Guidelines for practical implementation of the ketogenic diet for dietary management of epilepsy and neurometabolic disease

PART 1
These dietary management guidelines:

- Are intended for use as a general aid to implementing the very high fat, low carbohydrate, adequate protein ketogenic diet (KD) in children aged over 1 year, adolescents and adults diagnosed with drug resistant epilepsy or an inherited neurometabolic disorder, for example, Glut-1 Deficiency Syndrome (Glut-1 DS) or Pyruvate Dehydrogenase Deficiency (PDHD), where its use is indicated and evidence based.

- Focus primarily on the dietetic application of the KD, not the clinical management associated with its use.

- Do not relate to the particular challenge of KD implementation in infants i.e. those under 12 months of age. Further guidance from more specialist resources should be sought for this group.

These dietary management 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 sole responsibility of the Multi-Disciplinary clinical Team (MDT), i.e. a dedicated ‘keto-team’, to ensure patients managed on the KD are suitable to undergo this form of dietary therapy and they undertake and implement all the assessments, procedures, investigations and monitoring required in accordance with locally agreed procedures specific to the intervention.

We advise that you read these guidelines in conjunction with your local and national protocols and general recommendations for the use of the KD in the dietary management of drug resistant epilepsy and neurometabolic disease.

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

Recommended general references for the practical implementation of the KD


N.B. All other references are located in Part 3
PART 1

1.0 The Ketogenic Diet (KD)
   1.1 Overview of the KD

2.0 The KD in more detail
   2.1 Foods used in the KD
   2.2 Comparison of the 5 versions of KD and considerations

3.0 The patient (non-infant) journey on a KD

4.0 Pre-KD assessment
   4.1 Before starting a KD
   4.2 Diet related clinical assessments
   4.3 Anthropometric and dietetic assessments
   4.4 Choosing a version of the KD

PART 2

5.0 Guidelines for the practical implementation of each version of the KD
   Glossary of terms
   5.1 Pre KD education and preparation
   5.2 Classical Ketogenic Diet (CKD)
   5.3 Medium Chain Triglyceride Ketogenic Diet (MCTKD)
   5.4 Low Glycaemic Index Treatment (LGIT)
   5.5 Modified Atkins Diet (MAD)
   5.6 Modified Ketogenic Diet (MKD)
   5.7 The Choices system for fat, carbohydrate and protein foods

PART 3

6.0 Further practical information for implementation of the KD
   6.1 Enteral feeding
   6.2 Troubleshooting and fine tuning
   6.3 Foods high in fibre, calcium and vitamin D useful in the KD
   6.4 Foods suitable for use in the management of diet related side effects on the KD
   6.5 Changing to a different version of the KD
   6.6 Discontinuing the KD

Appendix

7.1 Links to useful KD resources, e.g. websites, charities, recipes.
7.2 Vitaflo ketogenic products and website
7.3 References for Parts 1, 2 and 3
The Ketogenic Diet (KD)
1.0 Overview of the KD

Comparison of a typical human diet with the KD

Figure 1 represents the relative proportions of energy from macronutrients typically consumed in the human diet. Intake of a high proportion of carbohydrate in comparison to fat and protein combined results in the production and utilisation of glucose as the major source of fuel for the body when sufficient food is eaten.

In comparison, macronutrient distribution and content is manipulated in the KD so energy from fat significantly predominates over that from carbohydrate and protein combined (Figure 2).

The very high fat content of the KD produces ketones from dietary fatty acids which are used as the main energy source instead of glucose from carbohydrates i.e. the KD is designed to be ‘keto-genic’ – ketone generating. Provided carbohydrate is restricted, adequate protein included and sufficient fat consumed to meet individual energy requirements, glucose release from muscle and organ breakdown is minimised, in favour of ketone production (Hartman and Rho 2012).

Figure 1. Typical human diet

Figure 2. Ketogenic Diet

History and development of the KD

The response of the body to fasting and starvation is a ‘metabolic shift’ from the production and usage of glucose predominantly from dietary carbohydrates to ketones generated from fat stored in adipose tissue (Figure 3).

Following observations dating back to the 5th century BC by Hippocrates that fasting led to seizure reduction, the KD was designed in the 1920’s to replicate this metabolic process (Wilder 1921, Talbot et al 1927, Talbot 1930).

The KD proved efficacious in the management of epilepsy in children and adults. It was widely used prior to the development of anti-epileptic drugs (AED’s) in the late 1930’s. Then, seen as complex in comparison, its use declined until the early 1990’s when interest in the application of the KD began to re-emerge as an adjunct or alternative to medication (Cross 2013).
Metabolic overview of the KD

Figure 3

**Fasting and starvation**
- Fatty acids released from adipose tissue

**Ketogenic Diet**
- Fatty acids from high dietary fat intake

In the liver, beta oxidation of fatty acids produces acetyl-CoA for conversion to ketones - *ketogenesis*

Ketones are transported to organs and tissues via the bloodstream and absorbed into cells. Here they are converted back into acetyl-CoA and then enter the Kreb's cycle for oxidation in the mitochondria to energy.

**N.B. the degree of ketosis achieved via the KD is an individual response to an individual dietary regime.** It does not always correlate with successful seizure control or other improvements in well being - both high and low ketone levels can produce equally good results (Hartman and Rho 2012).
The KD has proven efficacy in the dietary management of drug resistant epilepsy - 25 - 30% of all patients with epilepsy fail to respond adequately to AED's (Martin et al 2016). In addition to lack of seizure reduction and control, side effects from medication can contribute towards a poor quality of life.

Studies on the use of the KD in such cases in children and adults show that approximately 50 - 60% will have a 50% or more reduction in seizures, and in those in whom it is beneficial, 15% will become seizure free (Kossoff 2012).

The exact mechanism (or mechanisms) by which the KD can be successful in the dietary management of drug resistant epilepsy has yet to be fully elucidated. However, the consumption of a high proportion of daily energy requirements from fat combined with a low intake of carbohydrate appears crucial. It is likely the benefits of the KD, which in addition to control of epileptic symptoms may include, for example, improvements in cognition, sleep, developmental progress and well-being, are due to more than ketosis alone.

The KD now and in the future

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 future (Cross 2013). 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 (Paoli et al 2013).

There are 5 versions of the KD in clinical use worldwide

Although there are slight differences in the proportions of macronutrients and how each version is calculated and applied, all are very high in fat, low in carbohydrate, provide adequate protein and are designed to achieve ketosis.

Choice and application of the versions of the KD varies by country, keto-team, clinician or dietitian, and is usually based on factors such as history, experience and familiarity of use.

The CKD and MCTKD are the traditional versions of the KD. However over the past decade, development of the 'modified' versions - the MAD, LGIT and MKD - has enabled less prescriptive, more flexible and accessible methods for implementation of the KD whilst still retaining its original efficacy.

The use and application of the KD is evolving to incorporate the different approaches, features and attributes of each of the versions to optimally meet individual requirements and lifestyle (Neal 2012, Wood 2015).
2.0 The KD in more detail

2.1 Foods used in the KD.

2.2 Comparison of the 5 versions of KD and considerations.
Foods high in natural or added sugars e.g. sweets (candies) and chocolate, dried fruit, fruit juices, fizzy drinks and cordials containing sugars, jams, honey, 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 in the KD
(always check local product availability, product ingredients and keto-team policy)

- Water and sugar free fluids e.g. carbonated drinks, cordials, squashes; herbal teas, coffee.
- Unsweetened soya, coconut or almond milk
- Salt, pepper, carbohydrate-free flavourings, stocks and essences.
- Sweeteners - liquid, powder or tablets, e.g., sucralose, saccharin, stevia - always check labels as some brands contain carbohydrate
- Fresh and dried herbs and spices. N.B. carbohydrate content may be counted in some versions of the KD.

Other foods that can be incorporated into the KD in measured amounts

Foods, such as bread, milk, yogurt, pasta and rice, fruit and vegetables can be incorporated into the KD by calculation and weighing or by the use of the Choices system (Part 2). 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.

Many tasty and easy recipe ideas and suggestions for meals and snacks are available for all versions of the KD.

For further details, refer to the ‘Links to useful KD resources’ section in Part 3 of these guidelines, and to the Vitaflo patient resource website https://www.myketogenicdiet.com
### 2.2 Comparison of the 5 versions of the KD and considerations

#### Key practical references for the specified version of the KD

<table>
<thead>
<tr>
<th>Version</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKD</td>
<td>Magrath and Neal 2012, Fitzsimmons and Sewell 2015</td>
</tr>
</tbody>
</table>

#### History

- The original KD devised by Wilder (1921), Talbot et al (1927) and Talbot (1930).
- Still extensively and successfully used worldwide, especially in young children.

- Developed by Huttenlocher et al (1971) as a modification of the CKD, using medium chain triglyceride (MCT) oil to replace a proportion of long chain triglycerides (LCT) and take advantage of the greater ketogenic potential of the medium chain fatty acids (MCFA) C8 (octanoic) and C10 (decanoic).

For further details, see the Vitaflo booklet 'Guidelines for the use of MCT and betaquik in the ketogenic diet'.

#### Key points

- A ratio expresses the proportion of fat to protein plus carbohydrate combined. E.g. a 4 to 1 CKD indicates for every 4g of fat there is 1g of protein and carbohydrate combined.
- Although the higher ratios of 4 to 1 and 3 to 1 are potentially the most ketogenic, a lower ratio of 2 to 1 may be as efficacious for seizure reduction (Neal (2012), Janek (2012).
- Once individual daily energy and protein requirements (which form the basis of the dietary prescription and calculation) are determined, the target ratio is chosen.
- In comparison to the CKD, the MCTKD permits:
  - Proportionally more carbohydrate and protein to be included
  - Less total fat
  - Enhanced palatability.
- The percentage of total daily energy for LCT, MCT, protein and carbohydrate is used to express macronutrient distribution. 45 - 50% of energy from MCT is likely to achieve gastrointestinal tolerance and good ketosis but can range from 30 – 70% on an individual basis (Neal et al 2009, Liu 2008).

#### Ratio of fat to carbohydrate and protein combined.

- The typical human diet is approximately 0.3 to 1
- e.g. 1 to 1, 2 to 1, 3 to 1, 4 to 1
- Approximately 1.6 to 1

#### Comparisons of approximate proportions of dietary energy from fat, protein and carbohydrate

- Traditional
- CKD
- MCTKD

![Pie charts showing ratios of dietary energy from fat, protein, and carbohydrate for Traditional, CKD, and MCTKD versions of the KD.](chart.png)
## Modified

<table>
<thead>
<tr>
<th>LGIT</th>
<th>MAD</th>
<th>MKD</th>
</tr>
</thead>
</table>

**Developed from observations that:**
- Blood glucose levels are stable on the CKD and during fasting.
- Low glycaemic diets are linked with favourable health measures and outcomes (Livesey et al 2008).
- Excessive intakes of high GI foods may provoke seizures in some people with epilepsy (Pfeifer 2012).

**Only carbohydrate foods (40 – 60g per day **including fibre** with a GI of < 50 are permitted.)**
The level of carbohydrate in the LGIT has been chosen to reflect that 50g per day is the physiological maximum below which the body will use fat as its primary energy source (Pfeifer 2012).

**In comparison to the CKD designed to offer:**
- Greater flexibility with food choices and with eating away from home
- Increased patient access – useful option for older children, teenagers and adults
- Reduced involvement of keto-team in pre-diet preparation and monitoring.

Carbohydrate is very restricted at first to 10g, 15g or 20g per day, depending on age, but can be at any time.

There is usually no limitation on energy intake and requirements are not typically formally assessed beforehand.

Consumption of sufficient fat to satisfy appetite and meet individual energy needs is essential to prevent undesirable weight loss or gain. Protein intakes may need regulating to promote ketosis.

**Approximately 1 to 1.**

Carbohydrate content is usually more generous than the MAD, e.g. 30 - 40g per day, depending on the individual.

The Choices system (Part 2) is used for fats and carbohydrates, which together with advice on moderation of protein foods helps ensure macronutrient and energy intakes are appropriate.

This approach provides structure and guidance for food selection and portion sizes.
### 2.2 Comparison of the 5 versions of the KD and considerations - macro and micronutrients

<table>
<thead>
<tr>
<th></th>
<th>CKD</th>
<th>MCTKD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fat - LCT</strong></td>
<td>• Proportionally, intakes of saturates, mono or polyunsaturates will predominate depending</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E.g. saturates from butter and double (heavy) cream, monounsaturates from olive oil use</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Prudent inclusion of a variety of sources of LCT from both animals and plants, provides a</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fat - MCT</strong></td>
<td>Once established on diet, MCT can be introduced and used to ‘boost’ ketone production without</td>
<td>MCT is consumed regularly throughout the day e.g. at each meal and bedtime to ensure a steady</td>
</tr>
<tr>
<td></td>
<td>needing to increase the ketogenic ratio.</td>
<td>supply of ketones are generated.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Essential fatty acids (EFA) - omegas 3 and 6</strong></td>
<td>The ratio of omegas 6 to 3 EFA can be above recommendations. Use of different LCT sources</td>
<td>EFA’s are not present in MCT and intakes can be low. Although some will be provided via LCT,</td>
</tr>
<tr>
<td></td>
<td>provides balance, together with inclusion of small amounts of vegetable oils (e.g. walnut,</td>
<td>inclusion of oil and food sources of omega 3 is advised, as per CKD.</td>
</tr>
<tr>
<td></td>
<td>flaxseed, linseed) and foods (oily fish, fortified eggs, seeds, nuts and green vegetables)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>naturally high in omega-3 fatty acids.</td>
<td></td>
</tr>
<tr>
<td><strong>Protein</strong></td>
<td>For all versions of the KD sufficient protein and essential amino acids must be included for</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To ensure adequate intakes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Include HBV protein (meat, fish, eggs, cheese) in each meal every day.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Avoid sole reliance on plant sources of protein (vegetables, tubers, grains, soya, pulses,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Carbohydrate</strong></td>
<td>Daily carbohydrate intake is influenced by protein and energy needs and diet ratio. E.g. on</td>
<td>The quantity of carbohydrate permitted is more generous than the KD which helps with palatability.</td>
</tr>
<tr>
<td></td>
<td>a higher protein, lower energy, 3 to 1 or 4 to 1 ratio KD there is less carbohydrate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>compared to a lower protein, higher energy 2 to 1 ratio. This may influence acceptability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and compliance as it affects palatability.</td>
<td></td>
</tr>
<tr>
<td><strong>Micronutrients</strong></td>
<td>Micronutrient content is inherently low and/or inadequate in all versions of the</td>
<td></td>
</tr>
</tbody>
</table>
Comparison of the 5 versions of the KD and considerations - macro and micronutrients

<table>
<thead>
<tr>
<th>Version</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LGIT</td>
<td>Very restrictive but typically a slightly more generous allowance compared to the MAD, especially at diet initiation, e.g. 30-40g per day. Carbohydrate may be adjusted by increasing or decreasing incrementally depending on efficacy.</td>
</tr>
<tr>
<td>MKD</td>
<td>As for CKD</td>
</tr>
<tr>
<td>MAD</td>
<td>40–60 g per day of carbohydrate from foods with a GI of &lt; 50 are permitted daily. N.B. This quantity of carbohydrate includes the fibre content of these foods. For further explanation, see Part 2.</td>
</tr>
<tr>
<td>MKD</td>
<td>Very restrictive. Depending on age, 10, 15 or 20g per day initially. After 1 to 3 months this may be increased up to 25g per day if the MAD proves efficacious (Kossoff et al 2015).</td>
</tr>
</tbody>
</table>

C8 and C10 are considered to have the greater ketogenic potential (Bergen et al 1966, Marten et al 2006). are therefore recommended in preference to coconut oil as a source of MCT and MCFA in the KD. permitted foods and drinks as part of a meal or snack, or as an ingredient in recipes. Ketogenic Diet potentially beneficial health effects in comparison to saturated fatty acids with longer chains (Bhavsar & St-Onge 2015).

Once established on diet, MCT can be introduced and used to ‘boost’ ketosis without the need for an increase in LCT or reduction in carbohydrate intakes.

40–60 g per day of carbohydrate from foods with a GI of < 50 are permitted daily. N.B. This quantity of carbohydrate includes the fibre content of these foods. For further explanation, see Part 2.

A free choice of protein food(s) can be made but moderate intakes are advised, i.e., normal sized portions. If eaten to excess, protein foods, due to their high palatability, may replace those providing fat and compromise ketosis.

Micronutrient content is inherently low and/or inadequate in all versions of the KD. A comprehensive, daily supplement is advised, or as per keto-team policy. See Part 3 for further advice and information on the Vitaflo product, Fruitivits.
3.0 The patient (non-infant) journey on the KD
3.0 The patient (non-infant) journey on the KD

Drug resistant epilepsy → Neurometabolic disease e.g. Glut-1 DS → Referral to ‘keto-team’

Pre-KD nutritional and diet related clinical evaluation → KD inappropriate - discuss further management

KD suitable

Anthropometric and dietetic assessments → KD version chosen and planned to meet individual patient nutritional requirements

Education of patient and / or carers → Implementation of KD for 3 month trial

Drug resistant epilepsy – continue KD for up to 2 years, then consider trial of weaning off and return to normal diet

KD SUCCESSFUL

Seizure control maintained/and/or controlled with medication – continue normal diet

Drug resistant epilepsy – continue KD for up to 2 years, then consider trial of weaning off and return to normal diet

Glut-1 DS – continue with KD

Discontinue KD → Compliance issues, adverse side effects or reduction in efficacy, despite fine tuning on an individual patient basis

Based on Kossoff et al 2009.
4.0 Pre-KD Assessment

4.1 Before starting a KD

4.2 Diet related clinical assessments

4.3 Baseline anthropometric and dietetic assessments

4.4 Choosing a version of the KD
4.0 Pre KD Assessment

4.1. Before starting a KD

The KD is complex and not without implications for patients and their carers.

It can have side effects.

Before any patient is started on a KD, ensure the following has taken place:

- Discussion between the patient and/or carers and the keto-team about the KD and what it involves.
- Careful assessment and appropriate management of relevant pre-existing clinical issues.
- Prior planning and education for the patient and/or carers and all those involved in their wider care e.g. extended family, teachers, respite staff.
- A commitment has been obtained from the patient and/or their carers and all parties involved that the KD will be tried for at least 3 months. This is the recommended trial period to determine efficacy (Kossoff et al 2009).

Ongoing support for patients on a KD from an experienced keto-team is recommended, and that is easily accessed by them and/or carers on their behalf.

4.2. Diet related clinical assessment

Does your patient currently have this?  

**Gastrointestinal disorder(s)**
Gastroesophageal reflux (GOR), delayed gastric emptying, oesophageal and foregut dysmotility.

To consider...

- GOR may be aggravated by a high fat diet (Kang et al 2004). BUT...
  - including MCT in a KD can lower total fat intake (Neal 2012) and promote gastric emptying (Beckers et al 1992).

**Physical feeding problems**
Oro-motor impairment causing:
- Difficulties with chewing, biting & swallowing.
- Increased aspiration risk.
- Prolonged feeding times.

Action BEFORE starting KD

- The KD has a soft, semi solid texture due to its high fat content. This consistency can be well suited to those with feeding difficulties.
  - If a frequent meal and snack pattern is normally followed throughout the day due to feeding issues, its continuation will help with achieving and maintaining ketosis on a KD.
  - The high energy density of fat means that relative to a normal diet, ketogenic meals and snacks are much smaller in size.
  - This reduction in volume may help those who struggle to consume adequate food by facilitating quicker and more efficient feeding and an improved nutritional intake.

**Behavioural feeding problems**
E.g. food refusal, food avoidance, selective or faddy eater.

To consider...

- The restricted range of foods permissible on the KD may suit fussy eaters.
- Personal & family food preferences can be incorporated into the KD and may aid compliance and acceptance.

N.B. If any of these issues continue or develop once on the KD, refer for specialist assessment and advice.
<table>
<thead>
<tr>
<th>Condition</th>
<th>Relevance to the KD</th>
<th>Action BEFORE starting a KD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constipation due to immobility, low fibre content of usual diet and/or poor fluid intake</td>
<td>Constipation may affect seizure control (Moezi et al 2015). Fibre intakes are low on the KD due to restricted carbohydrate intakes. Fluid - see below.</td>
<td>Advise on using KD compatible foods that are relatively low in carbohydrate yet high in fibre to promote normal laxation e.g. seeds (e.g., flax, chia), berry fruits, avocados and certain vegetables, e.g. spinach, mushrooms, broccoli and cauliflower (see Part 3). Prophylactic laxatives (carbohydrate free) before and whilst on the KD may be indicated to prevent and manage constipation.</td>
</tr>
<tr>
<td>Inadequate fluid intake due to poor/unsafe swallow</td>
<td>Low fluid intake is linked to acidosis, constipation and renal stones. Foods high in fat, which comprise such a significant proportion of energy intake, are low in moisture and those that typically contribute water in a normal diet e.g. vegetables and fruits are restricted on a KD, thus inherent fluid content is low.</td>
<td>Advise on, and achieve, appropriate and safe fluid intake.</td>
</tr>
<tr>
<td>Habitual low fluid intake</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutritional deficiency on pre-KD screening e.g. anaemia, hypovitaminosis D</td>
<td>The predominant intake of fat, inherently low in micronutrients, combined with restrictive food choices on the KD, increases the risk of nutritional deficiencies, especially long term.</td>
<td>Start pre-KD micronutrient supplementation. A daily comprehensive micronutrient supplement is advised on the KD or as per keto-team policy.</td>
</tr>
<tr>
<td>Food allergies e.g. milk, egg.</td>
<td>All versions of the KD can be given as an exclusion diet, or to meet individual or family dietary choices using preferred and permitted foods.</td>
<td>Ensure the correct diagnosis has been made and that food exclusion is actually required. Correct any deficiencies resulting from food restrictions with appropriate macro and/or micronutrient supplementation. Consider asking patient and/or carers if they will permit inclusion of animal protein foods to ensure nutritional adequacy of diet.</td>
</tr>
<tr>
<td>Food intolerance e.g. lactose, wheat.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coeliac disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food restrictions, self imposed or cultural e.g. vegetarian, vegan, halal, kosher</td>
<td>N.B. Due to the restriction of carbohydrate, quantities of protein foods used in a vegan KD (especially a CKD) e.g. nuts, lentils, beans, soya and quorn, may not provide adequate intakes of the individual essential amino acids needed for normal growth, development and maintenance of body tissues.</td>
<td></td>
</tr>
<tr>
<td>On full or partial enteral feeding (oral or via a feeding tube)</td>
<td>Ketogenic feeds can be calculated and prepared from commercially available products designed for the KD, or on a modular basis using these and/or locally sourced ingredients.</td>
<td>See Part 3.</td>
</tr>
</tbody>
</table>

**Expectations**

- Patients &/or carers need to be motivated and have decided they definitely want to embark on a KD.
- The KD doesn't always work, although for some individuals improvements in seizure management and quality of life may be better than anticipated.

As part of the assessment and pre KD preparation process, realistic goals for dietary management and clinical outcomes should be discussed and agreed between the keto-team and patient and/or carers.
4.3. Anthropometric and dietetic assessments

Anthropometric and dietetic assessments aid choice of the most suitable version of the KD for your patient and its implementation. Once established on diet, this initial information acts as a reference point for on-going follow-up.

**Anthropometric assessment**

### Children and adolescents

- **Weight (kg)**
- **Height (cm)**
- *If aged between 1 and 2 years - head circumference (cm)*

Optional - calculate Body Mass Index (BMI).

Plot on growth chart along with any historical growth data.

N.B. Children’s growth velocity and expected weight gain may slow on the KD (Nation et al 2014).

### Adults

- **Weight (kg)**
- **Height (m)**

Calculate BMI = \( \frac{\text{weight in kg}}{\text{height in metres}^2} \)

**Overweight pre KD** Some initial weight loss may be beneficial for initiation and maintenance of ketosis at the start of a KD. In children, aim for stabilisation of weight over time to allow for growth once on the KD.

**Underweight pre KD** Advise on increasing energy intake by adding extra fat into the current diet - both to promote weight gain and to get used to eating more before formally starting the KD.

**Ongoing anthropometric and dietetic assessment**

- Once on the KD, regular assessment is important for monitoring children’s growth and for those with pre-existing compromised nutritional status, feeding problems and/or impaired mobility and activity levels, to help ensure dietary intake is appropriate.

- If the KD proves efficacious, reduction in the frequency and duration of seizures can significantly impact energy requirements. Likewise, changes in mobility due to progress in development of ambulatory skills and ability will alter individual needs which may increase or decrease over time and be reflected in nutritional status.

- Refer to local policies and keto-team for advice, and Part 2 for specific guidance on the implementation and follow-up of each version of the KD.
Identifies

- For the CKD and MCTKD, detailed and specific information about current nutritional status and usual diet enables estimation of actual daily energy needs (which may differ from those recommended for age) and calculation of quantities of macronutrients for meals and snacks (Fitzimmons and Sewell 2015).
- In comparison, for the modified versions of the KD - MAD, LGIT or MKD - pre-diet evaluation may be less formal. Before starting a MAD, a diet history is not typically taken nor body weight noted for adults, as energy intake is not fixed. Encouragement to consume sufficient permitted foods, especially those high in fat, is given in order to satisfy appetite (Kossoff et al 2016).
- However, for these versions of the KD, prior insight into usual food intake and eating habits, ability and preferences is prudent, as is anthropometry for children. This information facilitates practical guidance to be given by the keto-team and can help achieve greater success in diet implementation and efficacy (Fitzsimmons 2012).

**Dietetic assessment tools e.g.**

- 3-4 day diet diary filled in by the patient and/or carer
- Verbal diet history (previous 24 hours and/or longer retrospective period) and/or
- Food frequency questionnaire

**Identifies**

- Specific details of foods and drinks consumed i.e. those avoided and restricted, textures (important for those with feeding problems), preferred food combinations, flavours, presentations, portion sizes.
- Usual eating and drinking intake, habits and patterns.
- How foods and drinks are prepared, and by whom.
- Sources and availability of foods, eating venues e.g. home and institutions (school, college, respite care), takeaways, cafés, restaurants.

**Action points when planning a KD**

Include familiar and favourite foods and drinks where possible to aid compliance.

If eating habits are irregular, advise that a consistent daily meal and snack pattern is established pre-KD as this will aid maintenance of ketosis.

Aim to normalise fluid intakes as

- too little is linked to side effects (Part 3)
- or
- if excessive - especially in young children - this may decrease appetite and food intake, affecting the ability to consume the KD properly and achieve ketosis.

Educate and provide information to all involved in preparing foods, drinks and feeding the patient. This is vital prior to starting a KD.

Give information and advice on making correct food and drink choices when eating out and away from home.
4.4. Which version of the KD might suit your patient?

<table>
<thead>
<tr>
<th>Are they one who….?</th>
<th>Suggestion</th>
<th>To consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Versions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is a younger child.</td>
<td>CKD</td>
<td>Labour intensive - all foods need weighing and measuring and all meals and snacks need calculating. Lots of fat, very little carbohydrate and protein; meals look small.</td>
</tr>
<tr>
<td>Would prefer a structured format and detailed, precise instructions to follow.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has a poor appetite, can be a fussy or slow eater or self restricts; prefers small meals.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needs an enteral feed taken orally or via a feeding tube.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is of any age (children, adolescent and adults).</td>
<td>MCTKD</td>
<td>Labour intensive - all foods need weighing and measuring and all meals and snacks need calculating. MCT is introduced gradually, building up to the required daily quantity. Hence it may take a while for the MCTKD to be fully tolerated and established before efficacy is determined. For further information, see Vitaflo’s ‘Guidelines of use for MCT and betaquik in the ketogenic diet’ Must be prepared to take MCT 3 -4 times daily.</td>
</tr>
<tr>
<td>Would prefer a structured format and detailed, precise instructions to follow.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likes carbohydrate and protein foods.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needs more protein than achieved from a CKD.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is willing to use the Choices system for fat, carbohydrate and protein.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needs an enteral feed taken orally or via a feeding tube.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modified Versions *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is an older child, adolescent or adult. Needs a less restrictive diet than a CKD or MCTKD i.e. less weighing of foods and more flexibility with food choices and quantities.</td>
<td>LGIT</td>
<td>40 - 60g carbohydrate (including fibre) each day from foods with a GI &lt; 50.</td>
</tr>
<tr>
<td>They and/or their carers can cope with a less structured KD.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eats out or is away from home regularly.</td>
<td>MAD</td>
<td>Very restrictive carbohydrate intake at first.</td>
</tr>
<tr>
<td>Wants 'normal sized' and 'normal looking' meals.</td>
<td>MKD</td>
<td>Has the potential to be the most ‘tailored’ to the patient’s nutritional and lifestyle requirements by incorporating elements of the other 4 versions of the KD</td>
</tr>
<tr>
<td>Willing to use the Choices system for fat and carbohydrate to assist with meal planning and portion sizes from the outset or as an aid to compliance (see Part 2).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LGIT, MAD, MKD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• High fat and strict low carbohydrate intakes are still required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Level of ketosis achievable may be inadequate for very young children with neurometabolic disease, e.g. Glut-1 DS. The CKD or MCTKD may be preferable.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>