Understanding Feeding in Barth Syndrome

A Health Professionals Guide to the Early Years



Written by Nicol Clayton

Specialist Paediatric Dietitian, NHS Specialised Services Barth Syndrome Service, Bristol Royal Hospital for Children

With contributions from:

Professor Colin Steward and Dr Germaine Pierre, NHS Specialised Services Barth Syndrome Service, Bristol Royal Hospital for Children

Dr Richard Kelley, Former Professor of Paediatrics, John Hopkins University School of Medicine, Baltimore

Dr Stacey Reynolds, Associate Professor in Occupational Therapy, Virginia Commonwealth University

Michaela Damin, Founder and Chair of the UK Barth Syndrome Trust.

The families of children with Barth syndrome

Introduction

For many families, managing feeding is one of the most difficult daily challenges of having a child with Barth syndrome. Often, food is not a source of joy but, instead, a cause of stress, anxiety, and pain, making the first few years the most demanding.

There are many factors that impact feeding in Barth syndrome, including fatigue, nausea, sensory issues, low oral tone, and gagging. Most children eat quite small amounts and eat in a grazing manner rather than at set meal times. The small size of meals can be very worrying for parents, and it can seem that only a few mouthfuls are taken at any one time.

Reducing anxiety and pressure, improving sensory tolerance, and avoiding overfeeding are important in improving the feeding experience. Feeding can slowly improve slightly with time, as the time taken to eat speeds up and food choices widen once children reach school age and beyond. However, children with Barth syndrome usually will not eat the same amount nor at the same speed as their peers, even as adults.

Weight gain is typically slow, and, although many children will track parallel to and at or below the 2nd centile, they usually have a normal to low-normal weight for their height. If nutritional supplements are needed, choose ones that contain both carbohydrate and protein. For those for whom eating enough is consistently impossible, gastrostomy feeding can relieve the stress and pressure of meal times, eventually allowing oral intake to increase.

The evidence base for supporting feeding and dietary interventions in Barth syndrome is limited (Reynolds, 2015). This booklet contains an overview of the published information and includes expert views of the UK Barth Syndrome Service Team and parental experiences of managing feeding in infants and pre-school children.

Growth

Understanding the typical growth patterns in Barth syndrome is vital to providing appropriate recommendations for feeding. Children with Barth syndrome are typically normal size at birth, but their growth rate decelerates in the first two to three years. Height usually falls to the 2nd centile and is often well below the 0.4th centile by the third year, with commensurate deceleration in rates of weight gain. Of patients under 18 years, 58% are <5th centile for weight and at or below the 5th centile for height. Even in medically well infants, there tends to be a slow drift down to these lower centiles, which can resemble the faltering growth of an endocrine disorder.

To a considerable extent, the growth pattern in Barth syndrome conforms to classical "constitutional growth delay" with late onset puberty. Delayed bone age has been seen in all boys attending UK Bristol Barth syndrome clinic, with a range of delay between 8 months and 2.5 years. However, the child's bone age is appropriate for his height age, indicating a normal potential for growth. As a result, boys with Barth syndrome typically have late pubertal growth spurts and often grow for longer, until age 20 years or later, and may even ultimately exceed mid-parental height, despite having been one of the smallest children in their classes during childhood.

To help with understanding and management of Barth nutrition, Barth-specific growth charts were published by Roberts et al (2012). Generally, the 50th centile for Barth syndrome for children under 5 years corresponds to around the 2nd centile on WHO growth charts. The following pictures show Barth syndrome boys alongside their peers to illustrate the difference in height.

Figure 1 - Jacob from Living with Barth syndrome (photo courtesy of Amanda Clark)

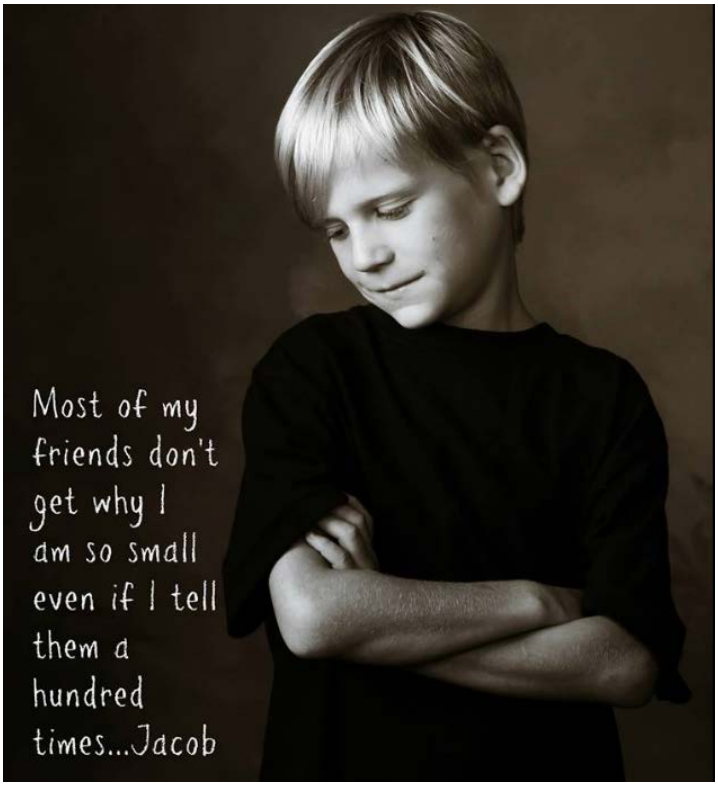

Figure 2: Caleb

Caleb (Barth syndrome) is on the right next to Charlie and both are 15 months old

Caleb (Barth syndrome) on the right at 15 months next to his cousin Wyatt on the left who is 7 months.

Figure 3: Height differences continue throughout childhood

Isaiah (Barth syndrome) at 4 years and 5 months old, with Brynli who is 3 years 4 months old

Elijah (Barth syndrome) on the left in the grey waistcoat is 11 years old and his friend is 8 years old

Figure 4: During puberty height differences are marked, as the pubertal growth spurt occurs much later

Justin and Michael (both Barth syndrome) and Gavin are triplets shown here at aged 14 years. Gavin, on the right doesn't have Barth syndrome and is on the 50th centile for height.

Damon (on the left) and Jacob (Barth syndrome) are brothers. Damon is 14 years old and Jacob is 17 years old.

Energy Requirements

Energy requirements are normal at birth then decrease relative to weight throughout early childhood, owing to reduced physical activity, slower growth, and reduced muscle mass. However, there are some infants and children who, perhaps due to other medical factors such as cardiac failure or early fatigue on feeding, cannot consume sufficient calories to sustain even slow growth. These children typically look very slim, have weights that are two or more standard deviations below height, and their disproportionately low weights can rapidly decrease further during acute illness and recover slowly, or not at all, after the illness. When needed, tube feeding usually works well. The Barth Syndrome Foundation Registry found that 50% of children had received supplementary tube feeding at some point. Currently, 4 out of 25 children in the UK receive supplementary tube feedings; three have a gastrostomy and one has nasogastric feeding. All eat small amounts orally. A Barth syndrome parent has documented their journey with Barth syndrome and tube feeding on an online blog called Momma's thoughts. This is a helpful resource for families and health professionals and can be found https://mommas-thoughts.blog/author/jasminechampagne/.

Figure 5 - Caleb with his g-tube from the blog "Momma's thoughts"

If there are cardiopulmonary problems affecting respiratory rate or food intake and absorption, additional energy may be needed. However, in calculating requirements, it is important to take into account low muscle mass; because healthy Barth syndrome patients often have energy requirements at the lower end of the normal range (around 80% of normal), feeding at normal rates can provide this additional nutrition without the risk of over-feeding.

Many patients do not tolerate feeding calories in excess of normal requirements for age except when, following a period of poor feeding, significant catch-up growth is needed. Overfeeding typically results in vomiting and diarrhoea. A sign of overfeeding is a decreased linear growth rate and weight centile exceeding the length centile.

As growth parameters can be misleading, causing a well-nourished boy to look undernourished when plotted on normal growth curves, physical appearance is important in assessing the need for supplemental nutrition. Patients are often 1-2 years smaller than their age peers. It can be a delicate balance to get nutritional supplementation right, as extra weight reduces mobility, places strain on already hypermobile joints, and increases fatigue.

Moving on to solid food

Moving on to solid food is often very challenging. Weaning can commence at the normal time, at around 5-6 months. However, as many Barth syndrome infants have poor muscle tone, this may need to be delayed until they are able to sit and support their heads. If transition to solid food is either not possible at 6 months or is very slow, families are encouraged to offer very small amounts of pureed fruit and vegetables on fingertips or the tip of a spoon. This exposes the infant to a wide variety of tastes until a greater volume of food is possible.

The slow transition to solid food can take many years, and during the first three years, many will continue to have a degree of oro-motor weakness and sensory issues, leading to a hypersensitive gag reflex, poor chewing skills, and extended mealtimes. Portion sizes can be very small, and hard to compare to the same age peer group. A regular meal pattern of three meals and three snacks (which includes milk) is encouraged, even if all six meals and snacks are the same size. We suggest basing portion sizes on the size of the child's hands e.g. a portion of protein foods should be the size of their palm, a portion of carbohydrate foods the size of their fist and fruit and vegetables around a handful.

Gagging is very common and can result in vomiting that appears effortless. The rate of progression of feeding can be directly related to the sensitivity of the gag reflex. Therapy to reduce sensitivity can be very helpful. It is common for infants at one year to still require feeding with smooth pureed meals, and they will often be unable to tolerate mixed textures of lumps in food.

A challenging time occurs between 12 and 18 months, when purees may start to be refused, but chewing ability and independent spoon feeding remains delayed. For younger infants, finger foods that dissolve easily, like yoghurt melts, baby puff snacks, and rusks, can be helpful. Some children prefer food chopped into very small bits to help self-feeding such as:

- Cooked white rice or miniature pasta shapes with rice-sized pieces of very soft corned beef, chopped wafer thin meat, or grated cheese with grated cooked soft vegetable.
- Pancakes and soft fruit, both chopped into tiny squares
- Scrambled egg
- Small squares of cheese on toast
- Dry breakfast cereals that dissolve in the mouth, like Rice Krispies or Cheerios, with a drink of milk

This stage occurs later and will last longer than normal, so amounts taken will be much smaller than other children the same age. Because using cutlery can be tiring and takes longer to master, chopping food small helps children to self-feed. Parents often feel anxious at this transition, as it may appear that even less food is being consumed than when purees were eaten. Continuing with a regular intake of milk (or dairy equivalents) of around 600mls a day throughout childhood will provide supportive nutrition.

Restricted variety in the diet is extremely common, and easy to eat foods often make up most of the diet. Chewing can remain difficult for many years, and, at times, children will chew and then remove food without swallowing.

Food fads, especially for savoury and sharp or acidic tasting foods, are common. Young Barth children often desire excessive quantities of salty crisps/chips (sometimes just licking off the salt). A recent internet patient survey described boys as having cravings for pickles, hot/chilli sauce, olives, mayonnaise, ketchup, soy sauce, cheese, milk and especially salt, from adding salt to food to drinking the brine from feta cheese to eating raw salt. A study published in 2015 (Reynolds) found that subjects with Barth syndrome had a lower than normal sensory response to salty foods. For older children, adding small amounts of cheese or saltier-tasting sauces, such as gravies, ketchup, and soy sauce, to new foods can improve their acceptance. There is no evidence of a renal salt-losing state or other medical condition causing the urge to eat salty foods.

In a child receiving tube feeding, transitioning back to a solid diet can be difficult, especially if weight gain has been excessive or if key stages in feeding development have been missed. In most cases, a slow approach is the most successful. Calories provided by supplemental nutrition and rate of weight gain should be reviewed frequently to ensure that appetite is not being suppressed.

Feeding plans that encourage oral eating include using top-up feeds in the evening and skipping lunch-time feeds when children are in day care and can eat with peers. Even if all nutrition is given by tube feeding, seat infants and children at the table during family meals to expose them to the sights and smells of food and to benefit from the social aspects of meal times. Encourage children to help prepare food, but do not pressure them to eat what they prepare. Helpful approaches include sensory play with food (cooking, tasting, playing) and being positive and encouraging about their preferred food choices, even if these are not as “healthy” as they should be, e.g. unusual or salty snacks. Occupational therapy and speech and language therapy may be helpful to desensitise children, but there is no evidence base establishing that such therapy produces consistent outcomes (Reynolds, 2015).

Specific Nutritional Considerations

Breast Feeding. Although a small number of infants with Barth syndrome have successfully breast fed, supplemental feeding with high energy formulas or nasogastric feeding can be necessary due to the low volumes taken and the need to ensure an adequate protein intake. In the UK, high energy feeds giving 0.9 to 1 kcal/ml are used and are best given as small frequent feeds. At times, a low birth weight premature baby formula has been used to increase protein without providing excessive calories. A frequent 3-4 hourly feeding pattern often continues until age 1 year.

Protein. It is a general view that protein requirements are increased in Barth syndrome, and, unless a high protein diet is otherwise contraindicated, the aim is to give up to 2g/kg/day of protein throughout childhood. There is increasing evidence of defects in the electron transport chain in Barth syndrome, which can lead to a metabolic preference for protein and carbohydrate over fat for producing energy. Because the requirement for higher-than-normal amounts of protein amino acids for energy synthesis can deplete muscle mass, the Barth diet typically requires a higher percentage of protein calories.

Arginine. Plasma arginine levels have been reported to be consistently low in many patients, although the extent of this is not clear. In a French review, Barth syndrome patients were found to have significantly lower plasma arginine levels than controls. A number of boys across the world take amino acid supplements, but there currently is no protocol for this therapy in the UK. More recently citrulline supplementation has been used in place of arginine supplementation, because citrulline is better tolerated and has a greater effect on the levels of arginine, into which citrulline is rapidly converted after absorption. Foods high in arginine (lentils, peanuts, pumpkin seeds, salmon, tuna, eggs) or citrulline (watermelon) can be included in the diet if liked; however, providing the daily supplementation dose of arginine and/or citrulline with foods alone is not possible.

Anaemia. Mild anaemia may be seen, usually with normal MCV and ferritin levels. This can prompt use of iron supplements but we have not seen an impact of iron supplementation on haemoglobin levels. The typical mild anaemia of Barth syndrome may represent a relative protein deficiency or anaemia of chronic disease and can improve with age. In addition, because higher iron and iron-saturation levels can damage mitochondria, iron supplements should not be given for anaemia unless iron deficiency has been proven by laboratory testing.

Vitamin A. Levels of vitamin A can be low even when supplemented, potentially because the availability of the transport protein (RBP) is limited, and not because tissue levels of vitamin A are low. Increased levels of Vitamin A (retinyl esters) have been found in chylomicrons; these provide an alternative method of transport to tissues, which will not be detected when measuring serum vitamin A. As vitamin A toxicity can cause health problems, high doses of vitamin A should be avoided (conference abstract). However, as vitamin needs are not decreased in proportion to the lower energy requirements of Barth syndrome, we advise that an age-appropriate multi-vitamin and mineral supplement providing around 50% of the RNI be taken.

Hypoglycaemia. Hypoglycaemia and (usually mild) lactic acidosis have been reported in Barth syndrome, principally in sick neonates and during the first year (Donati, 2006), although levels of 1.1 mmol/L have been documented following an illness in a 2-year-old (Kelley, 1991). Self-reported data from the Barth Syndrome Registry paper refers to 4% of patients having had hypoglycaemia.

The UK NHS Barth Syndrome Service has had three patients who require overnight tube feeding and several patients who take uncooked cornstarch with protein before bed, to keep blood glucose consistently above 3.5 mmol/L. One of these patients was admitted to hospital unconscious with an unrecordable blood glucose level following a period of fasting due to a diarrhoeal illness. The reasons for hypoglycaemia in Barth syndrome are not fully understood, and families are encouraged to ensure that infants do not go for long periods without feeds, and that they should continue to be fed in the night for the first years at least, and until glucose stability can be assured. Early admission to hospital is advised if intercurrent illness substantially limits feeding. However, feeding with concentrated emergency glucose regimens must be carefully monitored. Not adding protein or other source of amino acids after the 24 hours of getting only IV glucose can increase metabolic fragility in a child whose mitochondria are dependent on protein amino acids for generating energy.

A detailed factsheet is available on the Barth Syndrome Foundation website that outlines the additional monitoring and special nutritional management required during any surgical interventions that would otherwise require more fasting than would be safe for a Barth child. (Information for Anaesthesiologists and Surgeons Taking Care of Patients with Barth syndrome)

Potassium. Due to reduced muscle mass, which serves as a major stabilizer of blood potassium levels, potassium balance may be precarious. Similarly, extra attention to potassium levels is needed during times of potassium loss due to diarrhoea. However, because supplementation of potassium in children with much reduced muscle mass has been linked to fatal arrhythmias (Kelley, 2007) potassium levels must be closely monitored, especially if IV fluids containing potassium are used.

Other. There is no current, consistent evidence for benefit from using mitochondrial antioxidants or pantothenic acid. L-carnitine supplementation may help if there is a deficiency; however it has caused increasing muscle weakness and deterioration in cardiac failure (Ostman-Smith, 1994).

Views from the Families

- They want to eat. They want to be like everyone else. But they just can't.
- They'd rather starve than eat what they don't want.
- He ALWAYS claims to be hungry and insists on being given food. But then he won't eat or will eat almost nothing. Repeat that process 10 times daily, 365 days a year.
- He claims he is soooo hungry and then get food and take 1 to 2 bites and that's it.
- Feeding has always been a struggle for us too. Tremendous gag response to anything but formulas. Trying to find the right product for him so he won't throw up but gaining weight has been almost impossible. Many formulas and additives tried and many discarded over the years.
- Feeding is our biggest issue at the moment. He is 3yrs old and still doesn't swallow anything other than smooth purée. It's so frustrating, all the specialists we have seen have no answers for us. We've tried everything but seem to be making very little progress. He wants to eat solid food but will either lick all the flavour off or chew it up and spit it out. I could go on and on....
- We are the same. He would not drink formula; he refused and would gag and vomit. He's 3 and ½ years and hardly eats by mouth. All day long he says I'm so hungry. Then I give him a snack and he says no thanks maybe later. He's very particular about what he eats also. He will only eat junk food but a very small amount. I'm talking like 2 chips or 2 goldfish crackers.
- Frustrating, maddening, impossible, heart-breaking.
- You know you're a Barth mom when you love that your boy has a g-tube so you can catch up on all the calories missed each day. The struggle is real.
- It's another example of how they aren't like their friends or family members.
- My son is 3 years old. It has still been a struggle to get him to eat anything ever since after the age of 6 months. Now even with his new heart he still refuses to eat or drink anything. He's now on a feeding tube. We still try everything, every day and we even have an OT come twice a week. He still refuses everything. Every so often he will lick a Ritz cracker or a salty chip but when you try giving it to him the next day, he turns it away. He would rather put his fingers, toes, furniture, or toys in his mouth than food.
- We have had no problems with food, luckily. But, he prefers something (salty) and doesn't like certain foods. But when he is in a bad period he changes his behaviour and often is looking for food he won't eat because its taste. He says water changes its taste too, ham is not the same and so on.

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