative fat source to provide 60% of energy energy⁸⁻¹⁰. MCT is absorbed and metabolised more effectively than LCT, which gram per gram results in a higher ketone yield. As a result of this increased ketogenic potential, less total fat is required in the MCT KD compared to the Classical KD; 70-75% versus 85-90% respectively. This increases the amount of protein and carbohydrate that can be consumed, improving palatability and compliance. In particular, an MCT KD is a viable dietary option for children with large appetites and energy requirements or who have difficulty keeping to the stricter requirements of the classical KD¹¹. The MCT version of the KD has been shown to be as equally effective as the Classical diet, and was confirmed in a randomised, controlled study¹².

In practice, 40-50% MCT is well tolerated and achieves an adequate ketosis. Foods have to be weighed and measured, but an exchange (or Choices) system is used for greater flexibility¹¹⁻¹³. The MCT, as an oil, emulsion or in a powdered form, needs to be consumed regularly throughout the day and is included with meals and/or snacks. Giving food at the same time as MCT has been shown to help counteract any gastrointestinal side effects effects¹⁴.

Modified versions of the KD - MAD, LGIT and MKD

These are modifications of the CKD and MCTKD, developed in the last decade. In comparison, they are more flexible in terms of food choices, and are slightly lower in fat, yet have been shown to be efficacious in seizure management^{15,16}. Individuals following these versions are encouraged to eat food high in fat ad lib, to have a moderate intake of protein foods, but keep carbohydrate intake to a strict minimum, e.g. 20 - 30g per day. On the LGIT, 40-60g per day of carbohydrate food with a GI value of less than 50 can be eaten (this includes fibre)¹⁵.

Summary

It is the very large amount of fat that must be consumed daily to ensure ketosis is established and maintained that can make any version of the KD difficult to tolerate and undertake. It can be the barrier to its success, both perceived and actual. Despite this, however, as awareness rises of its effectiveness in the management of epilepsy in all age groups, from infancy to adulthood, its use is increasing¹⁷.

In practice, the CKD and MCTKD tend to be used for younger children, while the MAD, LGIT and MKD versions are followed by adolescents and adults. However, this is dependent on individual requirements and lifestyle. Each version has its own attributes and disadvantages and the KD is evolving to incorporate the aspects of each that work best. Reported results suggest the MAD and LGIT versions are at least as effective as the CKD and MCT KD¹⁵⁻¹⁷. A randomized trial comparing efficacy, safety and tolerability of CKD and MAD in 104 children aged 1-18 years found the mean percentage of baseline-seizures to be lower in the CKD group at 3 months. As the difference was not statistically significant, the study concluded that both diets had their place in the treatment of childhood drug resistant epilepsy¹². In infants under 2 years, the CKD showed statistically significant efficacy advantages and the authors recommended it should be first diet choice in this younger age group, while the MAD may be suitable for many older children¹⁸.

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