Nutritional management of short bowel syndrome in adult patients

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Abstract

Patients who have undergone extensive small bowel resection require chronic parenteral nutrition and administration of fluids via the intravenous route. Dietary care is the supplementation of the process of treatment. After the alignment of nutritional status of the patient and controlling the loss of nutrients, electrolytes and water, it is possible to start nutrition via the alimentary route, including orally. The supply of nutrients by the enteral route should be started with small volumes, and be gradually increased, controlling the number of defecations and the patient's hydration status. Properly managed enteral nutrition exerts a positive effect on the process of adaptation of the bowel. Patients with Short Bowel Syndrome (SBS) should receive individual dietary recommendations, considering the extent of resection, its cause, nutritional and hydration status, nutritional preferences, and the degree of meeting the demand for nutrients via the parenteral. In the planning of dietary management it is also important to consider the social and emotional context of oral food intake, affecting the quality of life of patients with short bowel syndrome. The objective of the study is presentation of the state of current knowledge concerning dietary management in adult patients with short bowel syndrome.

Key words:

bowel resection, short bowel syndrome, dietary treatment, home parenteral nutrition, clinical nutrition

Introduction

Short Bowel Syndrome (SBS) is the condition after discontinuation of intestinal function due to surgical removal of a large portion of the small intestine, or a functional disease as a result of which the intestine, despite its normal length, becomes inefficient, e.g. due to an intensified inflammatory process or disorders in the gastric motility [1,2,3]. In adult patients, SBS is related with a decreased functional length of the small intestine of the length less than 200 cm [1,2,3]. Among the main causes of SBS in adults are mentioned mesenteric vascular occlusion (as a result of arterial or venous thrombosis), Crohn's disease, complications following surgical treatment, radiation enteritis, malignant tumours, familial polyposis, more rarely abdominal injuries, sclerosing peritonitis, and numerous intestinal fistula [4,5]. SBS is the most frequent pathophysiological mechanism of chronic intestinal failure (CIF), and among adult patients occurs in 64.3% of patients with CIF [6].

In physiological conditions the absorption of the majority of nutrients and minerals occurs within the first 100 cm of the jejunum. Vitamin B_{12} and bile acids are absorbed mainly in the distal part of the ileum, while magnesium in the distal part of the ileum and the proximal part of the colon. Absorption of water and sodium occurs within the whole intestine and depends, among other things, on the mechanisms of transport of sodium and osmolality in the intestinal lumen [2]. About 9 litres of fluid pass through the small intestine daily, including the beverages and food consumed, saliva, gastric juice, pancreatic juice, and bile. In physiological conditions, 7 litres are reabsorbed in the jejunum and ileum, 2 litres pass through the ileocaecal valve and are absorbed in the colon [2]. In the final part of the ileum and the initial part of the colon are produced many gastrointestinal hormones and neuromodulators which play a key role in the control of gastrointestinal secretion and regulation of the intestinal motility [2]. In patients with SBS, due to the decreased functional surface area of the intestine, the absorption of nutrients, electrolytes and water is insufficient. In the case of the lack of their proper supply by the intravenous route, there occur dehydration, fatal complications related with electrolytic disorders and organ complications (mainly renal failure) [2]. Insufficient digestion and absorption of nutrients, trace elements and vitamins are associated with the occurrence of severe malnutrition and serious deficiency of vitamins and microelements. In patients with SBS, the absorption of enterally administered drugs is also disturbed [7].

SBS is a difficult clinical condition, often causing disability, and related with high morbidity, mortality, and a decreased quality of life of patients [8]. Estimation of the incidence of SBS is difficult. This results, among others, from its multifactor etiology and discrepancies in the assessment of the length of the intestine related with the use of various methods of measurement of the intestine left. Estimations concerning the occurrence of SBS are based on data from registers of patients covered with Home Parenteral Nutrition (HPN). SBS is the most common indication for HPN and concerns 75% of patients receiving chronic nutritional therapy [2]. The frequency of application of HPN in England is 12 (6-19)/1,000,000 population, in Italy 30/1,000,000 population, in the USA > 40/1,000,000 population. In Poland, about 28/1,000,000 inhabitants are covered with HPN [7].

Patients with SBS are exposed to specific complications, including an increased frequency of the occurrence of cholelithiasis, an excessive secretion of gastric juice, nephrolithiasis, magnesium deficiency, electrolyte disorders, and lactic acidosis [2]. Chronic parenteral nutrition exerts an effect on the development of some complications, such as chronic renal failure, hepatic diseases, and metabolic bone disease [2].

The occurrence of deficiency of nutrients and minerals after extensive resection of the bowel depends on the site of surgery, its extent and type of surgery undergone. Considering the anatomy of the portion of intestine left, 3 types of SBS are distinguished (Fig. 1):

Type 1 – with end-jejunostomy formed (SBS-J);

Type 2 – jejuno-colonic anastomosis with part of the colon in continuity (SBS-JC);

Type 3 – jejuno-ileal anastomosis with ileo-cecal valve and the entire colon in continuity (SBS-JIC) [2].

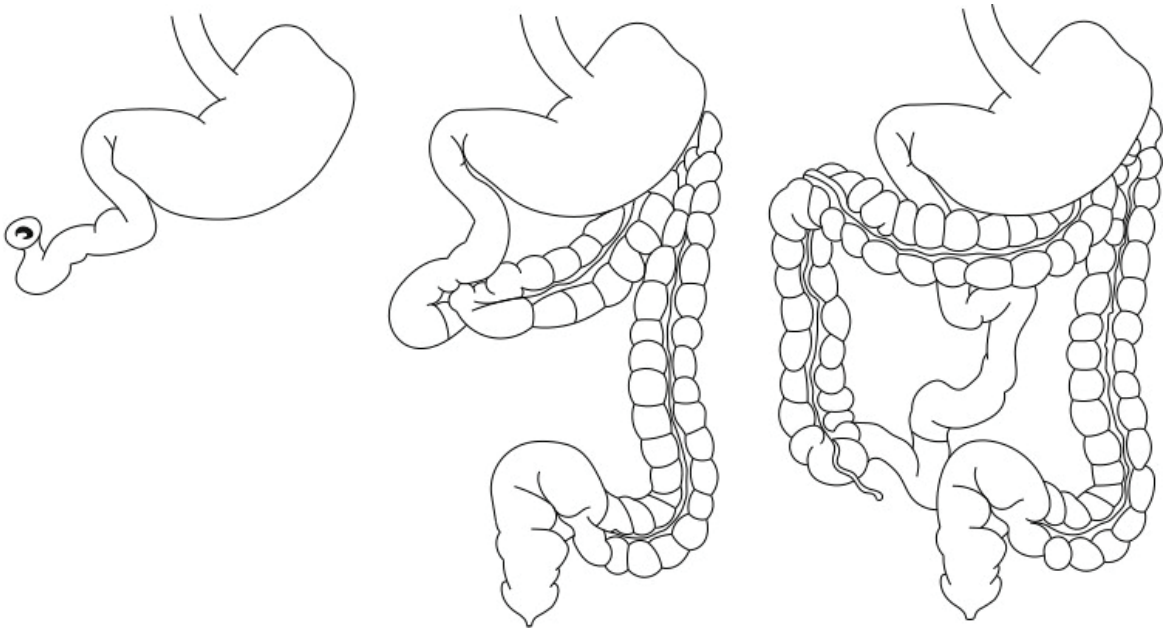

Fig. 1.
Anatomy of the portion of intestine left in SBS, from left to right: type 1 – with end-jejunostomy formed (SBS-J); type 2 – jejuno-colonic anastomosis with part of the colon in continuity (SBS-JC); type 3 – jejuno-ileal anastomosis with ileo-cecal valve and the entire colon in continuity (SBS-JIC)
Source: own compilation.

In the course of SBS, 3 phases are distinguished: acute phase, adaptation phase, and stabilisation phase. The acute phase lasts, on average, for 3-4 weeks after resection. An excessive secretion of gastric juice and disorders in the secretion of gastrointestinal hormones and neuromodulators usually persist for up to 6 months [2]. In order to avoid serious complications in the acute phase, such as dehydration and acute renal failure, electrolyte deficiency or metabolic acidosis, it is necessary to monitor the state of the patient in hospital conditions [2]. In the acute phase, oral nutrition is contraindicated considering an increase in fluid loss from the gastrointestinal tract, and therefore an increased number of defecations. The demand for nutrients, minerals, fluids and electrolytes is entirely covered via the parenteral route.

In the adaptation phase, there occurs a gradual regaining of efficiency by the intestine. During this time, the patient requires HPN, compensating for water-electrolyte disorders and the deficiency of nutrients [2]. In parallel, rehabilitation of the intestine is also carried out, including dietary care and pharmacological treatment, mainly of disorders on the part of the gastrointestinal tract [7]. Intestinal adaptation leads to structural and functional changes increasing the absorption of nutrients and fluids in the portion of the intestine left [5]. Adaptation changes (villous hyperplasia, deepening of the crypts, increase in the enzymatic activity of the brush border) are related with an increase in the area and mass of the intestinal mucosa, and consequently, an increase in the absorption of nutrients, minerals, water, and electrolytes [5,9]. The adaptation process takes place most intensively during the first 2 years after resection; however, an increase in the capability for absorption of nutrients, water and electrolytes by the intestine left is also possible during the later period [5,9]. Nutrients administered to the intestinal lumen, through trophic stimulation of the intestinal epithelium, increase in blood flow, regulation of secretion of the pancreatic juice and intestinal hormones, exert an effect on the activity of the intestinal neurons and intestinal motility [5,9]. The volume of enteral nutrition should be gradually increased, paying attention to the number of defecations [5]. Due to intestinal adaptation, in a considerable number of patients with SBS it is possible to limit the supply of nutrients and water administered via the parenteral route to the benefit of enteral nutrition, including orally [9].

At the final stabilization phase the intestine left obtains the maximum degree of absorption capability. However, the achievement of nutritional autonomy is

not possible in all patients, and this depends, among other things, on the length of the intestine left [7].

The goal of treatment of patients with SBS is the provision of a proper supply of nutrients, vitamins, electrolytes and water, indispensable for the maintenance of the normal status of nutrition and hydration, introduction of enteral nutrition, with a simultaneous limitation of parenteral nutrition, decrease in the number of complications resulting from the primary disease, and the provision of an appropriate quality of life [1]. Properly managed nutritional therapy via the parenteral route should minimize the feeling of hunger and thirst experienced by the patient. The treatment of patients with SBS frequently lasts until the end of their life, from more than a dozen months to several dozen years. The quality of treatment, its outcomes and the frequency of complications considerably affect the quality of life of patients [7].

Assessment of nutritional and hydration status of patients with SBS

Due to the reduction in the functional length of the intestine, patients with SBS are exposed to malnutrition and an excessive loss of fluids. The objective of the study by K.U. Jang et al. was assessment of the clinical factors related with the nutritional status of patients who had undergone bowel resection due to Crohn's disease. The study included 394 patients. Nutritional status was assessed using the body mass index (BMI) and modified nutritional risk index (mNRI). Aggravation of the primary disease, possession of ileostomy and length of the intestine left ≤ 230 cm are the factors which may exert an effect on deterioration of the nutritional status of patients after small bowel resection. However, no correlation was observed between time which had elapsed from the last surgery and the nutritional status of patients. According to K.U. Jang et al., while evaluating the nutritional status of patients after small bowel resection, the results of bioelectrical impedance vector analysis (BIVA) should be taken into consideration [10]. BIVA is a non-invasive technique for the estimation of body composition using measurements of bioelectrical impedance, resistance and reactance. The BIVA method allows an overall assessment of hydration and mass of soft tissues in any clinical condition [11]. P.G. Fassini et al. confirmed that in patients with SBS, BIVA was a more sensitive method in the detection of changes in the state of hydration and muscle mass, compared to the standard BIA [12]. It is emphasized that in the long-term assessment of the nutritional status of patients with SBS, body water content and cell mass are important elements in the analysis of body composition [13].

Basic assumptions of oral diet in patients with SBS

Nutritional therapy via the parenteral route and a proper intravenous supply of fluids and electrolytes play the most important role in the treatment of patients with SBS [5,6]. Appropriately adjusted oral diet in patients with SBS with an aligned nutritional and hydration status may result in an increase in absorption of nutrients, vitamins and fluids from the gastrointestinal tract, and therefore reduce the number of defecations [14]. The assumptions of an oral diet should consider general principles referring to all patients with SBS, individual nutritional preferences of patients, and their experiences related with the intake of specified types of products and meals [8,15]. In order to increase the probability of observance of nutritional recommendations by patients with SBS and increase the effectiveness of dietary management, it is important to explain to patients the rationale of the applied diet modifications, imparting of information concerning the type of the recommended products and meals, and methods of their preparation [14,16].

Patients with SBS should consume 6-8 low volume meals during the day, slowly, exactly biting and chewing every mouthful [8,15]. In association with disturbed absorption related with SBS, as much as 50% or more of nutrients from oral diet may not be normally absorbed [1]. Allowed fluids should be drunk between meals, instead of during meals [8].

As a result of an increase in the intestinal absorptive surface in the process of its adaptation, changes

in nutritional status and levels of microelements in serum, the dietary recommendations for patients with SBS will be subject to modifications [16]. Dietary counselling in patients with SBS should be managed by a qualified dietician [15].

Protein

In patients with SBS, protein in the oral diet should supply from 20 – 30% of energy, most of which should be protein with a high nutritional value, originating from products such as meat, poultry, fish, eggs, and dairy products [14,16]. In patients with SBS, a high amount of protein is lost with intestinal contents, and additionally, the presence of an inflammatory process increases the demand for this nutrient [8]. Dairy products which are simultaneously the source of lactose should not be routinely eliminated from the diet when their consumption does not result in an increased number of defecation in patients with SBS [15]. A reduced intestinal surface area, to a slight degree, disturbs the absorption of nitrogen, therefore, usually it is not necessary to apply diets containing protein in a hydrolized form [17].

Fats

Fats are the best source of calories; however, at the same time, they are the nutrient which is most difficult to digest and absorb. In some patients with SBS, an excess of fat may result in the occurrence of fatty stools and intensification of loss of nutrients, fat-soluble vitamins, water and electrolytes [15,16]. The total content of fats in the diet of patients without a colon (SBS-J), in the case of their normal tolerance, should not exceed 40% of the energy value of oral diet [15,16].

In patients with SBS with a preserved colon (SBS-JC, SBS-JIC), fat in the diet should constitute 20-30% of energy value of the oral diet [1,17]. An excessive amount of fat in the diet is related with calcium and magnesium and may intensify the absorption of oxalates in the colon [1,17]. Therefore, patients with SBS-JC, SBS-JIC are especially exposed to the development of urolithiasis, especially when as a result of dehydration the amount of excreted urine decreases to less than 1 litre/daily [15]. It is possible to reduce the absorption of oxalates by reduction of the content in oral diet. Then, the consumption of products which are the source of oxalates should be limited, including, among others: beetroot, spinach, rhubarb, strawberries, chocolate, tea, wheat bran and pulses (except for green beans) [14]. A low-fat diet in patients with SBS may result in an increased risk of deficiency of indispensable polyunsaturated fatty acids, including fatty acids of the n-3 family and fat-soluble vitamins [15].

Carbohydrates

A high amount of simple carbohydrates in the diet contributes to an increase in its osmolarity, retention of water in the intestinal lumen, and may be the cause of osmotic diarrhea [5]. Therefore, patients with SBS should avoid products with a high content of simple carbohydrates: sweets, carbonated beverages, fruit juices and drinks [5]. Some simple carbohydrates, e.g. fructose, are classified into fermentable oligosaccharides, disaccharides, monosaccharides and polyols (FODMAP). FODMAP pass through the gastrointestinal tract in an unchanged form, undergo bacterial fermentation taking course with an enhanced production of carbon dioxide and hydrogen, and as a result of further transformations - hydrogen sulphide and methane. They cause an accumulation of fluids and gases in the lumen of the intestine result in the acceleration of its motility, and for this reason may be responsible for intensification of complaints on the part of the gastrointestinal tract, e.g. pain, diarrhea, constipation, or bloating [17]. In a randomized prospective study of patients with inflammatory bowel diseases, which are among causes of bowel resection, N. Pedersen et al. confirmed the effectiveness of diet with a low content of FODMAP in the reduction of symptoms on the part of the gastrointestinal tract, and the improvement of the quality of life of patients during the phase of clinical remission, compared to ordinary diet [18]. Nevertheless, further studies are necessary, which would confirm the effectiveness

of a diet with a limited content of FODMAP in the elimination of complaints on the part of the gastrointestinal tract, including in patients with SBS.

Irrespective of the anatomy of the intestine left, the basic source of energy in patients with SBS should be complex carbohydrates with a low content of dietary fibre from wheat, wheat-rye, corn bread, fine cereals, and white rice. The addition of soluble fibre (e.g. pectin) to the diet in order to increase intestinal absorption is not recommended [15]. In patients with SBS, a moderate intake of soluble fiber is often encouraged [8]. As a result of bacterial fermentation of undigested soluble dietary fibre, in the colon are produced short-chain fatty acids (SCFA), the absorption of which may be an additional source of energy [2,5]. A high amount of dietary fibre in the diet of patients with SBS is not recommended. Fibre delays emptying of the stomach, accelerates intestinal passage, and increases the number of defecations [8,15]. Vegetables and fruits should be subjected to mechanical and thermal processing in order to increase their digestibility. Seeds of legume plants (peas, beans, lentils, soy beans), similar to gas-producing vegetables (onions, leaks, cabbage, cauliflowers, broccoli) are usually not recommended in the diet of patients with SBS.

Fluids and electrolytes

In patients with SBS, the supplementation of electrolytes and fluids should be carried out mainly via the parenteral route. Thirst caused by dehydration in unbalanced patients with SBS is frequently related with the consumption of larger amounts of water. Then, the volume of fluids secreted into the intestinal lumen and the number of defecations increase, and the symptoms of dehydration aggravate [5]. In patients with SBS-J, the daily consumption of liquids should not exceed 500 ml/daily [4].

The capability for maintaining the proper hydration status by hypotonic fluids depends on the presence of the colon. In the majority of patients with SBS with the colon preserved, it is possible to maintain proper hydration by means of hypotonic fluids [19]. In order to increase the intestinal absorption and reduce the number of defecations, patients with SBS are recommended to replace ordinary drinks by oral rehydration solutions (ORS) [19]. The absorption of sodium and water in the small intestine takes place at the concentration of sodium of at least 90 mmol/l, in the upper part of the small intestine. In the ORS preparations, in order to stimulate absorption of sodium and water, the system of coupled transport of sodium and glucose is used, acting mainly in the jejunum. An optimum concentration of sodium in ORS is from 90–120 mEq Na^+/l, with n optimum carbohydrates/sodium ratio 1: 1 [8]. Home ORS recipes are also available (Tab. 1). In order to improve the taste, ORS may be administered in a chilled form.

Patients with SBS lose large amounts of sodium, magnesium, potasium and calcium with the excreted intestinal content. In patients with SBS-J or ileostomy, the daily loss of sodium may reach even 105 mEq (2430 mg) per 1 litre of stool [8]. Therefore, patients with SBS are recommended to additionally salt meals and consume salty snacks, e.g. crackers, salty sticks, etc.

In patients with SBS there often occur disturbances in the absorption of fat-soluble vitamins, including vitamin D [5]. Among the causes of vitamin D deficiency are, among others, an insufficient exposure to sunshine, insufficient amount of products which are the source of this vitamin in the diet, limited tolerance of products with a high-fat content in patients with SBS, concomitant diseases, and administered drugs. S. Fan et al., in the prospective study including 60 adult patients with SBS, determined the level of vitamin D in blood serum (25-OHD) and bone mineral density. In all patients, vitamin D deficiency was observed, despite routine oral supplementation. Only in 2 patients the normal bone mineral density was noted. It was found that a low 25-OHD level was related with decreased bone mass [23]. The concentrations of vitamins, trace elements and mineral salts in blood serum of patients with SBS should be strictly monitored [5]. In practice, in patients chronically receiving nutritional therapy, the determination of their levels is performed every 3 months.

General assumptions of the diet for patients with SBS are summarized in Tab. 2.

Table 1.
Selected home ORS recipes – own compilation based on [20,21,22]

WHO Formula	St Mark's Electrolyte Mix	Home Made Cereal-Based	Basic Homemade Recipe	Cranberry juice
• ½ teaspoon of salt • ½ teaspoon of potassium chloride • 8 teaspoon of sugar • ½ teaspoon of baking soda • 1 litre of water Mix all ingredients thoroughly	• 20 g glucose • 2,5 g sodium bicarbonate (baking soda) • 3,5 g sodium chloride (table salt) Mix all ingredients thoroughly	• ½ glass of dry, or preliminarily cooked rice flakes • 2 glasses of water • ½ teaspoon of salt Combine all ingredients. Keep refrigerated. The solution should be dense.	• 1 litre of water • 1 glass of orange juice • 8 teaspoons of sugar • ½ teaspoon of baking soda • ½ teaspoon of salt Mix all ingredients thoroughly	• ½– ¾ glass of cranberry juice • 3 and ¼ glass of water • ¾ tablespoon of salt Mix all ingredients thoroughly

Table 2.
General assumptions of the diet for patients with SBS

Dietary component:	SBS-J	SBS-JC, SBS-JIC
Meals:	6–8 daily, exact biting and chewing food	6–8 daily, exact biting and chewing food
Proteins:	20–30%	20–30%
Fats:	30–40% energy Provision an adequate supply of indispensable essential unsaturated fatty acids (≥ 2% energy)	20–30% energy Provision an adequate supply of indispensable essential unsaturated fatty acids (≥ 2% energy)
Carbohydrates:	40–50% energy	50–60% energy
Dietary fibre:	In limited amounts ≤ 25 g/daily	In limited amounts ≤ 25 g/daily
Oxalates:	Lack of limitations	Limitations if daily urinary excretion < 1 l/daily
Salt:	Increased consumption by adding salt to food, or an increased consumption of products with high content of salt	Usual consumption
Liquids:	ORS, in some cases total limitation of supply of liquids	Hypotonic fluids or ORS, in some cases total limitation of supply of liquids

Source: own compilation based on [1,8]. ORS – oral rehydration solutions

Quality of life of patients with short bowel syndrome

Symptoms related with SBS, including diarrhea or a large number of defecations, stool incontinence, abdominal pain, need for constant eating, and dependence on parenteral nutrition and its potential complications (e.g. septic complications, thrombosis), exert a negative effect on the quality of life of patients [24,25]. The care of patients chronically receiving nutritional therapy should focus not only on the prolongation of survival time, but also cover an improvment in the quality of life (QoL) [26]. Patients dependent on HPN require regular intravenous infusions, which usually last for 12–14 hours, 1–7 days a week. One of the main assumptions of the study by S.T. Burden et al. was determination of the conditioning of QoL in patients fed HPN, with consideration of the effect of the clinical situation, method of treatment, including the number of weekly performed infusions, and personal characteristics of patients. It was found that gender, time elapsed from the onset of HPN, education and marital status, had no effect on the QoL, whereas a larger number of night HPN infusions was related with a decreased QoL of patients [27].

The possibility of consumption of meals together with loved ones and deriving pleasure from this significantly affects the QoL of patients with intestinal failure (IF). The goal of the study by M.F. Winkler et al. was an attempt to provide an answer to the question in what way the problems related with consumption of meals affect the quality of life of patients receiving HPN, by using a telephone interview technique including 24 adults with IF chronically parenterally fed, 23 of whom had SBS. During the conversation, the problems were raised concerning eating behaviours, feeling hungry and thirsty, consumption of meals in restaurants, and perception of unnecessary money spent on food products. It was confirmed that the achievement of pleasure and satisfaction from the consumption of meals by patients with IF was more important than controlling symptoms on the part of the gastrointestinal tract. Patients with SBS generally observe the reactions of their body to the consumption of individual types of food products. They know how much and what type of food they can eat without inducing specified symptoms on the part of the gastrointestinal tract (pain, diarrhea). All participants of the study felt safe in the knowledge that HPN covers their demand for energy, nutrients, and liquids, and enables regaining the original body mass from before the disease [28].

Conclusions

1. HPN conducted by the Clinical Nutrition Unit, is a basic strategy for the treatment of patients with SBS.
2. After aligning the nutritional and hydration status of the patient, intestinal rehabilitation should be conducted in parallel, consisting of proper dietary management and pharmacological treatment, mainly of disorders on the part of the gastrointestinal tract.
3. Patients with SBS, in association with multifactor etiology, are a very diverse group of patients.
4. SBS is related with a high risk of complications; therefore, it is important to provide treatment by a multi-specialist therapeutic team, including physicians, nurses, pharmacists, clinical dieticians, who are medically prepared, as well as psychologists and other specialists according to the needs.

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