

HISTORICAL OVERVIEW AND UPDATE ON NUTRITION IN CYSTIC FIBROSIS: ZOOMING IN ON SMALL

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Abstract. Cystic fibrosis (CF) was originally described as an exclusively digestive disease causing early death in infants due to extreme malnutrition before any sign of respiratory illness had developed. Once the pathological etiology was established, the suggestion was logical to introduce pancreatic enzyme therapy. One of the key findings in the care for people with CF was that energy is the magic cornerstone, which should be provided by food, rich in taste and calories. The next important step was to introduce enteral feeding using nasogastric tube and subsequently via gastrostomy. The help of psychologists is also invaluable in behavioural feeding problems at any age but especially in pre-school children. Since the earliest years, fat soluble vitamins were supposed to be problematic in CF because of the fat malabsorption. Their supplementation has been introduced and nowadays new specific preparations are available. Essential fatty acids and ω -3 long chain polyunsaturated fatty acids – increasingly have been demonstrated to be beneficial. Finally, feeding of newborns and infants has received the required attention. In many countries diagnosis is made at an early age thanks to systematic newborns screening. This is as efficient as the subsequent follow-up. At first stages breast-feeding should be continued. When it becomes impossible or not efficient, industry now puts a special formula (Cystilac) at our disposal, containing more energy, partially hydrolyzed protein, MCT fat, more salt, calories and vitamins, needing less enzyme substitution.

Key words: cystic fibrosis, nutrition, malnutrition, pancreatic enzymes, vitamin supplementation

INTRODUCTION

The title puts in words how present nutritional care in CF surpasses the mere treatment of malnutrition and increasingly zooms in on inconspicuous details like micronutrients and on the very small: newborns and young infants diagnosed early by neonatal

screening. This article will pay attention to both these items but first to recent evolution in the approach of malnutrition in CF.

THE PAST: TREATING STOOLS

Cystic fibrosis (CF) was originally described in 1938 as an exclusively digestive disease causing early death in infants due to extreme malnutrition before any sign of respiratory illness had developed [Anderson 1938]. Autopsies showed the pancreas to be the culprit: it was full of small cysts surrounded by fibrous scar tissue. The entity was therefore called “cystic fibrosis of the pancreas”. These abnormalities perfectly explain the clinical picture: the early progressive destruction of the organ causes elimination of its function which is central in the uptake of nutrients from the bowel as it produces the essential enzymes to digest starch, protein and especially fat. Consequences can easily be perceived by the senses. The repugnant smell of decomposing protein is characteristic and the amount of fat in the stools increases their volume, makes them look pale, yellowish, float on the toilet water and difficult to flush. This description is repulsive but gives useful information to the patient for free. The most important consequence is the loss of nutrients causing failure to thrive, severe malnutrition and early death.

Once the pathological ethiology was established, the suggestion was logical to replace the absent pancreatic enzymes by an animal surrogate: a powder made from dried, grinded, purified piglet pancreas to be taken with all food. Although it worked, the effect was minimal as large quantities only provoked small changes in stools. The unfortunate hypothesis was advanced that excessive fecal fat can successfully be reduced by eating less fat and fat prohibition was proclaimed; fat was banned from CF menu but as a result, so was taste. Fat free dishes were unpalatable and reduced the patients’ already poor appetite. The effect on stools was satisfying: never had they looked so well! However, as their volume diminished, so did the patients weight. While stools looked better, patients got worse. They developed a typical hunger profile. Their belly was massively swollen while the rest of their body was very skinny. They had no buttocks nor subcutaneous fat, hardly any muscles, looked pale and sad and had little energy reserve. No wonder they succumbed at the first serious infection. This was – erroneously – regarded as the typical CF appearance far into the eighties and most of these children remained so for the rest of their short life. In retrospect, it is incomprehensible that the medical world did not see that they inflicted an unacceptably high toll for the shape of stools.

THE DISCOVERY OF ENERGY NEEDS

Fortunately not all CF caregivers accepted this fat prohibition indiscriminately. Some, like good accountants, first compared expenses and revenues by the simple observation of the obvious [Pencharz and Durie 2000]. People with CF have higher energy expenses due to the disease itself [Shepherd et al. 2001], to the increased respiratory labour, the constant fight against infection and the imposed physiotherapy and sports. They also lose more in their stools as a result of maldigestion and malabsorption, in their sputa which also contain more protein and in their urine when they have diabetes. The addition of all these losses can raise energy needs by 20 to 50% and more

[Sinaasappel et al. 2002, Borowitz et al. 2002]. When this excess is not covered, weight gain nor growth can occur and defence mechanisms will be jeopardised making patients prone to serious respiratory infections [Milla 2004, Steinkamp and Wiedemann 2002, Sharma et al. 2001, Peterson et al. 2003, Konstan et al. 2003, Hart et al. 2004]. This is the vicious pathway created by fat prohibition since fat is the main energy provider in nutrition fat supplies nine calories/gram, more than twice as much as carbohydrate or protein. Conversely, the sequence can be reversed when more energy is taken nutritional state improves and pulmonary deterioration is prevented [Pencharz and Durie 2000].

This basic analysis led to the conclusion that energy could never be kept in balance with fat prohibition and a higher consumption was recommended.

It was only years later and by coincidence that the results of this approach became clear [Corey et al. 1988]. The CF centres of Toronto (Canada) and Boston (USA) closely collaborated by exchanging caregivers and following identical guidelines for respiratory treatment and use of antibiotics. Yet when the data were compared Canadians were doing much better than Bostonians: they were heavier, taller, had better lung function and were surviving longer. Scrutiny of all treatment details only showed a difference in diets: it was fat restricted in Boston while in Toronto they recommended a high fat consumption. Apparently this made the difference and hesitantly, fat restriction was progressively abolished. This was a hinge moment in the history of CF, although the basis was humiliatingly simple: people should be in the centre of medical attention, not stools. The resulting lesson is of key importance in the care for people with CF: energy is the magic cornerstone, which should be provided by food, rich in taste and calories.

At first sight, this seems easy in a community with a growing number of obese who eat too much. It is however torture when constantly eating more than appetite is mandatory, especially when this is suppressed by cough and illness. Increasing the volume of food eaten by 20 to 50% is impossible for most patients [White et al. 2007]. It is more effective to try to increase the calorie content by adding sugars and fat, thus also turning the fat free rubbish into tasty delicacies. This type of food preparation comes close to that of the general population, which is condemned as unhealthy because it causes obesity. For people with CF this is the right food although we are hesitant to recommend the generous use of double cream, fat rich sauces and sweet desserts out of unjustified fear for atherosclerosis [Bronwen et al. 2010]. Our shame disappears however when we see that patients appreciate it much more than the former fat free concoctions. People with CF are stimulated to become gourmets, dieticians are retrained from nutrient calculators to gastronomic advisors and parents are taught to become “cordon bleu” master chefs. It’s not always good for the parents’ weight but it’s excellent for the patient’s physical and mental health. When restrictive diets disappear the social function of eating returns. People with CF can go to a restaurant and, thanks to a better physical appearance, enjoy the company of friends and even consider creating a family [Edenborough et al. 2008].

BEHAVIOURAL OBSTACLES

In adolescents nutritional advice is often challenged by the supremacy of a slim figure imposed by lifestyle television programmes and glossy fashion magazines. These make great impression especially on young girls for whom encouragement to eat some-

what more in order to gain some weight is like incitement to sin. They are extremely difficult clients because they are encouraged by powerful advertisement and appreciation for a skinny figure by envious friends. Psychological help cannot only tackle the eating problem but also those of puberty and adolescence in general.

The help of psychologists is also invaluable in behavioural feeding problems at any age but especially in pre-school children. These are not specific to cystic fibrosis but probably more frequent and more frustrating because parents are cornered between an unwilling child and an insisting caregiver who “threatens with the deadly dangers of inadequate feeding”. The parents' reaction is often inappropriate leading to dramatic situations at the table and in the family [Hammons et al. 2010]. The resolution mostly takes a lot of time but the united endeavour of family, patient psychologist and dietician can do miracles [Stark et al. 2011].

In recent years more attention has been given to “the “side show”” of eating. It is clear that the environment and company at a meal can be more important than what is on the plate. This is certainly true for the special circumstance of CF where people have constantly to eat more than their appetite. We therefore have to be very broadminded and allow, even stimulate, food which is discouraged for others as unhealthy. Fast food like pizza or chips, dressings, chocolate, peanut butter and candy bars can at times be helpful resources. After all... the tricks and attempts to enrich regular food can lead the horse to the water, but cannot make it drink nor absorb.

Yet digestion and absorption is severely put to the test by the higher fat consumption and even more attention must be given to adequate quantities of pancreatic enzymes with all food. Fortunately pancreatic enzyme preparations have become more potent, thanks to the enteric coating, a better presentation and a higher concentration. Nevertheless in a vain attempt to resolve all digestive problems, patients have excessively increased dosage of the highly concentrated preparations and thus created a new disease, “fibrosing colopathy”, in which the walls of the right large bowel thicken and eventually even obstruct passage. Thanks to a better control of enzyme dosage the disease has practically disappeared [Fitzsimmons et al. 1997].

The value of adjuvant medication has been discovered like that decreasing gastric acid production thus preventing rapid destruction of pancreatic enzymes [Chalmers et al. 1985]. It reinforces enzymatic activity so successfully that it became part of standard treatment in some centres.

SPECIAL AIDS

When infections occur appetite can be very low while just then more energy is needed. ... For these special circumstances industry offers concentrated sip-feeds in small brick packs containing easy to take high calorie drinks in various colours and flavours, very suited as in between snacks or supplements after meals [Smyth and Walters 2007]. They are very successful in repairing energy balance over a short period but should not become easy sweet substitutes for regular food.

Once the dietary intake becomes problematic and this can be anticipated to be of longer duration a more drastic solution must be proposed: enriched regular meals continue to be given supplemented by hyper-caloric sip-feeds. In addition, a high quantity of calories can be supplied “effortlessly” by tube [Conway et al. 2008]. This can be

performed most conveniently through a gastrostomy, a direct opening between stomach and skin through which a discrete silicon device is placed using endoscopy. During the day, when the gastrostomy is closed, all normal activities like going out, swimming, sports, normal eating are possible. At night the gastrostomy is opened and connected to a feeding bag. A large quantity of calories and nutrients is provided in the form of a special formula containing the latest advances in nutritional science like “predigested” proteinhydrolysate and MCT fat, needing minimal quantities of pancreatic enzymes.

MAXI IMPORTANT MICRONUTRIENTS

Anti-oxidants are an important subject for the latest nutritional research, paramount for CF. In this disease inflammation is at the origin of pulmonary damage. It is initiated by infection and oxidation is its mode of action. Normally it is counteracted by anti-oxidants but in CF these are not sufficiently available since one of the most potent, vitamin E is fat soluble and thus not well absorbed. There is fortunately no problem for the most important water soluble one, vitamin C, which is naturally abundant in fruits and vegetables. These foods are however not the most popular for children and medical caregivers insufficiently include them in their nutritional recommendations which mainly stress fat and calories. In a recent study our dieticians found out that 20% of our CF patients took less than the minimal recommendations (not published) while they probably need more. Since then more attention is paid to fruits, vegetables and oils rich in anti-oxidants and to the daily systematic consumption of at least 200 ml of juice.

Since the earliest years, fat soluble vitamins (A, E & K) were supposed to be problematic in CF because of the fat malabsorption. But, remarkably, even though blood levels have been reported to be low, symptoms of deficiency have very rarely been described. To stay on the safe side however a supplement is systematically prescribed [Maqbool and Stallings 2008], preferably in a single preparation. Vitamin E is given in a higher dosage, for the reasons above and because there is no danger in giving more than the daily needs. This is also true for vitamin K, shown to be important in more than the known blood clotting but also central in the maintenance of bone integrity. The cornerstone in this respect is vitamin D for which we recently demonstrated that the sun is as valuable as oral supplements [Robberecht et al. 2010]. Since it is not available during the long dark winters building a stock by sun exposure during the sunny months should be encouraged.

Calcium is the substrate for vitamin D; it is the third nutritional brick in the bone wall. It can copiously but almost exclusively be found in milk and dairy products, excellent food for CF since they contain a myriad of beneficial factors, easy to take, at a cheap price and with a multitude of applications in the kitchen. Yet our dieticians found out that it is insufficiently present in the menu of 40% of people with CF. Patients should know that maintenance of good bone health is of utmost importance [Aris et al. 2005] since very painful fractures of ribs and vertebrae can occur without trauma. They should be encouraged to drink 800 ml of liquid dairy product a day, providing the necessary 1 gram of calcium. Hard cheese is even richer and can be grated to add to many dishes.

Essential fatty acids – EFAs – are increasingly shown to be beneficial in CF [Strandvik 2004]. Omega 3 receives most attention e.g. in fish oils. The EFA should

abundantly be present in a varied CF menu as fatty fish like salmon, halibut, herring, etc. or oil of cole-seed (canola) [Cawood et al. 2005].

YOUNG STARTERS

Finally, the food of the very small, the newborn and young infant should receive attention. In many regions and countries diagnosis is made at an early age thanks to systematic newborn screening. This is as efficient as the subsequent follow-up and thus only the very best nutrition is good enough. For every infant this is the mother's own milk. Pancreatic enzymes should be given at each feeding session and the infant must be followed very closely in order to detect problems as soon as the first indication appears. When breast feeding is impossible, industry now puts a special formula (Cystilac) at our disposal, containing more calories, salt, vitamins, protein hydrolysate and MCT fat, needing less enzyme substitution.

IT IS WORTH WHILE!

The provision of nutrition to somebody with CF is not easy. It is demanding and often frustrating to withstand the publicity tsunami of "slim and light is healthy" and to continue the search for the miraculous nutrient which will put more weight on the balance and yet goes down just right. This daily endeavour is however not in vein since it is an established fact that survival mainly relates to the nutritional status [Steinkamp and Wiedemann 2002, Sharma et al. 2001]. As the latter declines so does survival. This is increasing every year without negative effects on the quality of life and steadily crawls to the final goal for people with CF: the prospect to develop diseases of old age...

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PRZESZŁOŚĆ I TERAŹNIEJSZOŚĆ ŻYWIENIA W MUKOWISCYDOZIE: MAŁE JEST WAŻNE

Streszczenie. Mukowiscydoza początkowo została opisana jako choroba dotycząca wyłącznie przewodu pokarmowego, prowadząca do śmierci ze względu na ciężkie niedożywienie, przed pojawieniem się objawów oskrzelowo-płucnych. Logiczną konsekwencją ustalenia etiopatogenezy choroby stało się włączenie suplementacji enzymatycznej. Jednym z kluczowych zagadnień opieki na chorymi na mukowiscydozę było stwierdzenie, że magiczne znaczenie ma podaż energii, która powinna być dostarczona w smacznym i kalorycznym pożywieniu. Kolejnym istotnym krokiem było wprowadzenie żywienia dojelitowego przez zgłębnik nosowo-żołądkowy, a następnie także przez gastrostomię. Pomoc psychologiczna jest niezwykle cenna po wystąpieniu zaburzeń behawioralnych związanych z żywieniem w każdym wieku, zwłaszcza u dzieci w wieku przedszkolnym. Od najwcześniejszych lat uważano, że u chorych na mukowiscydozę występują niedobory witamin rozpuszczalnych w tłuszczach ze względu na zaburzenia trawienia i wchłaniania tłuszczów. Wprowadzono ich suplementację, obecnie dostępne są nowe swoiste preparaty witaminowe. Wykazano pozytywny wpływ niezbędnych nienasyconych kwasów tłuszczowych i ich długołańcuchowych pochodnych z rodziny ω -3. W końcu położono także stosowny nacisk na żywienie noworodków i niemowląt. W wielu krajach rozpoznanie mukowiscydozy następuje bardzo wcześnie dzięki badaniu przesiewowemu noworodków. Jego skuteczność zależy od następowo wdrożonego postępowania. Początkowo należy kontynuować karmienie piersią. Kiedy staje się to niemożliwe bądź jest nieefektywne, trzeba skorzystać z dostępnych obecnie specjalnych diet przemysłowych (Cystilac). Charakteryzują się one większą gęstością energetyczną, zawierają częściowo zhydrolizowane białko, tłuszcze MCT, więcej soli i witamin. Dzięki stosowaniu takiej diety zmniejsza się zapotrzebowanie na enzymy.

Słowa kluczowe: mukowiscydoza, żywienie, niedożywienie, enzymy trzustkowe, suplementacja witaminowa

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