DOI: 10.1002/ncp.10951

INVITED REVIEW

Navigating nutrition and hydration care in the adult patient with short bowel syndrome

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Funding information
Financial support for the publication of the Nutrition in Clinical Practice supplement in which this article appears was provided by VectivBio AG.

Abstract

Attending diligently to the nutrition and hydration needs of patients with short bowel syndrome (SBS) is a key tenet of their care, both postoperatively and in the years that follow. For, without each, patients are left to themselves to navigate the nutrition consequences of SBS, including malnutrition, nutrient deficiencies, renal compromise, osteoporosis, fatigue, depression, and impaired quality of life. The intent of this review is to discuss the initial nutrition assessment, oral diet, hydration, and home nutrition support for the patient with SBS.

KEYWORDS

diet, fluids, home nutrition support, intravenous infusions, parenteral nutrition, short bowel syndrome

INTRODUCTION

The nutrition management of short bowel syndrome (SBS) is an integral component of the process of intestinal rehabilitation, which includes the early introduction and manipulation of enteral and/or oral nutrients to counteract nutrition deficiencies imposed by malabsorption, all with the goal of slowing the transit of nutrients and promoting intestinal adaptation. Intestinal adaptation is characterized by the ability of the remaining small bowel to compensate and maximize its absorptive potential for enteral or oral nutrient and fluid absorption.[1] The process of intestinal adaptation may transpire over a span of 2 years or longer, during which time structural and functional changes occur to the existing small bowel and, to a lesser degree, the colon, when present.[1] The presence of polymeric (intact) enteral or oral nutrients in the small bowel is proposed to stimulate crypt cell hyperplasia, enteric hormonal production, growth of the villi, and intestinal secretions to promote intestinal autonomy.[2,3] The length and function of the remaining small bowel, as well as the presence of residual colon and ileocecal valve in continuity, aids in the determination of potential for enteral autonomy. Presented here are the essential aspects of the initial assessment, application of oral diet, optimization of hydration, and utilization of home nutrition support (NS) in SBS.

NUTRITION ASSESSMENT

Delivering the appropriate nutrition therapies in SBS requires an extensive nutrition assessment surpassing typical measurement (eg, anthropometrics, biochemical assays, dietary intake, and social/environmental considerations) (see Table 1 for assessment parameters in SBS). Although recommendations are available for macronutrient dosing,[8,9] the chronic maldigestion and malabsorption present in the patient with SBS requires the clinician to focus on weight, functional status, and muscle strength as markers of nutrition status. The interpretation of body weight changes requires an in-depth assessment of gastrointestinal (GI) function and hydration status.

Whether in the hospital setting or the ambulatory clinic, nutrition assessment in the patient with SBS begins with an accurate determination of the remnant intestinal anatomy, as this aids in determining the optimal medical nutrition therapy and identifying useful pharmacotherapy.[10] In addition, an awareness of the residual bowel anatomy allows the clinician to estimate the risk for parenteral nutrition (PN) dependence. For example, although minimum residual small bowel lengths vary in the literature, those with <30 cm of small bowel anastomosed to the entire colon including the ileocecal valve intact, <60 cm of jejunum anastomosed to partial colon (typically without the ileocecal valve), and <115 cm of small bowel without any colon in continuity are at highest risk for long-term PN dependence.[11,12]

Evaluation of remaining bowel length

A review of operative reports, where available, is the best method to identify postsurgical anatomy, including the remaining bowel length. An intraoperative measurement of bowel length, starting at the ligament of Treitz, is the preferred method for determining residual bowel length. Given the great variation in small bowel length (300–800 cm) among individuals, the documentation of the remaining small bowel length is far more important than the amount resected in predicting clinical outcomes. When this information is unknown, barium contrast imaging studies to determine small bowel length and transit time can be used to estimate small bowel function and length (see Table 1).

Dietary intake assessment

In the patient with SBS, it is not uncommon for oral consumption to reach 150% of the usual intake because of the adaptive hyperphagia that ensues.[9] In some, this quantity of food may significantly worsen diarrhea. A 2-to-3-day diet record, including what and how much, to identify the usual diet habits is useful to help target the dietary education process. This allows the diet to be tailored to the individual as opposed to simply providing a standard short bowel diet without an explanation of how to incorporate those foods where possible. Furthermore, it will inform the clinician if the energy consumption ought to be adequate to sustain the individual. In the ambulatory setting, periodic 2-to-3-day diet records will allow the clinician to evaluate adherence to medical nutrition therapies and further tailor nutrition care plans.

Stool assessment

All patients with SBS should undergo a 24-h stool volume assessment. Stool characteristics associated with improvement in absorption include thicker stool, lower stool volumes, and less detection of undigested food. As stool characteristics improve and stool volume decreases, urinary output should also increase, further supporting that absorption is improving. Although the typical ileostomy output ranges from 600 to 800 ml/day, output occurring in patients with SBS and an end jejunostomy may be twice that volume or more (see Table 1). The true measure of bowel autonomy is when stool output is optimized to allow the individual to achieve their goal body weight and hydration is adequate to promote kidney perfusion and sufficient urinary output.

Nutrition-focused physical exam (NFPE)

The NFPE is a head-to-toe examination that is used to diagnose malnutrition, dehydration, and micronutrient abnormalities.[13] Abnormal physical findings should be correlated to specific biochemical assessments to confirm a diagnosis. Abnormal findings of fat (eg, orbital, triceps, and fat overlying the rib) and muscle loss (eg, temporalis, clavicles, deltoids, quadriceps, and gastrocnemius) are associated with the presence of malnutrition and a decline in functional status.[14] In dehydration, poor skin turgor, dry conjunctiva, a multifurrowed tongue, and slow capillary refill may be present.

Micronutrient assessment

An appropriate interpretation of an individual's micronutrient status requires an understanding of the inflammatory environment and laboratory findings to correlate

TABLE 1 Assessment parameters in SBS.[4–7]

Parameter	Select uses in SBS	Possible interpretations
Biochemical assessment		
Electrolytes, serum	• Sodium, potassium, magnesium, and phosphorus status	• In euvolemia, elevations reflective of excessive IV delivery • Low serum levels: o Potassium or phosphorus: refeeding syndrome o Magnesium: excessive losses or refeeding syndrome o Bicarbonate: excessive stool losses o Sodium with jejunostomy or ileostomy: excessive stool losses or hypervolemia
Serum urea nitrogen	• Indicator of kidney function	• Elevated: late dehydration, GI bleed, or, rarely, too much protein
Creatinine	• Indicator of kidney function	• Elevated: reflective of CKD or possible late dehydration • Low: reflective of low muscle mass
Lactic acid	• Deciphering L-lactate and D-lactate	• Presence of D-lactic acidosis
Body composition		
Body weight	• Indicator of nutrition and hydration status	• Fluctuations of ≥2 pounds within 24 h is indicative of fluid shifts (hypervolemia and hypovolemia)
Bone density	• Indicator of osteoporosis and osteopenia • Can be used to determine changes in lean body mass and fat mass	• A decline in bone mineral density correlates with poor nutrition status; optimization of diet, EN, or PN should be considered • Referral to endocrinology for management of bone health
Urinary assessment		
24-h collection	• Indicator of kidney function and hydration status	• Goals: >1-L urinary output/day; urine sodium >20 mmol/L • Urinary sodium <20 mmol/L may indicate the need for optimization of sodium intake
Spot urine collection	• Quick and easy assessment of fluid and electrolyte status. Less accurate compared with 24-h urinary collections	
Electrolytes	• May be more sensitive markers of salt depletion	• Sodium/potassium ratio <1 may represent hyperaldosteronism • In euvolemia, low urinary electrolytes may indicate increased need • Elevated urinary electrolytes may indicate excessive intake or diuretic-induced excretion
Stool collection		
Color	• Comparison with normal	• Yellow/orange: steatorrhea • Green: choleric diarrhea or bile salt wasting • White/gray: possible hepatobiliary abnormality • Brown: optimal
Consistency	• Comparison with normal	• Bristol stool type 1–2: constipation • Bristol stool type 3–5: goal • Bristol stool type 6–7: diarrhea, maldigestion, and malabsorption
Volume	• Comparison with normal	• Ileostomy output: 600–800 ml/day • Ileostomy output while not receiving oral feeding: >800 ml/day is possible secretory or osmotic diarrhea or gastroenteritis • Ileostomy output: <600 ml/day possible small bowel obstruction, poor oral intake, and nothing by mouth status

(Continues)

TABLE 1 (Continued)

Parameter	Select uses in SBS	Possible interpretations
Bowel length and function		
Surgical reports	• Measured length of remaining small bowel • Health of mucosa	• <200 cm functional small bowel "defines" adult SBS • Increased HPN dependence with <30 cm small bowel and entire colon; <60 cm of jejunum and partial colon; <115 cm small bowel and no colon
Pathology reports	• Resected sections and length of the intestine	
Endoscopy	• Ileoscopy • Colonoscopy	• <200 cm functional small bowel "defines" adult SBS • Both tests visualize health of remaining bowel
Transit studies	• GES • SmartPill • Small bowel follow through • Colonic scintigraphy	• Normal GES: nearly 4 h to empty completely • Normal small bowel transit ranges from 2.5 to 8 h • Normal colonic transit ranges from 30 to 40 h

Abbreviations: CKD, chronic kidney disease; EN, enteral nutrition; GES, gastric emptying scintigraphy; GI, gastrointestinal; HPN, home parenteral nutrition; IV, intravenous; PN, parenteral nutrition; SBS, short bowel syndrome.

with the NFPE. Because inflammation can influence positive and negative acute phase reactants and complicate the identification of true deficiencies, their measurement is best done in an ambulatory setting. Monitoring serum trends of specific micronutrients together with an inflammatory marker such as C-reactive protein may help to determine the best response to the repletion strategy.[15] For example, worsening visual acuity at night or the presence of a bitot spot in the cornea of the eye that is correlated with a low serum retinol level and a normal C-reactive protein level should prompt the immediate treatment of a vitamin A deficiency.[15] Importantly, micronutrient deficiencies do not tend to occur in isolation and, therefore, the presence of one confirmed deficiency should trigger the testing of additional micronutrients.[8]

In the patient with SBS, the micronutrients of greatest concern are the fat-soluble vitamins (A, D, E, and K), vitamin B_{12}, zinc, copper, selenium, and iron.[16,17] Water-soluble vitamin deficiencies are primarily of concern in cases of near total enterectomy, if the remaining small bowel is diseased, or when patients are nonadherent to prescribed oral and parenteral micronutrient regimens. Lifelong monitoring of micronutrient levels is a necessity for all patients with SBS (see Table 2 for the recommended indices and frequency of monitoring). It is important to note that most published strategies for the repletion of micronutrient deficiencies are based on clinical experience or consensus opinion and are not evidence based. Therefore, although these papers can provide guidance on diagnosis, monitoring, and repletion, they should not replace clinical judgement.[8] As always, collaboration with an interdisciplinary team when establishing micronutrient treatment strategies is warranted.

ORAL DIET

After surgery, as soon as medically feasible, the initiation of an oral diet should commence. The composition of the diet recommended is dependent on the segments of small bowel remaining and whether the colon is in continuity.[20] The therapeutic manipulation of specific oral nutrients, especially carbohydrate (CHO) and fat, is carried out to reduce output while allowing nutrients to interact further with the small bowel to enhance digestion and absorption (see Table 3 for specific recommendations). All food groups should be included in the diet for short bowel.

Liberalization of the diet can occur over time with the progression of intestinal adaptation. To achieve intestinal adaptation, and to counteract the malabsorption that arises postoperatively, adaptive hyperphagia (consuming 150% of baseline nutrition needs) may be necessary.[26] Jeppesen appropriately notes, however, that "in patients who have fully stretched their ability to compensate for malabsorption, and who already have a low percentage of absorption, the effort may be in vain,"[21] resulting in a significant worsening of malabsorption. Consuming six small frequent meals throughout the day has been shown to reduce vomiting, fullness, and bloating in patients with various GI disorders and in healthy individuals to increase caloric intake.[27] Portion size, along with the frequency and timing of meals, needs to be individualized. The primary focus for nutrition education and counseling for diet in SBS is to help identify the best food options for the specific anatomy while factoring in symptoms, preferences, access, culture, lifestyle, and quality of life (QoL).

TABLE 2 Monitoring parameters for patients with short bowel syndrome receiving home nutrition support.[18,19]

Parameter	Baseline (after recovery from surgery)	Unstable PS solution	Stable PS solution or EN regimen
Outpatient clinic visit		2–4 weeks	3–6 months
Weight	X	1–2 times weekly	Weekly
Temperature	X	Daily	Daily
Serum metabolic and chemistry tests: sodium, potassium, chloride, bicarbonate, urea, creatinine, glucose, calcium, phosphate, and magnesium	X	1–2 weeks	1–3 months
Hepatic indices: total protein, serum albumin, total bilirubin, alkaline phosphatase, AST, ALT, and serum prealbumin	X	Monthly	1–3 months
Complete blood count	X	Monthly	1–3 months
Fatty acid profile	X		6–12 months
Vitamins: A, 25(OH)D, E, B_{12}, folate, and INR	X	***IF*** deficiency exists ***and*** high-dose supplementation required, monthly. Otherwise, every 3–12 months	6–12 months
Trace minerals: copper, zinc, selenium, and manganese	X	***IF*** deficiency exists ***and*** high-dose supplementation required, monthly. Otherwise, every 3–12 months	6–12 months
Iron studies: iron, total iron-binding capacity, iron saturation, and ferritin	X	***IF*** deficiency exists ***and*** high-dose supplementation required, monthly. Otherwise, every 3–12 months	3–12 months
DEXA	X	—	1–2 years

Abbreviations: 25(OH)D, 25-hydroxyvitamin D; ALT, alanine transaminase; AST, aspartate aminotransferase; DEXA, dual-energy x-ray absorptiometry; EN, enteral nutrition; INR, international normalized ratio; PS, parenteral support.

Protein

Protein needs vary depending on the presence of malnutrition, postoperative state, and nutrient losses. As the absorption of protein is least affected in SBS, the use of elemental protein (peptides and amino acids) is not indicated, and whole foods should be used to meet the protein needs of the patient.[20] The consumption of protein of high biological value, including some plant protein, is desired to maximize the intake of all essential amino acids to achieve nitrogen balance.

Complex CHO

Dietary fiber is a complex CHO indigestible by humans and found in plant-based foods (fruits, vegetables, grains, and legumes). Other forms of complex CHO include starches (eg, breads, pasta, and rice) and other vegetables (eg, potato and yam). Although humans cannot digest fiber, fiber undergoes digestion by intestinal bacteria through the process of fermentation. Fiber influences stool output consistency and frequency based on the characteristic of the fiber (solubility, fermentability, and viscosity).[28] Solubility refers to the ability of the fiber to dissolve in water (soluble vs insoluble), in which high-soluble fiber may aid in thickening output. Fermentability refers to the ability of intestinal bacteria to ferment, or digest, fiber (low fermentable vs high fermentable), in which low fermentable fiber may produce less gas. Viscosity refers to the ability of the fiber to resist flow in the GI tract (low viscous vs high viscous), in which high-viscous fiber may aid in slowing transit. Consumption of small particle sized fiber may also aid in tolerance, which involves texture modification of fiber (eg, blended, chopped, mashed, minced, and peeled).

In patients with colon in continuity, the intake of CHO in the form of fiber and starches stimulates bacterial fermentation to produce short-chain fatty acids, which are used as a source of energy not only to colonocytes but also to the individual. When compared

TABLE 3 Key nutrient comparisons for short bowel syndrome diets with or without a colon.[2,10,20–25]

Nutrients	Colon in continuity	No colon
Protein	• No restriction • Choose protein of high biological value as much as possible	• No restriction • Choose protein of high biological value as much as possible
CHO/fiber	• Eat CHO and fiber at each meal • Apply small particle size when appropriate (blended, chopped, mashed, minced, and peeled) • Consider the type of fiber to include in the diet to help with symptom reduction	• Consume CHO and fiber as tolerated • Apply small particle size when appropriate (blended, chopped, mashed, minced, and peeled) • Consider the type of fiber to include more in the diet help with symptom reduction
Lactose	• Include lactose-containing dairy unless with symptoms, then apply a low-lactose diet to 20 g a day (eg, lactose-free dairy and hard cheeses) • Treat low-lactose dairy as a slice, sprinkle, or as a garnish • OK to have dairy daily	• Include lactose-containing dairy unless with symptoms, then apply a low-lactose diet to 20 g a day (eg, lactose-free dairy and hard cheeses) • Treat low-lactose dairy as a slice, sprinkle, or as a garnish • OK to have dairy daily
Sugars	• Decrease intake of concentrated sweets (eg, cakes, cookies, pies, fruit juices, and sodas) • Limit portions to "a taste," or shared with others, and not consumed daily	• Decrease intake of concentrated sweets (eg, cakes, cookies, pies, fruit juices, and sodas) • Limit portions to "a taste," or shared with others, and not consumed daily • Avoid sweetened oral liquid nutrition supplements
Fat	• Reduce fat intake in the diet • Limit fried and creamy foods to small portions and not consumed daily • Use low-fat cooking methods (baking, grilling, and steaming) • If MCT oil is used, aim for 1–3 tbsp/day, spread out between all the meals	• Eat fat liberally in the diet • If MCT oil is used, aim for 1–3 tbsp/day, spread out between all the meals
Sodium	• No restriction	• No restriction
Oxalates	• Limit oxalates if present with a stone and urinary output <2000 ml/day • Follow a low-fat diet • Ensure adequate fluid intake to support hydration	• No restriction unless impaired kidney function
Recommendations	• All food groups (protein, dairy, grains, fruits, and vegetables) can be included in the diet • Food choices made will address symptom management while factoring in preferences, access, culture, lifestyle, and QoL • Implement 4–6 small meals throughout the day to satisfy hunger; avoid excess fullness	

Abbreviations: CHO, carbohydrate; MCT, medium-chain triglyceride; QoL, quality of life.

with a low-CHO/high-fat diet (20%/60%), stool output was reduced in those patients with SBS and a colon on a high-CHO/low-fat diet (60%/20%).[9] With the high-CHO/low-fat diet, some patients with SBS and a jejunostomy experienced an increase in output, whereas other patients did not. Fat can be consumed as tolerated in those with an ostomy.

Simple sugars

Sucrose found in table sugar is the most common contributor to concentrated sweets in the diet. Fructose is found in fruits and especially in fruit juices, sodas, honey, molasses, and agave nectar. High concentrations of sweets are osmotically active and pull water into the GI tract, thus leading to an increase in output in all bowel anatomies of SBS. Although it appears to be a widespread practice for many clinicians to recommend sweetened oral liquid nutrition drinks when a patient is struggling with an inability to gain weight, in the patient with SBS, this only acts to raise stool volume more and should be avoided. Restricting sweets as much as possible or limiting them to very small portions will aid in reducing output.

Lactose malabsorption is often presumed after significant bowel resection because of reduced lactase enzyme production. However, consumption of 20 grams

of lactose daily was demonstrated to be well tolerated in adult patients with SBS. Furthermore, there was no significant difference in stool weights before and after lactose ingestion.[22,29] As dairy products are a good source of protein and calcium, incorporation into the diet can be valuable if tolerated. In those who experience symptoms potentially associated with dairy, high-lactose dairy (eg, cow's milk) may need to be consumed in small portions, and a low-lactose diet could be trialed in the short term. Notably, a low-lactose diet is not a dairy-free diet and includes dairy products that have low amounts of lactose (eg, hard cheeses).[30]

Fat

Bile salts aid in the emulsification of fat, which is then recycled via the distal ileum to the liver through enterohepatic circulation. With an ileal resection of <100 cm and colon in continuity, bile salts pass into the colon causing cholerrheic diarrhea; resections of >100 cm of the ileum result in bile salt depletion from the disruption of the enterohepatic circulation causing steatorrhea. A fat-restricted diet is generally recommended in the patient with SBS and colon in continuity. In contrast, in patients with an end jejunostomy, a high intake of fat, regardless of the type, does not seem to influence stool output, although the increased malabsorption of divalent cations (calcium, magnesium, iron, copper, and zinc) has been noted.[31] Therefore, patients with SBS should be encouraged to ingest fat (eg, egg, fish, avocado, nut butters, and oils) in amounts appropriate for their anatomical type, with particular attention to those containing essential fatty acids (eg, sunflower, walnut, and soybean oils) to prevent deficiency.

The use of medium-chain triglycerides (MCTs) as a caloric addition is often recommended in SBS, as MCTs do not need bile salt emulsification prior to absorption unless ingested in large quantities. MCTs appear to promote a reduction of fecal fat output and weight gain.[23,32] If used in the patient with SBS, excess portions beyond 1–3 tablespoons may result in diarrhea.[24] MCT oil is not to be used as the primary source of fat in the diet, as MCT oil lacks essential fatty acids, has fewer calories per gram, adds another expense to the patient, and has poor palatability.

Sodium

There is a substantial risk of sodium depletion in patients with SBS and an end jejunostomy (~1 teaspoon of salt lost/liter of stool).[33] These patients need to be encouraged to consume high-salt foods/fluids. Clinicians should investigate if their patient has a prior history of sodium restriction (eg, a history of hypertension), as these habits are sometimes hard to change. There is a risk of dehydration and the development of kidney injury when sodium losses become chronic. The addition of salt to meals is encouraged to aid in the continued repletion of sodium.

Oxalates

Oxalates from the diet are not absorbed in the small bowel; rather, oxalate forms a complex with calcium in the GI tract and is excreted in the stool. In the setting of fat malabsorption and a colon in continuity, free fatty acids alternatively bind to calcium leaving oxalates unbound. Unbound oxalates enter the colon, are absorbed across the mucosa, and eventually reach the kidney, increasing the risk of nephrolithiasis. Contributing to this risk of nephrolithiasis are suboptimal urine production, low concentrations of urinary sodium, and dehydration.[34,35]

HYDRATION: ALL TOO OFTEN TAKES A BACK SEAT TO NUTRITION

Although nutrition, hydration, and electrolytes are fundamental considerations in the patient with SBS, nutrition status is the focus of many clinicians, sometimes at the risk of marginal hydration status. Although all clinicians seek to reduce or eliminate PN when possible, it is imperative that, in doing so, the ability to maintain both nutrition and hydration status are considered.

CONSEQUENCES OF CHRONIC DEHYDRATION

Chronic dehydration can lead to fatigue, nephrolithiasis, acute kidney injury, chronic kidney disease, and in the worst-case scenario, renal failure requiring dialysis. If a patient with SBS is expected to nourish and hydrate solely through oral consumption, then it is incumbent upon the managing clinician to determine that the patient can achieve those goals by measurable outcomes, such as weight stability and consistent, adequate urinary output. Patients who are marginally hydrated may require additional interventions, such as further gut slowing, oral rehydration solutions (ORSs), or even periodic or daily PN or intravenous (IV) fluids,

TABLE 4 Common encounters to evaluate with marginally hydrated patients.

Encounter	Result
Patient was instructed to "just drink more"	Leading to increased stool or ostomy losses worsening dehydration
Patient discovers that stool output is less when drinking less!	Unfortunately, the urinary output drops also, further worsening kidney injury
Patient decides to drink A LOT "since they have so much diarrhea"	Again, driving stool or ostomy losses further
Patient just cannot/does not drink enough, period.	—
Patient develops insatiable thirst	Patient is often already severely dehydrated, and drinking will only make things worse

particularly during the hot summer months. It is critical to educate patients to identify the signs and symptoms of dehydration and instruct them on how to protect their kidneys. Lifelong monitoring of hydration status should also be a high priority for clinicians taking care of patients with SBS. See Table 4 for common patient encounters in the clinic to consider when evaluating the marginally hydrated patient.

Assessing hydration status

Achieving euhydration, the normal state of body water content (or the absence of hyperhydration or dehydration), is the goal in SBS. Signs and symptoms of dehydration are hypotension, tachycardia, fever, tachypnea, fatigue, and abrupt weight loss; however, significant differences exist in defining dehydration. Liu et al[36] has suggested that the most robust definition should include a combination of laboratory tests, clinical history, and examination findings. See Table 5 for common parameters used to assess for dehydration.

Physiological homeostatic mechanisms normally preserve serum chemistries. However, these mechanisms are altered in SBS. For example, serum urea nitrogen and creatinine levels, common indices used by clinicians to signal impending dehydration, may not rise until severe dehydration is present.[33] Further confounding the identification of dehydration is the common finding of low muscle mass in patients with SBS. As serum creatinine corresponds to muscle mass, it can lead to an overestimation of true kidney function.

TABLE 5 Assessing hydration status.[25,36–38]

Parameter	Findings
Laboratory tests	• Serum urea nitrogen/creatinine ratio (late marker) • Raising creatinine (impending acute kidney injury) • Spot, or 24-h urinary sodium (urinary sodium <20 mEq/L indicates sodium deficiency)
Clinical history	• Low urinary output (<1200 ml/24 h) • High stool output (>1500 ml/24 h) • Dark urine • Assess for dehydration admits or ER visits for IV fluids • Kidney stones • Decreasing kidney function with increasing creatinine
Examination findings	• Thirst and dry mouth • Rapid weight loss (>0.5–1.0 kg/day) • Chronic fatigue • Hypotension • Dizziness on standing • Muscle cramps • Headaches • Tachycardia • Fever • Tachypnea

Abbreviations: ER, emergency room; IV, intravenous.

Hyperaldosteronism

The renin-angiotensin-aldosterone system is affected in patients with SBS, particularly those marginally hydrated or dehydrated. Electrolyte homeostasis is partially regulated through the actions of aldosterone on the kidneys and distal colon.[39] The physiologic response to aldosterone release is to promote sodium absorption and net potassium secretion in both the kidney and the colon. As water follows sodium by osmotic forces, extracellular fluid volume and blood pressure improve. As chronic stool losses are associated with low plasma volume and sodium depletion in SBS, reduced sodium output in the urine results in an activation of the renin-angiotensin-aldosterone system. Because the effects of aldosterone are greater in the colon than in the

kidney, this is particularly a problem in the patient with SBS and an end jejunostomy in which the sodium concentration in the ostomy fluid can be as high as ~120 mEq/L. Provided the patient is not on diuretics, sodium depletion with secondary hyperaldosteronism can be assessed by measuring a spot urine sodium. A urinary sodium <20 mEq/L suggests the aldosterone level is elevated.[40–43] A urinary sodium-to-potassium ratio <1 also suggests compensatory hyperaldosteronism in the setting of salt depletion and dehydration.[37,44] A 24-h urine volume collection with a sex-specific urinal is a tool that should be provided for periodic measurements of urinary output. A goal of ≥1000–1200 ml/day of urine output is often recommended for those with SBS to prevent the many consequences of dehydration. In known kidney stone formers, the goal should be ≥2000 ml.

HYDRATION OPTIONS

Oral fluids

Hydrating the patient with SBS starts with an understanding of their GI anatomy. Those with a colon in continuity will be easier to hydrate, as the colon avidly absorbs sodium and water. In contrast, those with an end jejunostomy will have a higher stool volume and more sodium lost per liter of stool (~1 teaspoon [2300 mg/100 mEq]/L) because of the increased "leakiness" of the jejunal epithelium.[33] Regardless of the bowel anatomy, *hypertonic* fluids are the most problematic for the patient with SBS, as the osmotic gradient pulls *water* into the bowel lumen causing net water secretion to *dilute* the hypertonic fluid to isotonicity. *Hypotonic* fluids pull sodium (and water) into the bowel to adjust luminal contents to achieve isotonicity. Hence, both hypertonic and hypotonic fluids cause a net fluid loss, aggravating dehydration. Patients with end jejunostomies who are both sodium and water depleted can often find themselves with an insatiable thirst, driving them to drink more fluid (often hypotonic fluids inadequate in sodium, such as water), resulting in further fluid and sodium stool loss, worsening dehydration. Therefore, both hypertonic and hypotonic fluids can exacerbate stool losses (see Table 6 for a list of hypertonic and hypotonic fluids).[25,38] Some patients will require an oral fluid restriction with the addition of IV fluids to decrease the sheer volume of stool lost and to stabilize the patient until some degree of adaptation occurs.

Oral rehydration solutions (ORSs)

ORSs are recommended to improve hydration in patients with SBS, particularly in those with an end jejunostomy.[25,38,45] ORSs utilize the Na+-coupled glucose transport system residing primarily in the jejunum.[46] The increased osmotic forces created by the system pull water from the small bowel lumen into the intercellular spaces in the jejunum followed by absorption into the bloodstream. The coupled transport is unidirectional, so once absorbed, it stays in the

TABLE 6 Hypertonic and hypotonic fluids.

Type of Fluid	Examples
Hypertonic fluids	• Fruit juice/fruit drinks, sodas, sweet teas or coffee drinks, syrups, ice cream, or sherbet • Sugar-free gelatin and other liquids sweetened with sugar alcohols (erythritol, isomalt, lactitol, maltitol, mannitol, sorbitol, xylitol, and HSHs) • Carnation instant breakfast, Ovaltine, or hot cocoas • Sweetened commercial liquid supplements o Ensure, Boost, store-brand equivalents, etc
Hypotonic fluids	• Water (plain, unsweetened flavored) • Diluted fruit drinks • Unsweetened tea • Coffee • Alcohol • Diet drinks • Crystal Light, etc

Note: Adapted and used with permission from Parrish CR, Wall E. The clinician's toolkit for the adult short bowel patient part I: nutrition and hydration therapy. *Pract Gastroenterol*. 2022;46(6):32-53.

Abbreviation: HSH, hydrogenated starch hydrolysate.

TABLE 7 Commercial and homemade ORSs.

Type of ORS	Examples
Commercial ORSs	• CeraLyte • DripDrop • EquaLyte • Hydralyte ORS • Liquid IV hydration multiplier • Parent's Choice pediatric electrolyte • Pedialyte • Rehydralyte • Trioral (reduced osmolarity ORS) • WHO packet (Jianas Brothers)
Homemade ORSs	
"Regular" Gatorade	• 1 ½ cups Gatorade • 2 ½ cups water • ½ teaspoon salt
Gatorade powder	• 32 ounces of water • 2 tablespoons of Gatorade powder • ½ teaspoon of salt • ¼ teaspoon of Splenda or to taste
Powerade	• 1 ½ cups Powerade • 2 ½ cups water • ½ to ¾ teaspoon salt
Water/flavored water (sugar free and calorie free)	• 32 ounces (1 quart) water • ½ teaspoon table salt • 2 tablespoons sugar • Optional: Crystal Light or Splenda to taste
Chicken, beef, or vegetable broth	• 2 cups liquid chicken broth (*not low sodium!*) • 2 cups ounces water • 2 tablespoons sugar
Water	• 32 ounces (1 quart) water • ½ to ¾ teaspoon table salt • 2 tablespoons sugar • Optional: Crystal Light to taste

Note: Adapted and used with permission from Parrish CR, Wall E. The clinician's toolkit for the adult short bowel patient part I: nutrition and hydration therapy. *Pract Gastroenterol.* 2022;46(6):32-53.

Many clear beverages can be made into an ORS-like drink if water content, carbohydrate, sodium concentration, and osmolality meet ORS criteria per liter (20–25 g glucose/sugar; 45–80mEq sodium; and osmolarity near 300); the cost will vary based on what other additives are included (like extra vitamins, water type, etc).

For more ORS and fluid options, please see: Parrish CR. *The Adult Patient's Guide to Managing a Short Bowel.* 5th ed. Takeda Pharmaceuticals; 2021. Available free at https://www.shortbowelsyndrome.com/sign-up

Abbreviation: ORS, oral rehydration solution.

bloodstream. ORSs are not a panacea, nor are they usually clamored for by patients because of their taste. Clinicians must be prepared to compromise with patients to find an ORS, or ORS-like beverage that the patient will accept, and drink, day after day. See Table 7 for sample ORSs and ORS-like options.

Enteral fluids

Although not widely used in adults, some patients with a gastrostomy tube may benefit from enteral infusion of ORSs via a pump, either overnight or during the day, to avoid or eliminate a central line.[47] The slower the infusion delivery, the more time for absorption of the ORS throughout the shortened GI tract. Occasionally, a gastrostomy tube may be placed for this purpose, but this should be considered carefully because of the potential challenges of placement in the patient with SBS.

IV fluids

Predicting which patients with SBS will need IV fluids can be challenging. A key determining factor is whether the patient can maintain an adequate urinary output consistently over 24 h (ideally ~1200 ml; 2000 ml if the patient is a known stone former). Below this volume, optimal kidney function may be at risk over time. Some patients will also require individual electrolytes added to IV fluids, magnesium being one of the more common. Obtaining IV fluids at home can be challenging, as some payors will not cover IV fluids even though it may be the only thing that keeps the patient safe, out of the hospital, and off hemodialysis. Options for securing IV fluids in the outpatient setting include:

- Home infusion companies pending insurance approval
- Outpatient infusion centers
- Skilled nursing facilities
- Paying out of pocket

EDUCATING THE PATIENT ON HYDRATION STRATEGIES

It is essential to provide education to patients with SBS describing the connection between hydration and kidney function so they understand the importance of this aspect of their care. In our experience, patients generally accept the importance of staying hydrated when they understand that higher stool volumes may lead to less fluid absorbed, which means less fluid for the kidneys to make urine.

It is often recommended that patients with SBS drink less fluid with meals and, instead, sip more between meals. The consumption of oral fluids in small doses throughout the day, particularly between meals, may improve absorption,[48] as smaller volumes prevent bowel distension, reflex peristalsis, and increase the rate of transit.[49] Some patients may require a personal demonstration by showing them how oral fluids generate their stool output. This can be achieved by *significantly* decreasing oral fluid intake for 24 h by giving the patient a specific fluid goal (eg, 120 ml of appropriate fluids four times daily) to be used over the course of the day as both fluid with meals *AND* with medications. This may require IV fluid support in some patients to prevent dehydration. Patient-specific goals for daily fluid consumption must be determined and translated into a measurement that the patient is able to adhere to (eg, ounces, milliliters, or cups). There is usually a "sweet spot" in each patient in which too little oral fluid will not hydrate and too much leads to a stool volume that makes it untenable to achieve euhydration.

MONITORING HYDRATION

All patients with SBS should have baseline 24-h urinary and stool output measurements ("short bowel vital signs") to not only ensure hydration but also to help inform the clinician about where interventions are needed. Until urinary output is adequate and stable, 24-h urine volume should continue to be periodically monitored. This will give the clinician and patient objective information as to whether the interventions are, or are not, making a difference. For those patients with very high stool output (>2000 ml over 24 h), a 24-h period of strict nonoral feeding will help differentiate the "net secretors" whose stool output exceeds their fluid input from those whose output is driven primarily by osmotic agents, food, and fluids where the stool output decreases significantly. In the hospitalized patient, this can be done by taking advantage of a period of nonoral feeding at midnight for a procedure the following day when the patient would not be allowed oral feeding anyway, and just extend it to the full 24 h to complete the nonoral feeding period.

When the patient is still in the hospital, whatever the hydration plan, it is important to demonstrate that the hydration plan works prior to their discharge from the hospital by having the patient achieve adequate 24-h urinary output for ≥48 h after the IV fluids, other than any IV fluids planned for home, have been stopped. Importantly, stopping the IV fluids and sending the patient home too soon (eg, within 24 h of stopping the IV fluids) because the urinary output appears adequate overlooks the fact that a patient's urinary output will only reflect the effects of IV fluids for about 24 h or so after stopping them.

HOME Nutrition Support (NS)

NS in the form of parenteral support (PS) (referring to both PN and IV fluids) and sometimes enteral nutrition (EN) and enteral hydration, is required by patients after massive bowel resection.[18] The goal of NS for patients with SBS is to augment oral intake to maintain adequate hydration, weight, and nutrient requirements for health, function, and survival. During the early postoperative phase of SBS, patients will receive PS of fluid and electrolytes, with or without nutrients. Most patients with SBS will continue to require NS after they are discharged home.[50] Safe and effective preparation for home NS starts early after bowel resection and requires the following:

- A stable prescription
- Determination of patient appropriateness for home NS
- Placement of venous (and potentially enteral) access
- Insurance approval (in the United States)
- Identification of a home health agency
- Patient/caregiver education

After hospital discharge, a multidisciplinary NS team (NST) should manage the NS regimen, including the assessment of the access device, laboratory, and metabolic responses to therapy; monitoring of intestinal adaptation and the potential for weaning infusion therapies; and attending to the patient's psychosocial needs.[18,51,52] In some cases, NSTs are a combination of clinicians from multiple facilities, including medical centers and home care agencies.

DISCHARGE PREPARATION

Patient selection

Patient appropriateness for home NS depends on key criteria including a clinical indication (SBS or malabsorption); the physical ability to perform all aspects of infusion therapy (or a caregiver who is able to assist); reliable utility services (electricity service and running water); geographical proximity to medical providers, home care agencies, and a laboratory testing facility; and an understanding of the goals for NS.[18,51,53] Patients without an appropriate home environment may require placement in a long-term nursing facility.

Access devices

Central venous access is essential for home PS; peripheral IV access is unstable and unsuitable for long-term PS. Tunneled central venous catheters are recommended for home, although in cases when PS is anticipated for <3 months a peripherally inserted central catheter may be a less invasive option for access.[52] It is advisable to place central venous catheters with the least number of lumens while allowing for a dedicated PS lumen.[18,54]

Home EN can be administered via nasoenteric or percutaneous tubes depending upon the length of anticipated need. Often a nasogastric tube is used temporarily to establish tolerance to, and the utility of, EN prior to discharge home. If a trial of EN improves hydration and nutrient absorption, and the need is anticipated to be >1 month, then it is recommended to place a percutaneous tube for stable, long-term enteral access.[55]

Patient/caregiver education

Training for home NS should commence once a patient is deemed to be an appropriate candidate and will continue in the home setting after discharge. Educators will assess the patient's literacy level, physical ability to perform the required tasks, and their emotional acceptance of the need for home NS. Most home NS patients require a care partner to participate in training sessions and to be available daily to assist once the patient is home. See Table 8 for the required elements of home NS training.

PN prescription

The initiation, advancement, and cycling of PN in preparation for home infusion should be accomplished *prior* to hospital discharge. Clinicians must identify the sites, length, and health of the remaining small bowel to anticipate the absorptive capacity and potential fluid/electrolyte losses. Meticulous measurement and documentation of intake (IV and oral) and output (urine, drains, and stool/ostomy) volumes is essential to understanding a patient's actual daily fluid and electrolyte requirements. Together with these measurements, the assessed energy, protein, micronutrient, and fluid needs are used to develop a PN formula. Once stable, the hospital PN formula translates into a home formula.

TABLE 8 Required topics for home nutrition support training.

- Discussion of goals for home nutrition support
- Roles of nutrition support team members: clinical team and home health providers
- Home environment requirements
- How to use the infusion pump
- Potential complications: signs, symptoms, and prevention
- Nutrition support preparation and infusion processes
- Self care of access device
- Monitoring: temperature, urinary output, and weight
- Contact information for home health and clinical team
- Medical follow-up: expectations and scheduled appointments

HOME PN

The typical home infusion regimen allows for 10–14 h of PN independence daily.[53] However, the final infusion rate will be based on individual response to rapid fluid and nutrient input, specifically glycemic control, cardiopulmonary tolerance (shortness of breath or swelling during the infusion), and if the patient remains hydrated when not receiving PN. Parenteral infusions typically occur at night, but sleep quality may suffer or caregiver schedules may be such that daytime infusions result in the best QoL. Some patients with high-volume fluid losses may require PS volumes that exceed the capacity of home PN bags (4 L), or the patient's ability to lift it. In this situation, additional IV fluids (provided in 1-L bags as needed), solely for the purpose of hydration, are usually infused during the time PN is off.[53]

The use of long-term home PN is associated with risks. An awareness of the potential complications along with how to recognize and address problems before they become life-threatening are important skills for clinicians managing patients who receive home PN. The common complications, signs to recognize the problems, and management recommendations are listed in Table 9.

Monitoring

Lifelong monitoring of overall health, nutrition status, and hydration status are central to the management of patients with SBS receiving home NS. See Table 2 for the recommended indices and frequency for monitoring.

Weaning

Results of a recent study show that the QoL for patients with SBS is inversely related to their volume of PS.[57] In fact, the ultimate goal for many with SBS is to achieve enteral autonomy and completely wean from PS.[58] Weaning from PS refers to the incremental, step-wise reduction of both volume and nutrient concentrations to the minimum necessary to maintain hydration and health. Generally, weaning is accomplished by either a

TABLE 9 Potential complications associated with home nutrition support.[56]

Complication	Signs and symptoms	Management recommendations
CVC infection	• Fever • Chills/rigors during infusion • Headache • Malaise • Hyperglycemia • Hyperbilirubinemia • Leukocytosis or leukopenia • Erythema, drainage, or induration at the insertion site or along the tunnel • Pain at the catheter insertion site	• Urgent medical attention • Blood cultures from peripheral and central line (all lumens) • Do not use the CVC • Possible hospital admission for IV antibiotics and hydration • Line salvage or removal and replacement • Prevention: strict attention to aseptic technique, chlorhexidine impregnated caps, and antimicrobial line locks
CVC mechanical	• Resistance with flushing • Bulging lumen with flush • Pump alarms (occlusion error)	• Urgent nursing assessment • Treatment with antithrombolytic, 70% ethanol, or 0.1 N hydrochloric acid • Possible catheter exchange
CVC displacement	• CVC out of body • Increased length of external portion of CVC • Neck, arm, or breast pain with flush or infusion	• CVC out: lay left-side down, apply pressure for 5 min, then occlusive dressing and medical attention for replacement • Increased CVC length or pain with infusion: chest x-ray to confirm tip location • Possible CVC replacement
Thrombosis	• Unilateral arm swelling or pain • Facial, neck, and chest swelling	• Medical attention to evaluate for thrombus: doppler site of swelling • Anticoagulation if deep vein thrombosis • Angiography to evaluate for venous stenosis or occlusion • Stenotic vein: can reduce PN volume and slow infusion rate; possible angioplasty or re-site catheter
Dehydration	• Thirst and dry mouth • Weakness, fatigue, and dizziness • Tachycardia • Rapid weight loss, ≥2 kg in 24 h • Dark colored urine • 24-h urinary volume <1 L • Urinary Na^+ <20 mEq/L	• Additional IV fluid • Assess PN volume and reformulate • Measure 24-h fluid output: urine, stool/ostomy drains
Edema	• Swelling • Rapid weight gain, ≥2 kg in 24 h • Hypertension	• 24-h measurement of intake: oral, enteral, and parenteral • 24-h measurement of output: urine, stool/ostomy, and drains • Assess PS volume and sodium concentration; reformulate if necessary • Elevate extremities as possible • Compression clothing • Unilateral swelling: rule out thrombus
Liver disease (steatosis, cholestasis, and gallbladder sludge/stones)	• Elevated liver tests, including AST, ALT, total bilirubin, direct bilirubin, indirect bilirubin, alkaline phosphatase, PT, and INR	• Maximize oral/enteral intake • Do not overfeed • Cycle PN • Allow for daily fasting hours (no PN/oral/enteral intake) • Reduce dextrose to ≤5 g/kg/day • Limit soy lipid emulsion to <1 g/kg/day • Try mixed-oil lipid emulsion or fish oil emulsion • Referral to a hepatologist

(Continues)

TABLE 9 (Continued)

Complication	Signs and symptoms	Management recommendations
Metabolic bone disease (osteopenia, osteoporosis, and osteomalacia)	• Often asymptomatic • Bone pain • Incidental fracture	• Screen for MBD-routine DEXA scan • Optimize calcium, magnesium, vitamin D, and phosphate: PN and oral • Avoid excess protein/amino acid input • Prevent metabolic acidosis • Treat hypomagnesemia • Encourage weight bearing exercise • Smoking cessation • Referral to a bone specialist
Anemia	• Fatigue • Pallor • Dyspnea on exertion • Impaired ability to maintain body temperature (chilled)	• Monitor cell counts, ferritin, iron, and iron saturation • Oral or IV iron replacement

Abbreviations: ALT, alanine transaminase; AST, aspartate aminotransferase; CVC, central venous catheter; DEXA, dual-energy x-ray absorptiometry; INR, international normalized ratio; IV, intravenous; MBD, metabolic bone disease; PN, parenteral nutrition; PS, parenteral support.

reduction of weekly infusion days or by reducing the daily PN volume and nutrient concentration.[58]

The process of PS weaning can start only after nutrition optimization, including weight and hydration stability.[58,59] Proper weaning necessitates a return to close monitoring. Some suggest achieving >1000 ml of urinary output is sufficient to begin PS weaning. Others suggest monitoring the urinary output change from baseline and weaning IV support once the urinary output is ≥10%.[60,61] After 1 week of adequate urinary output, stability/improvements in the biochemical assessment (eg, serum urea nitrogen, creatinine, and electrolytes), and maintenance of body weight, the patient can continue to transition to enteral and/or oral intake. An abrupt discontinuation of PS, without clinical monitoring, puts the patient with SBS at risk for dehydration with kidney injury, electrolyte disarray, and malnutrition.

Weaning of PS may only be possible in patients able to adhere to dietary, oral/enteral, and micronutrient supplement prescriptions. For some patients, the burdens associated with weaning (strict dietary adherence, sipping of isotonic fluids, and polypharmacy with medications and nutrient supplements) are so significant to their QoL that they prefer to continue receiving PS. Thus, patients and NS providers must have a mutual understanding of goals for NS.

HOME ENTERAL NUTRITION (EN)

EN is an effective adjunct therapy for some patients with SBS to supplement diet and/or PS.[62] EN and/or hydration should be considered in the adult SBS population to reduce the relative risks and costs associated with PS.[63] Patients with SBS most likely to have a positive response to EN are those who fail to gain/sustain weight goals with diet alone, are unable to physically or financially sustain a high-calorie diet, or have increased output the more they eat and drink.[62]

Enteral feeding with a polymeric formula can enhance intestinal adaptation and provide sufficient calories to allow for complete weaning from PS.[64] If possible, it is recommended to feed into the stomach with a pump infusion over time to allow for slow formula delivery, to maximize mucosal contact with nutrients, and to utilize the normal digestive processes.[55]

There are few contraindications or risks associated with EN in the patient with SBS. The only true contraindication is mechanical bowel obstruction, although relative contraindications for patients with SBS include intestinal dysmotility and stool/ostomy output >2 L daily.[55] In patients with a hostile abdomen, gastrostomy placement should be avoided altogether. Close monitoring of absorption is necessary to ensure that the EN does not worsen output or hydration.[62] Commercially available enteral formulas are relatively low in sodium, so it may be necessary to add sodium to the enteral formula to facilitate fluid absorption in the short bowel and prevent sodium depletion in those with a short bowel ostomy.[43]

CONCLUSION

The intent of this article is to equip the clinician with the tools to optimize nutrition assessment and diet intervention, ensure adequate hydration, and provide home care tips to ensure the patient with SBS will thrive. The

TABLE 10 Free resources for clinicians with nutrition information.

Resource	Description
Free educational SBS guidebook for patients and clinicians	• *The Adult Patient's Guide to Managing a Short Bowel*, 5th ed. ➢ https://www.shortbowelsyndrome.com/sign-up ▪ Go to the "Sign Up" tab on the top bar, it takes you to the section for sign up
Website *just for clinicians* to get answers about SBS/SBS cases	• SBSCurbside.org is a safe space (at no cost) for practicing clinicians to get answers to complex questions about adult patients with SBS ▪ http://www.sbscurbside.org
UVA Health GI nutrition website	• Extensive patient diet education materials under the patient education materials link ▪ http://www.ginutrition.virginia.edu
Oley Foundation	• The Foundation serves as a resource for consumers, families, and clinicians ▪ http://www.oley.org
Learn Intestinal Failure TeleECHO (Lift-Echo)	• Dedicated to supporting the treatment and management of patients with intestinal failure ▪ https://liftecho.org/web
ESPEN	• ESPEN practical guideline: clinical nutrition in chronic intestinal failure[52] ▪ https://doi.org/10.1016/j.clnu.2021.07.002

Note: Used with permission from Parrish CR, Wall E. The clinician's toolkit for the adult short bowel patient part I: nutrition and hydration therapy. *Pract Gastroenterol*. 2022;46(6):32-53.

Abbreviations: ESPEN, European Society for Clinical Nutrition and Metabolism; GI, gastrointestinal; SBS, short bowel syndrome; UVA, University of Virginia.

management of patients with SBS receiving home NS requires meticulous oversight and attention to detail, preferably by an interdisciplinary NST. Adherence to standards of care and practice guidelines will ensure patient safety. An awareness of how to monitor the clinical condition and how to anticipate, identify, and manage complications is paramount to the prevention of life-threatening illness. Collaboration between the NST, home health providers, and the patient/caregivers will facilitate the implementation of a patient-centered nutrition care plan that optimizes the patient's QoL while flourishing at home. See Table 10 for a list of SBS resources with nutrition information available.

AUTHOR CONTRIBUTIONS

Carol Rees Parrish, Kristen Roberts, Neha D. Shah, and Elizabeth Wall equally contributed to the conception and design of the manuscript; all four contributed to the interpretation of the data. Each author drafted a section of the manuscript: Kristen Roberts (nutrition assessment), Neha D. Shah (diet), Carol Rees Parrish (hydration), and Elizabeth Wall (home nutrition support). All authors critically revised the article, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

CONFLICT OF INTEREST STATEMENT

Kristen Roberts is a speaker for Takeda and an editor for *Adult Short Bowel Syndrome: Nutritional, Medical, and Surgical Management* (2018). Neha D. Shah is a consultant for GI on Demand (American College of Gastroenterology and Gastro Girl). Carol Rees Parrish is on the advisory board for Takeda, provided support for the Short Bowel Syndrome book for patients/families for Takeda, is a speaker for Coloplast, Inc, is on the advisory board for Napo Pharmaceuticals, is a speaker and consultant for 9 Meters Biopharma, and received an unrestricted educational grant from 9 Meters Biopharma. Elizabeth Wall is on the advisory board for Baxter, is a consultant for Takeda, and is on the advisory board for Zealand Pharma.

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How to cite this article: Roberts K, Shah ND, Parrish CR, Wall E. Navigating nutrition and hydration care in the adult patient with short bowel syndrome. *Nutr Clin Pract*. 2023;38:S59-S75. doi:10.1002/ncp.10951