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The Clinician's Toolkit for the Adult Short Bowel Patient Part I: Nutrition and Hydration Therapy

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The care of patients with short bowel syndrome (SBS) varies nationwide. How do we know? Because we receive emails and phone calls from patients and clinicians all over the country (and even outside the country), desperate for help. SBS patients also present to clinic suffering with SBS (or undiagnosed SBS), with very little to no education provided to them. Patients just want a reasonable life back, and to take the best care of their health going forward; clinicians want to help their patients achieve just that. This article aims to address the most common diet and hydration issues that SBS patients struggle with and to provide clinicians with the tools to successfully improve both nutrition and hydration status as well as the overall health and well-being of the adult SBS patient.

INTRODUCTION

The gastrointestinal (GI) tract is an intricate and carefully orchestrated food-processing organ designed to digest and absorb the foods and beverages that enter it. Significant loss of the primary absorptive surface area resulting in short bowel syndrome (SBS) will require modifications to the oral diet for the remaining GI tract to compensate for this loss. SBS is defined as < 200cm or >75% of working small bowel (SB—not to be confused with SBS) lost.[1] It is also described as an inability to nourish and hydrate an individual while consuming a normal diet and fluid intake. Luminal nutrients from food intake (or enteral infusion in some) are paramount to the GI tract adaptation process for those with SBS; these nutrients initiate the signaling in the GI tract through the secretion of enterohormones that control intestinal motility, absorption, and adaptation.[2,3] The most common etiologies that can result in SBS in adults are found in Table 1.[4,5]

SBS is not just about the loss of SB absorptive surface area causing malabsorption, but encompasses all the regulatory processes that the diseased or resected SB segment controls such as: gastric emptying, motility and transit time, and gastric secretions.[6,7] The loss of this "gut intelligence" results in:

- Intestinal hurry making it difficult for nutrients to have enough time to be absorbed before being excreted

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- Poor mixing of pancreatic and biliary secretions with ingested nutrients making digestion of fat particularly challenging
- Too much acid entering the upper gut from gastric hypersecretion can denature pancreatic enzymes and destabilize bile salts rendering micelle formation ineffective
- A diminished bile salt pool if too much ileum is resected as the bile salts will be lost in the stool instead of reabsorbed through enterohepatic circulation, and
- Small intestinal bacterial overgrowth due to loss of the ileocecal valve, or areas of stricture, narrowing, or slowed motility.

The SB primarily absorbs the vast majority of nutrients ingested. However, in addition to avid absorption of sodium and water, the colon can also absorb up to 500 calories per day through the generation of short chain fatty acids from fiber fermentation.[8] Therefore, the presence of a colon can significantly improve the outcome of an individual with SBS and substantially improve survival. In most settings, recruitment of any remaining colon should be performed.

Given the complex malabsorptive disorder associated with SBS, it is difficult for patients to nourish and hydrate themselves without the help of diet modification and attention to oral hydration, selective use of medications, and when necessary, parenteral nutrition or intravenous fluids. Negotiating all aspects of care required of individuals with SBS challenges even the fittest of our patients and exhausts the rest. Patient and caregivers buy into a near fulltime job with honorary degrees in medicine, nursing, physical therapy, pharmacy, dietetics and more. Clinicians on the other hand (many without formal training or experience with SBS), suddenly find themselves in the role of air traffic control at Chicago O'Hare on a Friday night with serious weather approaching when dealing with the complexity that is SBS. Part I of this two-part series will address the most common diet and hydration issues seen in clinic that SBS patients struggle with and will provide clinicians with the tools to successfully improve both nutrition and hydration status, and in turn, overall health and well-being of the adult short bowel patient.

Table 1. Common Etiologies That Can Result in Adult SBS[2,3]

- Inflammatory bowel disease (especially Crohn's)
- Malignancies
- Radiation enteritis/tumors
- Mesenteric ischemic events
- Trauma
- Surgical catastrophes
  - Hernia repairs
  - Bariatric surgery (volvulus, internal hernia)

A Word about Anti-motility Medications

While diet and hydration therapy are critical for the success of the SBS patient, most will also require antimotility medications to slow intestinal transit and optimize digestion and absorption of nutrients and fluids in the SB. Often, providers simply prescribe these medications with a flexible dosing schedule of two, three or four times daily. However, taking antimotility medications consistently in a scheduled fashion 30-60 minutes prior to meals will slow gastric emptying, improve digestion, and allow increased nutrient and fluid contact time with intestinal mucosa for increased absorption and reduced stool output.[9] There are some patients who will benefit from liquid antimotility agents or crushing the tablet to increase efficacy of the medication. The clinician should discuss proper timing of antimotility medications with meals when talking to SBS patients about diet and hydration. It is imperative for SBS patients to understand why providers might order these medications and how to administer the drugs to optimize absorption. Part II of this series will provide more in-depth information about medication use and abuse in the SBS patient.[10]

Table 2. Short Bowel Diet: General Guidelines

Enteral, whole foods (not elemental)
◆ *Recruits all digestive processes needed for adaptation*
◆ *Encourage consumption of a variety of foods from each food group - balance the meal plan*
Tailor meal plan to individual
◆ *Find out what they normally eat and drink*
◆ *Focus on all they can eat*
Chew foods well
◆ *Helps breakdown food particles when rapid gastric emptying and intestinal transit is present*
◆ *Slows mealtime and hopefully meal volume*
5-6+ small meals / snacks per day
◆ *Reduces food volume presented to GI tract allowing for enhanced absorption by decreasing the nutrient load per cm of SB remaining*
Colon segment remaining = limit fat in diet
◆ *Malabsorbed fat preferentially binds to calcium instead of oxalate in gut lumen*
◆ *Free oxalate is readily absorbed across colon mucosa increasing risk of kidney stones*
◆ *Calcium is lost in the stool with the fat*

Diet and Nutrition Therapy

Because different sections of the GI tract have different responsibilities, understanding normal anatomy and physiology, with knowledge of the patient's remaining GI anatomy, will help the clinician tailor the diet to the individual SBS patient. A crucial role of the dietitian is to translate alterations in digestion and nutrient absorption after a bowel resection into a meal plan that not only meets the individual's preferences and lifestyle but is also presented in a manner that the patient can understand. The patient must be informed of not only what they need to avoid, but more importantly, what they can eat, and the amount and frequency of meals and snacks. Clinicians should ideally start with a good 2 to 3-day diet record of what is normally consumed and then tailor the meal plan—it may feel less like taking things away when readjusting the diet that the patient is familiar with. Expertise in the SBS diet highlights the role of the dietitian as an invaluable team member to these patients.

The SBS diet is quite similar for those with and without a colon, however, there are some important differences. Table 2 lists the general SBS diet guidelines and Table 3 provides recommendations specific to remnant anatomy.

About Dietary Oxalate Restriction in SBS

Oxalate kidney stones are of concern for individuals with SBS and some colon in continuity. In the normal GI tract, dietary calcium and oxalate bind to form an insoluble complex that passes unabsorbed in the stool.[12] However, when dietary fat is malabsorbed, the fat will preferentially bind to calcium leaving oxalate free in the gut lumen. Free, unbound oxalate passes into the colon where it is readily absorbed across the mucosa into the bloodstream, is then filtered by the kidney, and can bind to blood calcium forming insoluble calcium-oxalate kidney stones.[13] As oxalate is not absorbed by the SB, calcium oxalate stones are only expected to occur in the setting of a colon in continuity (although patients without a colon are at higher risk for dehydration and therefore stone formation).[14]

Kidney stones are not only extremely painful to pass, but if left in the kidney can lead to end stage kidney disease. The last thing someone with SBS needs is reliance on hemodialysis or a kidney transplant. Prevention of calcium-oxalate kidney stones is the best approach. Limit dietary fat in those with a colon. Be mindful that treating bile acid malabsorption with bile acid binders

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Table 3. Short Bowel Diet: Specific Dietary Guidelines

Nutrient	Colon in Continuity	No Colon in Continuity
Protein	◆ High quality protein source at each meal and snack ◆ Glutamine – lacks supportive data	◆ High quality protein source at each meal and snack ◆ Glutamine – lacks supportive data
Carbohydrate	◆ Generous complex CHO intake (pasta, rice, potatoes, breads, etc.) with each meal and snack ◆ Avoid simple sugars in foods and beverages ◆ Avoid sugar alcohols in sugar free/dietetic/ diabetic foods • Sorbitol, mannitol, xylitol, maltitol, isomalt, erythritol, lactitol, hydrogenated starch hydrolysates [HSH] ◆ Lactose – up to 20 g/day is often tolerated if divided over the day[11]	◆ Generous complex CHO intake (pasta, rice, potatoes, breads, etc.) with each meal and snack ◆ Avoid simple sugars in foods and beverages ◆ Avoid sugar alcohols in sugar free/dietetic/ diabetic foods • Sorbitol, mannitol, xylitol, maltitol, isomalt, erythritol, lactitol, hydrogenated starch hydrolysates [HSH] ◆ Lactose – up to 20 g/day is often tolerated if divided over the day[11]
Fat	◆ Limit fat to < 30% of calories ◆ High fat increases the loss of Ca^{++}, Mg^{++}, Zn^{++}, Cu^{++} ◆ Use vegetable oils high in essential fatty acids (sunflower, soy, walnut, etc.) ◆ Medium chain triglycerides • Do not contain essential fatty acids • Can overwhelm receptors worsening stool output when consumed in large amounts • Adds burden of expense and are "another thing to do" • May promote deficiencies ◆ Transdermal vegetable oils do not replete essential fatty acids (EFA)	◆ May need to limit if high fat intake increases output such that the burden is greater than the benefit; or malabsorption is just too great ◆ High fat increases the loss of Ca^{++}, Mg^{++}, Zn^{++}, Cu^{++} ◆ Use vegetable oils high in essential fatty acids (sunflower, soy, walnut, etc.) ◆ Medium chain triglycerides • Do not contain essential fatty acids • Can overwhelm receptors worsening stool output when consumed in large amounts • Adds burden of expense and are "another thing to do" ◆ May promote deficiencies ◆ Transdermal vegetable oils do not replete essential fatty acids (EFA)
Fiber	◆ Encourage foods high in soluble fiber such as: green beans, oatmeal, beans, lentils, guar gum (Nutrisource® Fiber, Pronourish® Digestive Balance), Pectin (Sure-Jell®, Sure-Jell Certo®), Benefiber®	◆ Fiber as tolerated and desired ◆ **Do not use** fiber bulking agents (such as Metamucil®, etc.) to thicken stoma output as it reduces fluid absorption
Salt	◆ Normal salt intake	◆ Increase salt intake with foods and beverages ◆ Use oral rehydration solutions
Oxalate	◆ Best Defense: keep urine output > 1500 mL/day ◆ Limit **only** in those with colon segment who have formed a kidney stone and presence of hyperoxaluria based on urinalysis	◆ No need to restrict

Table 4. Potential Signs, Symptoms and Risk Factors of Dehydration

- Urine output < 1000-1200 mL/day
- Rapid weight loss
- Reduced frequency of urination or a darkening in the color of the urine
- Fatigue, feeling tired all the time
- Thirst: Dry mouth, sticky or thick saliva
- Hypotension
- Lightheadedness on standing
- Drinking high volumes of hypertonic or hypotonic beverages will worsen dehydration by increasing stool losses
- Ostomy or stool output > 1500 mL/day
  - Stool output that is greater than the total amount of fluid consumed
- Kidney stones (especially oxalate in those with remaining colon)
  - In patients who have formed kidney stones, it is important to maintain a higher urine output of 1500-2000 mL
- Worsening kidney function (rising creatinine)

can worsen fat malabsorption, further enhancing oxalate absorption in the colon. Work to balance bile salt sequestration and dietary fat restriction. Of note, for those with ≥ 100 cm of terminal ileum lost (or dysfunctional due to disease), the normal compensatory increase in bile acid synthesis cannot keep up to maintain the intraluminal bile acid pool. As a result, these patients should not be put on bile acid sequestrants or steatorrhea will worsen.[15]

The best defense against kidney stone formation is to flush the oxalate through the urinary tract by maintaining a urine output > 1500 mL/day.[16] A calcium citrate supplement taken with meals will correct metabolic acidosis, if present, and in addition, the calcium will bind free oxalate in the intestinal lumen to prevent absorption. Avoid using calcium carbonate in the setting of acid suppression (proton pump inhibitor or H2-receptor antagonist); the calcium will not solubilize at the higher pH, making it unavailable to bind oxalate.[6] A low oxalate diet on top of the SBS diet becomes very restrictive and should only be necessary once a patient has "earned it" by developing a kidney stone or hyperoxaluria. A 24-hour urine collection for volume and urine oxalate can help decipher need for dietary oxalate restriction and increased daily urine volume is warranted when there is concern for calcium oxalate kidney stone formation.

Essential Fatty Acids

Essential fatty acids (EFA) are required for health and development. Good sources of EFAs are plant-based oils such as sunflower, soybean, and walnut. Those with SBS who are dependent on parenteral nutrition and receiving less than 1 g soy-based lipid emulsion/kg/week are at risk of developing EFA deficiency.[1] Clinical signs of EFA are dry, scaly, or red patches of skin. Assessment for EFA deficiency (triene-tetraene ratio on a fatty acid panel) is suggested as part of the routine monitoring of micronutrient levels.

Hydrating the SBS Patient

Attaining adequate hydration can be very difficult for patients with end ileostomies;[17] it is even more difficult for those with SBS with SB stomas (without a colon in continuity). Renal impairment in the short bowel patient has been well documented.[18,19] Most clinicians are aware that individuals with SBS will have difficulty meeting nutritional requirements without diet modification, selected medications, and possibly parenteral nutrition. What is not so apparent is how well they can achieve hydration goals or what hydration goals are for an individual patient. Although serum laboratory values provide clues, they are not the most reliable criteria to assess hydration status; some are only abnormal when significant volume contraction occurs, or worse, acute kidney injury. It is therefore incumbent upon the clinician to ensure both nutrition and hydration adequacy (see Table 4 for signs and symptoms). Clinicians should always ask:

1. Can the patient nourish themselves?
2. Can the patient hydrate themselves?
3. How will each of the above be monitored to ensure success?

The best way to monitor for euvolemia is

to have patients periodically measure their 24-hour urine volume to ensure they can make a minimum of 1000-1200 mL/day. Keep in mind, there is nothing wrong with making more urine (ask any nephrologist), but there is a lot wrong with not making enough. Another promising measure of adequate hydration status is a morning spot urine sodium.[20] For those with kidney stones, collaboration with the managing nephrologist or urologist may help to determine the appropriate 24-hour urine volume for a particular patient. Remember, the goal for hydration is to protect kidney function and prevent end stage renal disease and future dialysis-dependence.

Hydration Management

Unfortunately, more than one SBS patient has been advised to "just drink more" when they have presented to clinic or the emergency room with dehydration as healthcare providers have presumed the patient was just not drinking enough. However, the true problem in SBS is the lack of absorptive surface area for both salt and water; that their remaining bowel just cannot absorb enough of the fluid consumed. In fact, a vicious cycle of drinking (often hypotonic or hypertonic fluids) can develop in SBS patients who experience an uncontrollable desire to constantly drink fluids. This is caused by chronic, severe, dehydration. In the same way that the patient malabsorbs food and feels constantly hungry (as they are starving); the same is true for the patient who cannot sufficiently absorb enough fluid; they feel constantly and insatiably thirsty. When a patient feels thirsty, they are already dehydrated. Hence, the cycle is perpetuated by drinking more fluids, aggravating diarrheal losses, leading to more thirst, and more drinking yet. Furthermore, there are patients who, no matter what they drink (including ORS), it only adds to their stool or ostomy losses and worsens their dehydration. Some patients just need IV fluids, at least until enough adaptation occurs. It is very important for clinicians to identify these patients before deterioration of their renal function occurs. See Table 5 for common scenarios patients report or experience.

Table 6 illustrates the experience of one such patient who thought she was supposed to drink a lot because she had a high output stoma (she was

Table 5. Common Scenarios Patients Report or Experience

1. Patient told to drink more fluids.
   - ◆ But it only increases diarrheal losses, further dehydrating patient.
2. Patient discovers if they drink less, stool output decreases.
   - ◆ Stool volume looks great, but 24-hour urine output is severely decreased.
3. Patient thinks they need to drink more which only drives their stool output higher.
4. If on parenteral support, they may think their parenteral support provides enough fluid, but no one ever measured a 24-hour urine volume.
5. Some patients are just drinking all the wrong beverages (soda, Ensure® or Boost®, Sweetened iced tea, fruit juices, etc.)
6. Some patients are just not drinking enough.

Table 6. Case Study of Excess Oral Fluid Volume on Ostomy Output

Time frame	Oral fluid (mL)	Ostomy (mL)	Urine (mL)	Fluid Balance (mL)
Baseline	4580	3600	2600	-1620
2 weeks later	3440	2990	1735	-1285
4 weeks later	3030	2435	2060	-1465
6 weeks later	2670	1650	1650	-630

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drinking primarily oral rehydration therapy, some water, and 6 ounces of coffee). Her oral fluid intake was reduced every 2 weeks with no other changes to demonstrate to her how much her drinking was driving her unwanted high ostomy output. This underscores how important it is to not only have patients record what they are eating, but what, and how much they are drinking.

Maintaining euvolemia and sodium balance while ingesting common oral liquids can be dependent on the presence or absence of a colon. With a colon segment in continuity, many SBS patients can tolerate hypotonic fluids without excessive fluid losses.[21] However, without a colon in continuity, high ostomy outputs are commonly encountered when excess fluid losses result from consuming either hypertonic or hypotonic fluids. Table 7 lists common types of beverages based on their tonicity.

It is not enough to suggest to a SBS patient what to drink, but equally as important to teach how to drink, especially how much to drink. It is recommended that in SBS, patients drink small amounts of fluids with meals to ease passage of the food bolus. However, the majority of fluid intake should come from sipping all day long between meals as fluids are more efficiently absorbed when consumed in small amounts, frequently, and between meals.[22] Some patients need to be educated on this behavior. A smaller volume of liquid prevents a surge of fluid in the small intestine. This surge can reduce fluid absorption rates through the SB as opposed to absorption.[23] In particular, for those with a SB ostomy, excessive fluid intake or drinking too fast (regardless of the fluid type), will lead to a significant loss of fluid, further worsening dehydration. Therefore, good practice is to advise patients of their daily fluid volume goal (which is patient dependent) and encourage sipping these fluids over the course of a day. Until urine output is adequate and stable, 24-hour urine volume should be measured and monitored to optimize volume status and protect kidney function. It may be necessary to demonstrate to patients how the oral fluids they are consuming drive stool output. This can be accomplished by asking the patient to decrease oral fluid intake to only 500mL over 24 hours and have them measure both urine and stool/ostomy output to illustrate the effect of the limited oral fluid intake. However, do not try this without a mechanism to ensure hydration of the patient.

Table 7. Tonicity Classification of Beverages

Osmolarity	Common Beverages
Hypertonic Fluids – AVOID	Fruit juices, sodas, sweetened drinks of any kind (tea, lemonade, Kool-Aid®, etc.) Commercial liquid nutritional supplements such as Ensure®, Boost®, etc., or their store brand equivalents
Hypotonic – The Lesser Evils	Water, tea, coffee, alcohol, diet drinks, Crystal Light®, Gatorade® Zero
Isotonic – RECOMMENDED	Oral rehydration solutions – See Table 8

Oral Rehydration Solutions (ORS)

In those SBS patients without a colon, additional sodium is often required since every liter of stool output contains 90-110mEq of sodium (2 g sodium or 1 teaspoon table salt).[24] However, this amount of salt is usually unpalatable, so consumption of salty foods and ORS is necessary to effectively replace sodium losses. Water absorption in the SB is dependent on the sodium-glucose co-transport system which draws glucose and sodium across the epithelial membrane in equimolar fashion, while allowing for water absorption via paracellular passage.[25] Commercial and homemade ORS recipes are based on this premise, and therefore, need similar concentrations of sodium and glucose to allow for water absorption and ultimately hydration of the individual. See Table 8 for examples of commercial ORS (and ORS recipes that can be made at home).

ORS, while lifesaving in many, is not a panacea for all patients with SBS. When starting ORS, it is advisable to have the patient sip 1-2 cups throughout the day while tracking 24-hour urine output. If urine output increases without significant increase in stoma or diarrheal output, then it is ok to slowly increase the daily ORS volume to somewhere between 1-2 liters/day. However, if

Table 8. Oral Rehydration Solutions – Commercial Products and Homemade Recipes

Goal range per liter: 20-25g glucose/sugar; 45-80 mEq sodium; osmolarity near 300 mOsm/L

Commercial Oral Rehydration Solutions

- World Health Organization (WHO) packets (Jianas Brothers)
- Trioral® (Reduced Osmolarity ORS)
- Rehydralyte®
- Pedialyte®
- EquaLyte®
- Parent's Choice® Pediatric Electrolyte
- CeraLyte® 70 and CeraLyte® 90
- DripDrop®
- Hydralyte® Oral Rehydration Solution
- Liquid IV® Hydration Multiplier

Homemade Oral Rehydration Solutions

Recipe	CHO (g/L)	Sodium (mEq/L)	Potassium (mEq/L)	Calories per L	Osmolarity
Water • 32 ounces (1 quart) water • ½ teaspoon table salt • 2 Tablespoons sugar • Optional: Crystal Light® or Splenda® to taste	25	50	0	100	~ 230
G2® (Lower Sugar) Gatorade® • 32 oz bottle G2 Gatorade® • ½ teaspoon salt	20	70	3.1	80	~ 275
Gatorade® Powder • 32 ounces of water • 2 Tablespoons of Gatorade® Powder • 1/2 teaspoon of salt • 1/4 teaspoon of Splenda® or to taste	24	57	3.1	96	~ 250
"Regular" Gatorade® • 1 ½ cups Gatorade® • 2 ½ cups water • ½ teaspoon salt	21	66	1.2	84	< 300
Gatorade® Zero • 32 oz bottle Gatorade® Zero • ½ teaspoon salt • 5 teaspoons sugar	20	68	3	95	~ 240
Flavored Water (sugar free, calorie free) • 32 ounces of water • ½ teaspoon salt • 2 Tablespoons sugar • Flavor with sugar free/calorie free water flavorings	25	50	0	100	~ 230
Chicken Broth • 2 cups liquid chicken broth (not low sodium) • 2 cups ounces water • 2 tablespoons sugar	26	76	3.5	104	~ 228

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Table 9. Examples of Oral Micronutrient Supplements[28]

- The following lists are only examples and not meant to endorse any one product or manufacturer.
- Some SBS patients may have better absorption with chewable, liquid, or gel cap supplements. Most gummie supplements are incomplete or may not provide enough of the required vitamins/minerals.
- Advise patients to check dietary supplement labels for 3rd party testing (USP, ConsummerLab, etc.) to verify supplement contents.

Multivitamin with Mineral Supplements – best tolerated when taken with a meal

ADULT

- Adult Centrum® – Complete Multivitamin/Multi-mineral (or Silver) in chewable, liquid, tablet
- Nature Made® - Multi Complete softgels
- Bariatric Advantage® – High ADEK Multi*
- DEKAs Plus® - softgel, chewable, or liquid*
- MVW Complete Formulation® – chewable, softgel, or liquid*

CHILDREN

- Flintstone's Complete® Chewable (adults will need to take > 2 tablets daily)

Fat-Soluble Vitamins

Multi Fat Soluble

- DEKAs Essential® – chewable, liquid, or softgel*

Vitamin A

- Bariatric Advantage® – capsule
- Nature Made® – softgel

Vitamin D

- Bariatric Advantage® – Cholecalciferol (D3) in gel caps, mini caps, or liquid*
- Nature Made® – High Potency Vit D3 gel caps

Vitamin E

- Aqua E® (Callion Pharma)- liquid*
- Nature Made® – softgel

Calcium citrate (on empty stomach)

- Citracal® – caplets, chews
- BeriMelts® – dissolvable caplets

Iron

- Bariatric Advantage® – chewable (contains vitamin C)
- Nature's Blend® - tablet

Zinc

- Nature's Bounty® - caplet
- Solimo® - caplets

Copper

- Solaray® - capsule
- Swanson® - tablet

Selenium

- Nature's Bounty® - tablet
- Nature's Way® - caplet

*Contains some or all water-miscible fat-soluble vitamins

slowly sipping ORS throughout the day leads to significantly increased stoma output (without a concomitant increase in urine output, or worse, a decrease in urine production), then the ORS trial has failed, and the patient should reduce the consumption of ORS. Before declaring an ORS trial a failure, make sure the patient is slowly sipping the ORS throughout the day and not rapidly consuming the solution just to finish it.

Vitamins and Minerals

Many SBS patients will require vitamin and mineral supplementation throughout their lifetime. The sites of remaining bowel, health of the bowel, intestinal

Table 10. Vitamin D Considerations to Achieve Repletion/Normal Serum Levels

- Vitamin D is notoriously low in SBS; therefore, larger or increased frequency of dosing may be required to achieve normal serum levels.
- Check 25-OH vitamin D every 2-3 months until stable, then twice per year.
- Check intact PTH at baseline, then as needed.
- Check baseline DEXA scan, then every two years as needed.
- Note: Standard 10 mL MVI for PN has only 200 units (5mcg) vitamin D2.
- Avoid 50,000 weekly dose as this will limit the patient to one opportunity per week to absorb some vitamin D. If they lose the tablet in their stool that day, game over.
- Daily dosing of vitamin D increases the chances that some will be absorbed.
- If daily dose does not increase level, double the dose and recheck in 2-3 months. If no change, double the daily dose again and consider giving half twice a day.
- May try water-miscible supplements
- Give daily dose as tablet (even crushed), or liquid (not capsule).
  - ◆ Try opening a capsule and giving it sublingual[31]
- Use tablets crushed or liquid form (may need to avoid those with sugar-alcohols). If insurance does not cover liquid, have patient try liquid versions from stores such as the Vitamin Shoppe®, GNC®, etc.*
- Other options:
  - ◆ Superior Source®–microlingual technology available in 400, 1000, 5000, 10000 units.
    - superiorsourcevitamins.com/microlingual-tablets/a-d-k-vitamins
  - ◆ Bio-D-Mulsion® Forte Drops absorbed on the tongue.
    - webmd.com/drugs/2/drug-152707/bio-d-mulsion-forte-oral/details
  - ◆ Ultraviolet (UV) Light[32]**
    - Sun exposure: If fair skinned, 10 minutes in the midday sun in shorts and a tank top with no sunscreen will give enough radiation to produce about 10,000 units of the vitamin. Avoid excessive, unprotected sun exposure.*
    - In winter, if north of Atlanta, it is impossible to produce adequate vitamin D from the sun because the sun never gets high enough in the sky for the UV B rays to penetrate the atmosphere.
    - Sperti lamP/UV light– Average Vitamin D Lamp sessions are 3-5 minutes, only 2 or 3 times per week.

*Might not be 3rd party tested (USP, ConsummerLab, etc.)

**Consult with a dermatologist with concerns

transit time, and nutrient quality of the habitual diet will influence the need for supplementation. Micronutrients of concern, specific to SBS, include fat soluble vitamins (A, D, E, and K), vitamin B_{12}, folate, calcium, magnesium, zinc, iron, copper, and selenium.[26] Rapid intestinal transit, chronic vomiting, and parenteral multivitamins less than five days a week (if parenteral support dependent), may necessitate water-soluble vitamin supplementation. The exception to this rule is for vitamin B_{12}; all SBS patients will need routine monitoring for vitamin B_{12} deficiency by checking both serum B_{12} and

Table 11. Common Clinical Blunders and a Suitable Solution

Common Clinical Blunders	Suitable Solution
Lack of clarity of underlying anatomy *OR* GI anatomy unknown	Obtain all/any operative reports and pathology reports to clarify amount of small intestine remaining, presence or absence of ileo-cecal valve and amount of colon remaining
Estimating 24-hour ostomy output based on number of bag changes or stool consistency	Obtain objective measurements of ostomy output: • Provide patient tools to measure urine and ostomy output • Goal stool/ostomy output < 1200mL • 1-2 liters output may decrease with pharmaceutical and dietary management • > 2 liters needs IV fluids and/or PN
Instructions to only measure stool/ostomy output	Measure 24-hour urine output and urine sodium
Encouragement to drink more fluids	Need to educate patient on fluid type and volume ORS ideal • Be prepared to provide beverage alternatives if patient will not drink ORS or ORS results in an increase in stool output
Lack of dietary education provided	Ensure patient is referred to a dietitian trained in SBS • Small frequent meals • Good food choices • Appropriate beverages and volume needed per day • Timing of bowel slowing agents • Limit fat if colon in continuity
Unclear risk of kidney stones and the appropriate interventions needed to reduce risk	• Measure urine output • If kidney stone contains oxalate, and with colon, start low oxalate diet and determine optimal daily urine volume
Unclear assessment of vitamin and mineral status	List specific vitamins and minerals and how often to obtain a biochemical assessment (every 3-6 months pending assessment), a nutrition-focused physical exam, and imaging. See SBS-IF guidelines[1]

Table 12. Resources for Clinicians

Website Just for Clinicians to Get Answers About SBS

- **SBSCurbside.org** is a safe space (at no cost) for practicing clinicians to get answers to complex questions about adult patients with Short Bowel Syndrome (SBS).
  - ➢ **SBSCurbside.org**

Free Educational SBS Guidebook for Patients and Clinicians

- The Adult Patient's Guide to Managing a Short Bowel, 5th Edition
  - ➢ **shortbowelsyndrome.com/**
    - Click the "Sign Up" tab on top bar

University of Virginia Health (UVA Health) GI Nutrition Website

- Extensive Patient Diet Education Materials under Patient Education Materials link
  - ➢ **ginutrition.virginia.edu**

Oley Foundation

- Serves as a resource for consumers, families, and clinicians
  - ➢ **oley.org**

Learn Intestinal Failure TeleECHO (Lift-Echo)

- Dedicated to supporting the treatment and management of patients with intestinal failure
  - ➢ **liftecho.org/web**

European Society for Clinical Nutrition and Metabolism (ESPEN)

- ESPEN practical guideline: Clinical Nutrition in Chronic Intestinal Failure[1]
  - ➢ **doi.org/10.1016/j.clnu.2021.07.002**

methylmalonic acid on a periodic basis. This is an area ripe for study.[27]

Table 9 lists examples of oral vitamin and mineral supplements that might be needed by those with SBS. Remember, micronutrient absorption can improve with bowel adaptation and therefore, lifelong monitoring of serum vitamin and mineral levels, as well as a periodic nutrition focused physical exam are essential for the SBS patient. Clinicians monitoring micronutrient levels must recognize that inflammation, acute illness, and hypoproteinemia, can alter transport protein concentrations leading to factitious serum and plasma levels making results difficult to interpret.[29,30] It is critical that clinicians do not rely solely on biochemical interpretations to develop micronutrient treatment strategies when a deficiency is suspected.

Bone health is an excellent example of the need for comprehensive assessment to determine the need for supplementation. Since calcium, vitamin D, and magnesium absorption are often suboptimal in those with SBS, periodic DEXA scans are recommended to evaluate bone density to guide therapy and prevent metabolic bone disease (Table 10).[1]

CONCLUSION

Maintaining both nutrition and hydration status are central components to the care of patients with SBS. Failure to attend to these key issues puts the SBS patient at risk for malnutrition, weight loss, nutrient deficiencies, dehydration (with or without electrolyte disarray), nephrolithiasis, and, worse-case scenario, for acute kidney injury, and over time, loss of renal function. With careful education regarding principles of nutrition and hydration, this will set the SBS patient on a path to ensure good health and protection of their renal function. Lifelong monitoring and support from a

healthcare team are necessary in all SBS patients as management goals can change over time. Table 11 provides a summary of common clinical blunders and the suitable solution in the care of SBS patients. See Table 12 for SBS-related resources for the clinician. ■

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