KETOCENIC DIETARY THERAPY FOR CHILDREN WITH EPILEPSY

Charlene Tan-Smith
Paediatric Ketogenic Dietitian
Ketogenic Service Christchurch Hospital
Epilepsy

- Epilepsy is common and for many treatable
- Intractable or medical refractory epilepsy - ~30%
- For this group, besides exploration of other drug alternatives, we have to look at other options
• “One who is confronted with the task of controlling seizures in a person with epilepsy grasps at any straw. When some 6-8 years ago, an osteopathic practitioner in Michigan stated that fasting would cure epilepsy, this seemed like a very frail straw... (but) in many patients there was freedom from seizures during fasting.”

Lennox 1928
Overview

• Historical info on dietary treatment
• Variations of KG diet
• Basic physiological basis of diet
• Results/efficacy

• Side effects and complications
• Christchurch Hospital
  • Criteria for selection
• Medications
• Case studies
Historical

- Hippocrates – 5th century BC
  - Middle aged man cured of epilepsy by total abstinence of food and fluid
- Biblical times
  - Mark recounts Jesus curing an epileptic boy
    “this kind can come out by nothing but prayer and fasting”
The last 100 years

• Gulpa and Marie – 1911
• Dr Hugh Conklin and Bernarr McFadden
  • All diseases cured by diet and exercise
  • Prescribed fasting for 3 days to 3 weeks
• Geyelin – 1921 -> NY based Endo
• Wilder – 1921 -> MayoClinic
• Wealthy Family -> donation -> John’s Hopkins hospital
The last 100 years

- It is difficult to find hard data from that time, but some of the success rates (improvement, not freedom) were quoted as being as high as 50%.

- 1938 – Merrit and Putnam discover Phenytoin...

  > After 1938, more and more anticonvulsants became used over time... the diet went out of flavour.
• Resurgence in use of diet in 1990’s
• Jim Abraham
  -> The Charlie Foundation
IN 1993 THE KETOGENIC DIET CURED CHARLIE ABRAHAMS' EPILEPSY

OUR STORY
Matthew’s Friends are a UK registered charity (since 2004) specialising exclusively in medical Ketogenic Dietary Therapies.

We support patients, families and professionals by providing information, training, research and grants to develop Ketogenic services and support systems for drug resistant (refractory) epilepsy as well as other neurological and metabolic disorders and emerging cancer types.

Our charity is supported by key medical experts in these fields so as to ensure the safety and efficacy of our information.

Please watch our introduction video by clicking here.

**The Ketogenic Diet**

Find out how it helped Matthew and drastically improved the quality of his life.
What is the Ketogenic Dietary Therapy?
What is the Ketogenic Dietary Therapy?

High fat, low carbohydrate and low protein diet

NOT a FAD Diet
What is the Ketogenic Dietary Therapy?

High fat, low carbohydrate and low protein diet

• Types of diet: “classic”, MKD, MCT, LGIT, MAD

• Typical ratio of fat to CHO and protein is 3:1 to 4:1 (i.e. 85 – 92% Fat)
What is the Ketogenic Dietary Therapy?

Modified keto

MCT

Modified Atkins

LGIT

Classic

Pictures courtesy of Charlie Foundation
Mechanism of Action

• Likely to be multifactorial and still not fully understood

• Fasting and the KG diet result in change in plasma ketones, glucose, insulin, glucagon, and FFA levels.

• This occurs within hours. Anticonvulsant effect though delayed by a couple of weeks.
Efficacy of the classic ketogenic and the modified Atkins diets in refractory childhood epilepsy


doi: 10.1111/epi.13256

Results/Efficacy
Study over 3 years (2011 – 2014)

1-18y

Dietary naive

Seizures >4 x/month

Rx failure of more than 2 drugs
• 104 patients – 51 KG diet, 53 MAD

• KG diet – 4:1 ratio

• MAD – CHO to 10g/day for 1st month, then may increase by 5g. Calorie restricted to 75%!
<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Classic KD (51) (%)</td>
<td>MAD (53) (%)</td>
<td>p-Value</td>
<td>Classic KD (17) (%)</td>
<td>MAD (20) (%)</td>
</tr>
<tr>
<td>3 months after DT</td>
<td>17 (33)</td>
<td>13 (25)</td>
<td>0.374</td>
<td>9 (53)</td>
<td>4 (20)</td>
</tr>
<tr>
<td>Seizure-free</td>
<td>19 (37)</td>
<td>17 (32)</td>
<td>0.314</td>
<td>9 (53)</td>
<td>5 (25)</td>
</tr>
<tr>
<td>&gt;90% reduction in seizures&lt;sup&gt;a&lt;/sup&gt;</td>
<td>22 (43)</td>
<td>22 (42)</td>
<td>0.527</td>
<td>10 (59)</td>
<td>8 (40)</td>
</tr>
<tr>
<td>6 months after DT</td>
<td>16 (31)</td>
<td>12 (23)</td>
<td>0.461</td>
<td>9 (53)</td>
<td>5 (25)</td>
</tr>
<tr>
<td>Seizure-free</td>
<td>19 (37)</td>
<td>16 (30)</td>
<td>0.474</td>
<td>10 (59)</td>
<td>7 (35)</td>
</tr>
<tr>
<td>&gt;90% reduction in seizures&lt;sup&gt;b&lt;/sup&gt;</td>
<td>20 (39)</td>
<td>19 (36)</td>
<td>0.321</td>
<td>10 (59)</td>
<td>9 (45)</td>
</tr>
</tbody>
</table>

DT, diet therapy; KD, ketogenic diet; MAD, modified Atkins diet.
<sup>a</sup>Includes children who reported seizure-free.
<sup>b</sup>Includes children who reported >90% seizure reduction and seizure-free.

*P-Value < 0.05, statistically significant.
Complications

- Exacerbation of gastro-oesophageal reflux
- Vomiting
- Constipation
- Diarrhoea
- Food refusal
- Renal stones (3-6%)

- Drowsiness (transient - at initiation)
- Increased bruising
- Pancreatitis
- Elevated serum lipids
- Osteopenia and an increased risk of fractures (long term)

Hypoglycaemia
Metabolic Acidosis
Hyperketosis
Ketogenic Dietary Therapy Service Team

Paediatric Neurologist – Dr Paul Shillito & Dr Cameron Dickson

Ketogenic Dietitian – Charlene Tan-Smith

Keto/ Epilepsy Nurse – Dawn Anderson

Pharmacist – Louise McDermott
How does it effect the Dietary Therapy?
Medications

- Patients are young/er
- Most will be on multiple medications
- Most of the medications = liquid form
  - Inability to swallow pills
  - Easier to administer (i.e. PEG or NGT)
Medications – ingredients with a carbohydrate value

- Brown/ Corn sugar
- Corn sweetener
- Corn syrup solids
- Dextrose
- Fructose
- Glucose
- High fructose corn syrup
- Honey
- Invert syrup
- Starch
- Lactose
- Levulose
- Maltodextrin
- Maltose
- Mannitol
- Mannitolol
- Molasses
- Polycose
- Sorbitol
- Sucrose
- Xylose
<table>
<thead>
<tr>
<th>Medication schedule</th>
<th>Am</th>
<th>Noon</th>
<th>PM</th>
<th>Total Carb (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clobazam (2ml x 2 per day)</td>
<td>5 mg</td>
<td></td>
<td>5 mg</td>
<td>2036 mg x 2 =</td>
</tr>
<tr>
<td>1 ml = 2.5mg</td>
<td></td>
<td></td>
<td></td>
<td>4072 mg carb</td>
</tr>
<tr>
<td>(1018mg/ml carbs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Valproate (600mg)</td>
<td>300 mg (7.5ml = 300mg)</td>
<td>300 mg (7.5ml = 300mg)</td>
<td>140mg x 15ml =</td>
<td>2100 mg carb</td>
</tr>
<tr>
<td>7.5ml x 2 twice a day (140mg/ml Carbs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamotrigine (Lamictal brand) brand) 1 tab (25mg) = ½ tab</td>
<td>12.5 mg</td>
<td>12.5 mg</td>
<td>26 mg carb</td>
<td></td>
</tr>
<tr>
<td>2x/day (1tab = 26mg carb)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domperidone 4mg 3x/day</td>
<td>4 mg</td>
<td>4 mg</td>
<td>4 mg</td>
<td>108 mg carb</td>
</tr>
<tr>
<td>(1 tab = 36mg carb)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carnitine (Stevia) 6.8ml</td>
<td>500mg</td>
<td>500mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td>6306 mg</td>
</tr>
<tr>
<td>Medication schedule</td>
<td>Am</td>
<td>Noon</td>
<td>PM</td>
<td>Total Carb (mg)</td>
</tr>
<tr>
<td>---------------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Clobazam (10 mg tablet= ½ tab 2x/day) (109mg/tab carb)</td>
<td>5 mg (½ tab)</td>
<td>5 mg ½ tab</td>
<td><strong>109 mg carb</strong></td>
<td></td>
</tr>
<tr>
<td>Sodium Valproate (600mg) 100mg tab x1 twice a day 200mg tab x1 twice a day (100mg tab = 80mg carb/tab) (200mg tab = 18mg carb/tab)</td>
<td>300 mg (100mg x1 tab) (200mg x1 tab)</td>
<td>300 mg (100mg x1 tab) (200mg x1 tab)</td>
<td><strong>196 mg carb</strong> (or 480mg –x6 100mg tab)</td>
<td></td>
</tr>
<tr>
<td>Lamotrigine (Lamictal brand brand) 1 tab (25mg) = ½ tab 2x/day (1tab = 26mg carb)</td>
<td>12.5 mg</td>
<td>12.5 mg</td>
<td><strong>3 mg carb</strong></td>
<td></td>
</tr>
<tr>
<td>Domperidone 4mg 3x/day (1 tab = 36mg carb)</td>
<td>4 mg</td>
<td>4 mg</td>
<td>4 mg</td>
<td><strong>108 mg carb</strong></td>
</tr>
<tr>
<td>Carnitine (Stevia) 6.8ml</td>
<td>500mg</td>
<td>500mg</td>
<td></td>
<td><strong>416 – 700mg</strong></td>
</tr>
</tbody>
</table>
# Medications

<table>
<thead>
<tr>
<th>Drug</th>
<th>Liquid/ tablet</th>
<th>Carbs (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paracetamol (Paracare, API Healthcare)</td>
<td>Liquid 120 or 250mg/5ml</td>
<td>67.5% carbs e.g. 250mg = 168.8 mg carbs</td>
</tr>
<tr>
<td>Paracetamol 500mg DISPERSIBLE tab (Paragesic Soluble, Rex Medical)</td>
<td>250mg needed 1 tab dissolved in 10ml water = 5ml (250mg)</td>
<td>0 mg carbs in Tab</td>
</tr>
<tr>
<td>Ibuprofen (Fenpaed, AFT)</td>
<td>100mg/5ml (Liquid) (18.32mg carbs/ml)</td>
<td>e.g. 5 ml = 100g (91.6mg carbs)</td>
</tr>
<tr>
<td>Ibuprofen (Ibugesic, Rex Medical)</td>
<td>200mg/tab (69.84mg carbs/tab)</td>
<td>e.g. 100g (34.9mg carbs)</td>
</tr>
<tr>
<td>Ibuprofen (Nurofen, Reckitt Benckisser)</td>
<td>200mg/tab (116.1mg carbs/tab)</td>
<td>e.g. 100g (58mg carbs)</td>
</tr>
<tr>
<td>MEAL</td>
<td>Carbohydrate (grams)</td>
<td>Protein (grams)</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>BREAKFAST</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kcals</td>
<td>289</td>
<td>3.5</td>
</tr>
<tr>
<td>Ratio</td>
<td>4:1</td>
<td></td>
</tr>
<tr>
<td><strong>MORNING SNACK</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kcal</td>
<td>148</td>
<td>1.7</td>
</tr>
<tr>
<td>Ratio</td>
<td>4:1</td>
<td></td>
</tr>
<tr>
<td><strong>DAILY TOTAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kcal</td>
<td>1168</td>
<td>13.9g</td>
</tr>
<tr>
<td>Ratio</td>
<td>4:1</td>
<td>% energy = 4.8%</td>
</tr>
</tbody>
</table>

2g Liquigen = 1g MCT oil
5g Liquigen (2.5g fat)
Blood sugar & Ketones tested x2 per day!
New Ketone & Glucose meter

CareSens™ Dual
Blood Glucose Monitoring System
Blood β-Ketone Monitoring System

- Easy Data Transfer by Bluetooth Connection
- GDH-FAD Based Test Strips
- Efficient Diabetes Management with Tagging Symbols
Food Pictures

3 : 1 ratio
~ 87% fat

2 : 1 ratio
~ 80% fat

4 : 1 ratio
~ 90% fat
Baby A
16 months old

Started
end Oct 2016

Modified Keto Diet
Oct 2016 Start ->
2 – 3 seizures per day

July 2017->
1 – 2 seizures per week
Feb 2018 Start ->
Started to weight bear on walker

May 2018
Started to walk
May 2018 Start ->
Stand up
unassisted

May 2018
Sit up unassisted
J Boy
8 years old

Started
end Jan 2017

Modified Atkins Diet
(MAD)
Jackson’s video diary
Jake
3 years old

Started end Aug 2016 (acute start)

Classic + MCT
April 2017=>LGIT
<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheese Mild (Alpine)</td>
<td>8g</td>
<td></td>
</tr>
<tr>
<td>Clearwater Clotted cream</td>
<td>15g</td>
<td></td>
</tr>
<tr>
<td>Cucumber, Telegraph (NZ)</td>
<td>13.5g</td>
<td></td>
</tr>
<tr>
<td>Olive oil</td>
<td>3.2g</td>
<td></td>
</tr>
<tr>
<td>Strawberry, raw (NZ)</td>
<td>16.2g</td>
<td></td>
</tr>
</tbody>
</table>

**3.6:1 (89% Fat) Ratio**

- **Fat**: 15.2g
- **Protein**: 2.4g
- **Carbs**: 1.8g
- **Calories**: 153.4kcal
Jan 2017
rehab started
May 2018
Thank you
Ketogenic Dietary Therapy Service
For the Treatment of Children with Epilepsy

International Results
50% to 60% of patients seizure reduction 50%
30% of patients seizure reduction 90%
10% of patients no result
10% of patients seizure free

Classic Ketogenic Diet
90% Fat
4:1 Ratio
FAT: Protein + Carbohydrates
Approx. 90% Fat

Rethink the Pyramid
25% Drop Out
It's not easy to do
Eating so much fat can lead to constipation, nausea and vomiting

2 years
Wean and keep benefits
After two consistent years, the diet is slowly removed and the benefits have a high chance of remaining. Saving on a lifetime of hospital visits and medication costs.

August 2016 We started
Neurologist, Dietitian, Nurse

60/6000 births/yr have epilepsy
1%
20-30% of patients not controlled by medicine
75%
of patients consider the diet
10 funded patients per year