Management of short bowel syndrome in adults

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INTRODUCTION

Short bowel syndrome (SBS) is a disabling malabsorptive condition that is associated with frequent complications. SBS in adults usually results from surgical resection for Crohn disease, malignancy, trauma, radiation, or vascular insufficiency. SBS is the most common cause of intestinal failure. This topic reviews the management of patients with SBS. The pathogenesis of SBS and associated chronic complications of SBS are discussed in detail separately. (See "Pathophysiology of short bowel syndrome" and "Chronic complications of the short bowel syndrome in adults".)

TERMINOLOGY

- **Short bowel syndrome** – SBS is a condition that results from surgical resection or congenital disease of the small intestine, which is characterized by the inability to maintain protein-energy, fluid, electrolyte, or micronutrient balances when on a conventionally accepted, normal diet [1]. It is a functional definition implying a significant amount of malabsorption of macronutrients and/or micronutrients. A length of functional small intestine less than 200 cm is an accepted definition of short bowel in adults [2].

  The physiologic course of SBS is divided into the following phases:

  - **Acute phase** – The acute phase is characterized by high intestinal fluid losses and the metabolic derangement. It starts immediately after resection and generally lasts for

three to four weeks.

- **Adaptation phase** – The adaptation phase is characterized by structural and functional changes to the remaining small bowel and colon in order to increase nutrient absorption and slow the gastrointestinal transit. The adaptive phase usually lasts for one to two years. (See "Pathophysiology of short bowel syndrome", section on 'Intestinal adaptation'.)

- **Intestinal failure** – Intestinal failure is defined as a reduction in gastrointestinal function below the minimum necessary for the absorption of macronutrients and/or water and electrolytes such that intravenous supplementation is required to maintain health/growth [1,3]. Intestinal failure may result from SBS, intestinal fistula, intestinal dysmotility, mechanical obstruction, or extensive small bowel mucosal disease. Intestinal failure may be transient or permanent.

- **Intestinal rehabilitation** – Intestinal rehabilitation refers to a multidisciplinary process aimed at improving intestinal function with the hope of liberating patients from parenteral nutrition and avoiding intestinal transplantation [4]. Comprehensive centers of excellence in intestinal failure use nutrition, pharmacologic, and in some cases, non-transplant surgical approaches to achieve this objective.

MANAGEMENT OF ACUTE PHASE

During the initial three to four weeks after lengthy intestinal resection, the predominant goals of management are to stabilize large fluid and electrolyte losses, and maintain fluid and acid/base balance.

Intravenous fluids — Large-volume gastric or proximal small bowel fluid losses are relatively common in the early phase. As a result, intravenous fluid replacement with normal saline (0.9 percent) and supplemental potassium and magnesium are important. Stomal and fecal losses should be measured and replaced every one to two hours with a solution separate from the nutrition solution. (See "Overview of postoperative fluid therapy in adults", section on 'Fluid resuscitation'.)

Acid suppression — A histamine 2-receptor antagonist or proton pump inhibitor should be administered intravenously initially to suppress gastric hypersecretion and reduce fluid losses [5-7]. Patients with SBS often develop gastric acid hypersecretion during the first six months following resection. This may be associated not only with acid-peptic disease and increased intestinal fluid losses, but also with deactivation of pancreatic enzymes and a reduction in the

optimal pH needed for fat absorption. (See "Pathophysiology of short bowel syndrome", section on 'Influence of SBS on gastric and pancreatic function'.)

Parenteral nutrition — Parenteral nutrition should be introduced once the patient is hemodynamically stable and fluid requirements are fairly constant. The need for long-term parenteral nutrition depends on the length of the small bowel resected, the site of resection, and the presence of colon in continuity with the small bowel. These determinants of intestinal function are discussed in detail separately. (See "Pathophysiology of short bowel syndrome", section on 'Initial determinants of intestinal function'.)

The formulation of parenteral nutrition, assessment of nutritional requirements, monitoring, and complications of parenteral nutrition are also discussed separately. (See "Postoperative parenteral nutrition in adults", section on 'Timing'.)

Enteral feeding — Enteral feeding, initially via a nasogastric or gastrostomy feeding tube, should be attempted as soon as possible after the patient's condition has stabilized after surgery. Even patients in whom there is little potential for ultimate transition to exclusive enteral feeding may be able to achieve some degree of enteral tolerance and reduction in parenteral nutrition support if continuous enteral feeding is used to maximize adaptation. (See "Overview of perioperative nutrition support", section on 'Early enteral feeding'.)

Continuous enteral feeding into the stomach permits constant saturation of carrier transport proteins and facilitates intestinal adaptation, thereby accelerating the progression to oral feeding, and is better tolerated than bolus feeding [8]. Continuous tube feeding (exclusively or in conjunction with oral feeding) in the postoperative period has been shown to significantly increase net absorption of lipids, proteins, and energy compared with oral feeding alone [8]. Overnight feeding allows maximal use of the gut while enabling normal activities during the day. Use of a standard polymeric isotonic enteral formula is generally well tolerated. Elemental formulas should generally be avoided because of their hypertonicity, expense, and lack of evidence supporting benefit over standard formulas. A fiber-containing formula may be advantageous in the patients with SBS and an intact colon. Although this has not been demonstrated to significantly increase macronutrient or energy absorption, it may increase stool/ostomy effluent viscosity [9,10].

MANAGEMENT IN ADAPTATION PHASE

Structural and functional changes to increase nutrient absorption and slow the gastrointestinal transit occur in the adaptation phase. (See 'Terminology' above.)

Oral diet — Patients should be transitioned to oral feedings in a slow and stepwise manner over a period of weeks to months. For those patients with SBS and a colon-in-continuity, a diet high in complex carbohydrates and modest in fat and oxalate is recommended (table 1). No change in dietary protein is generally necessary because nitrogen absorption is least affected by the decreased absorptive surface in SBS patients. The use of peptide-based diets in patients with SBS is unnecessary. Other than avoidance of hypertonic fluids and simple sugars (ie, antidumping diet), those patients with SBS and an end-jejunostomy do not require major dietary modifications.

- **Carbohydrate** – Complex carbohydrates are preferred and simple sugars should generally be avoided. In the absence of significant jejunal resection, lactose should not be restricted unless the patient is clearly lactose intolerant, given it is an important source of calcium and calories.

- **Oxalate** – In patients with SBS who have a colon-in-continuity, dietary oxalate should be restricted to reduce the risk of calcium oxalate nephrolithiasis, particularly in those with a history of nephrolithiasis. (See "Chronic complications of the short bowel syndrome in adults", section on 'Nephrolithiasis'.)

- **Fiber** – Soluble fiber supplementation may be helpful by enhancing adaptation via increased short-chain fatty acid production and providing an additional calorie source in those patients with SBS and a colon-in-continuity. In addition, fiber supplementation may slow gastric emptying and decrease the watery nature of the stools by absorbing stool water.

- **Fat** – We advise moderate restriction in fat consumption in those patients with SBS and a colon-in-continuity, particularly those with steatorrhea and oxalate nephropathy. A diet high in complex carbohydrates (60 percent) and low in fat (20 percent) has been shown in these patients to reduce fecal calorie loss, increase overall energy absorption, and improve wet weight absorption; a reduction in magnesium and calcium loss and a reduction in oxalate absorption has also been demonstrated [11-13]. If this restricts the patient's ability to consume sufficient calories, supplementation with medium-chain triglyceride (MCT) oil or MCT-based liquid supplements should be considered [14]. MCTs are absorbed from both the small and large intestine and do not require digestion by pancreatic enzymes for their absorption. MCTs, however, are generally not well tolerated long-term, have a slightly lower caloric density than long-chain triglyceride (LCT; 8.3 versus 9 kcal/g), do not contain essential fatty acids, exert a greater osmotic load in the small bowel and have less stimulatory effect on intestinal adaptation compared to LCT. The provision of essential fatty acids (ie, linoleic acid [an omega-6 fatty acid] and linolenic acid [an omega-3 fatty

acid]) found in such substances as safflower and soybean oils is important as deficiencies are common, particularly in the setting of low-fat diets and fat malabsorption [15]. Pure MCT can be used as a cooking oil, spread on toast, or salad dressing. MCT-based liquid nutritional supplements are no longer readily available in the United States; however, a substitute can be made by adding 10 mL of MCT oil to 8 ounces of nonfat milk, to which is added one packet of a powdered instant breakfast meal and briefly emulsified in a blender. Nonfat lactase-treated milk should be used in patients who are lactose intolerant. Among those with SBS, carefully performed energy balance studies suggest that MCT is most effective in patients whose colon remains in the fecal stream [16].

Fat restriction does not present an advantage with respect to net fluid, energy, nitrogen, or electrolyte absorption if a jejunostomy or ileostomy is present [17]. In the latter situations, a patient may more easily achieve caloric goals, and thereby a stable weight, if no fat restriction is imposed.

Fluid management — Patients with SBS are at risk for dehydration. Oral intake should be adequate to compensate for all losses and to maintain a urine output of at least 1 L/day. Measures to decrease intestinal fluid loss include:

- **Avoidance of hypertonic and hypotonic fluids** – Hypertonic fluids (eg, regular soda and fruit juices) should be avoided. Hypertonic fluids are concentrated and induce secretion from enterocytes in an attempt to dilute the concentration of the luminal contents, which then contributes to increased diarrhea.

  Hypotonic fluids (eg, water, tea, coffee, alcohol) do not contain the sodium or glucose necessary to optimally facilitate absorption in an end-jejunostomy patient and may lead to dehydration if consumed in large amounts. Patients with a residual colon, however, can usually maintain adequate hydration without excessive fluid loss with hypotonic fluids [18].

- **Glucose-electrolyte oral rehydration solution** – Patients with SBS and an end-jejunostomy should be advised to drink one to three liters of oral rehydration solution daily, sipped throughout the day, to maintain adequate hydration. Patients with SBS and a residual colon may also benefit from use of an oral rehydration solution, particularly those with difficult to control diarrhea and recurrent dehydration.

  The optimal sodium concentration of oral rehydration solution to promote jejunal absorption has been demonstrated to be 90 to 120 mEq Na+/L. NaCl should be added to commercially prepared oral rehydration solution with lower sodium. While fluid composition is less important in those with a colon, adequate dietary sodium should be

provided. (See "Oral rehydration therapy", section on 'Commercial and standard oral rehydration solutions'.)

Precautions for orally administered medications — Patients with SBS may be at risk for impaired absorption of oral medications. Most drugs are absorbed in the stomach and proximal small bowel, and thus their effect is preserved. Enteric-coated drugs and timed/delayed-release medications, in contrast, may not be absorbed properly and should generally be avoided. When feasible, alternative methods for medication delivery (eg, liquid, transdermal, suppositories) should be used and medication levels should be monitored.

Pharmacologic therapy to reduce fluid loss — A number of pharmacologic agents have been used to reduce secretory losses and decrease intestinal motility/transit in patients with SBS.

Acid suppression — We administer proton pump inhibitors orally twice daily for hypergastrinemia in the first 6 to 12 months after enterectomy in patients with SBS. After this period, many patients with SBS will still require acid suppression due to continued dyspeptic symptoms. Nonetheless, as gastric acid has a role in suppressing overgrowth of upper gut bacteria, acid-suppressing agents should be used sparingly thereafter, particularly when there is documented small intestinal bacterial overgrowth. (See "Small intestinal bacterial overgrowth: Etiology and pathogenesis", section on 'Protective mechanisms against bacterial overgrowth'.)

Antidiarrheals — We treat all patients with either loperamide or diphenoxylate as first-line agents to reduce intestinal motility and prolong transit time. These agents also have a small impact on reducing intestinal secretion. While antimotility agents may be effective in reducing intestinal transit, in cases where bowel dilatation has occurred, antimotility agents can rarely worsen diarrhea by allowing bacterial proliferation. Therefore, their use should be monitored closely with dose escalation or discontinuation according to the response.

These medications are generally administered about 30 minutes before meals and again at bedtime. As loperamide enters the enterohepatic circulation, which is disrupted in SBS patients without an ileum, high doses are frequently needed (ie, up to 16 tablets per day). Patients on high-dose loperamide require close monitoring for adverse drug reactions and arrhythmias in particular. When ineffective, especially in those patients without a colon-in-continuity or those who are left with a minimum of residual jejunum or duodenum, we may add codeine sulfate (15 to 60 mg two to three times a day) or tincture of opium. Loperamide and codeine may have a synergistic effect when used together [19]. The use of codeine and tincture of opium tends to be limited by their sedating effect.

Additional management for patients with high fluid losses

Antibiotics for small intestinal bacterial overgrowth — The combination of bowel dilatation and altered transit frequently seen in SBS is thought to facilitate the development of small intestinal bacterial overgrowth (SIBO) [20]. Because of limitations in the tests used to diagnose SIBO (ie, small bowel aspirate/colony count, hydrogen breath test) in SBS, securing the diagnosis of SIBO is challenging. As such, in the presence of bowel dilation and typical symptoms (eg, gas-bloat, diarrhea, discomfort), empiric antimicrobial treatment is often provided. A variety of oral broad-spectrum antibiotics can be used with success being judged on improvement in symptoms and/or oral intake, reduction in stool output, and/or weight gain. The continuous use of low-dose, rotating cycle of antibiotics in SBS may be necessary in some patients. Antibiotic treatment regimens for SIBO are discussed in detail separately. (See "Small intestinal bacterial overgrowth: Management", section on 'Antibiotic therapy'.)

Octreotide — The use of octreotide should be reserved for patients with intravenous fluid requirements that are greater than 3 L per day and only after the period of maximal intestinal adaptation [21]. Typical candidates include patients with SBS and a high-output end-jejunostomy. A typical starting dose is 100 mcg subcutaneously three times per day. The dose can be increased to 300 mcg three times daily. If helpful in decreasing fluid losses, a long-acting formulation can be used. Octreotide increases small bowel transit time and reduces fluid losses, but tachyphylaxis often develops. In patients with no significant reduction in stool output within four to six weeks despite titrating the dose, octreotide should be discontinued. Octreotide diminishes splanchnic protein synthesis, which can interfere with the process of adaptation [22-24]. In addition, octreotide is expensive, requires a painful subcutaneous injection, and predisposes patients to the development of gallstones for which patients with SBS are at high risk. (See "Chronic complications of the short bowel syndrome in adults", section on 'Cholelithiasis'.)

Other agents — We reserve the use of clonidine and exenatide to patients with high fluid losses that are refractory to other measures. The choice is determined by concerns regarding the patient's blood pressure and the patient's willingness to administer a subcutaneous injection.

- Clonidine – Clonidine, which can be administered both orally and transdermally, has also shown modest benefit in treating high output stool losses presumably via its effects on intestinal motility and secretion [25]. Its clinical benefit, however, has yet to be clearly demonstrated.

- **GLP-1 analogues** – In a retrospective open-label study, a long-acting GLP-1 analogue was associated with a reduction in parenteral nutrition requirements in five adult SBS patients, presumably through slowing gut transit given its lack of intestinotrophic properties [26]. A

subsequent placebo-controlled study evaluating the acute effects of continuous infusions of GLP-1, GLP-2, and a combination of both GLP-1 and GLP-2 in adults with SBS found that all treatments significantly reduced the fecal wet weight, energy, nitrogen, sodium, and potassium losses compared with placebo [27]. The effects of GLP-1 were less potent than GLP-2, while the combination of the two showed additive effects. In an open-label pilot study, liraglutide was subcutaneously administered daily to eight SBS patients with an end-jejunostomy. Liraglutide reduced ostomy wet weight output and increased both intestinal wet weight and energy absorption. Transiently reduced appetite and nausea were described. Larger and longer duration studies are needed before this treatment can be recommended [28].

Patients with improving intestinal function — As the bowel adapts, allowing greater nutrient and fluid absorption, parenteral nutrition requirements are likely to decrease.

Weaning parenteral nutrition — Our practice is to wean parenteral nutrition proportionate to the amount of oral and/or enteral nutrition (ie, kilocalories) being delivered. An optimal interval for making weaning decisions has not been defined. Gradual parenteral nutrition reductions can be made by decreasing the days that parenteral nutrition is infused per week [29]. However, decreasing the daily parenteral nutrition infusion volume equally throughout the week (eg, 10 to 30 percent reduction daily) is associated with a lower risk of dehydration. Parenteral nutrition reductions are based on tolerance as determined by the development of symptoms, hydration status, electrolytes, and weight [29]. A useful approach to monitor hydration status is to maintain the urinary sodium concentration >20 mEq/L and daily urinary volume >1 L and enteral balance (oral fluid intake minus stool output) between 500 and 1000 mL per day.

Monitoring for micronutrient deficiency and supplementation — Patients with SBS are at greatest risk for nutrient deficiencies during and after the time that parenteral nutrition is being weaned or has been discontinued. Patients may develop deficiencies of fat soluble vitamins, vitamin B12, trace elements, and electrolytes. Lifelong monitoring and supplementation for micronutrient and electrolyte deficiency is discussed separately. (See "Chronic complications of the short bowel syndrome in adults", section on 'Electrolyte and micronutrient deficiencies'.)

PATIENTS WITH PERSISTENT INTESTINAL FAILURE

SBS-associated intestinal failure reverses completely in approximately 50 percent of adults within the first two years. Thereafter, significant intestinal adaptation occurs in only a minority of patients. In the absence of additional intervention (eg, trophic factors, autologous

gastrointestinal reconstruction, and intestinal transplantation) these patients remain dependent on chronic parenteral nutrition. (See 'Prognosis' below.)

Glucagon-like peptide-2 analogue — We reserve the use of teduglutide to patients with SBS who are unable to be weaned from parenteral nutrition despite aggressive use of the more conventional measures, particularly in those SBS patients who have developed significant complications or describe severe impairment in quality of life related to parenteral nutrition use (eg, loss of vascular access sites, recurrent catheter-related bloodstream infections, and liver disease). Teduglutide is a long-acting GLP-2 analogue. GLP-2, an enteroendocrine peptide released in response of luminal nutrients, initiates and maintains small bowel adaptive responses to resection and improves nutrient absorption [30-32]. Teduglutide is available in the United States and Europe for adult and pediatric SBS patients as a long-term aid to parenteral nutrition weaning. The duration of its use will vary depending upon its effectiveness and tolerance but is generally administered for at least six months and potentially lifelong. Longer-acting GLP-2 analogues (eg, glepaglutide and apraglutide) with the potential advantage of less frequent administration are in development [33,34].

- **Monitoring** – Laboratory assessment including serum electrolytes, liver function, and pancreatic enzymes are recommended prior to initiating teduglutide and every six months while on treatment. Patients on teduglutide should be carefully monitored for volume overload and adverse reactions to medications due to increased absorption. For those SBS patients with a colon, colonoscopy should be performed within six months before starting teduglutide, one year later, and then, in the absence of a polyp, at least every five years. A risk evaluation and mitigation strategy ([REMS] http://www.gattexrems.com/) program is required of prescribers.

- **Efficacy** – Teduglutide has been studied in two phase 3 clinical trials in adult SBS patients and one phase 3 clinical trial in pediatric SBS patients [35] and has been demonstrated to modestly reduce the volume and number of days of parenteral support [36,37]. Additional studies are needed to determine whether the intestinal adaptation due to teduglutide is sustained after discontinuation of therapy and if long-term use is associated with a reduction in complications associated with parenteral nutrition [38,39].

  In the pivotal (second) phase 3 randomized controlled trial in adults, 86 SBS patients with intestinal failure were randomized to teduglutide (0.05 mg per kg per day) or placebo for 24 weeks. A significantly higher proportion of patients treated with teduglutide had a 20 percent reduction in the volume of parenteral support as compared with placebo (63 versus 30 percent, respectively) [37]. The mean reduction in parenteral support volume after 24 weeks was 4.4 L in the teduglutide group compared with 2.3 L in the placebo

group. Fifty-four percent of those receiving teduglutide reduced at least one parenteral support day per week compared with 23 percent for placebo. In a two-year extension study, 65 patients (74 percent) completed the study. Of the 30 patients treated for 30 months with teduglutide, 28 (93 percent) made additional reductions in parenteral support with a mean decrease of 7.6 L per week, and 21 (70 percent) eliminated at least one infusion day [40]. A total of 15 of the 134 (11 percent) patients treated in both phase III studies and their extension studies were able to be completely weaned from parenteral support [41]; most of these patients had a portion of colon-in-continuity and lower baseline parenteral support requirements.

- **Adverse effects** – Data from the extension studies suggest a tolerable safety profile with abdominal pain, injection site reactions, and stomal complaints being most common [42]. The only contraindication to teduglutide is active gastrointestinal neoplasia. A systematic review [43] indicated that treatment with teduglutide for up to 30 months in humans without a history of cancer did not confer an increased risk of colon neoplasia. Nonetheless, due to the small number of patients studied and animal studies showing growth of existing neoplasia, exploration of the colon is still recommended before treatment and at regular intervals while using teduglutide. Side effects include intestinal obstruction, fluid overload, cholecystitis, elevation of pancreatic enzymes, and an increased risk of adenomas in the bile duct and the small and large intestines. Stomal enlargement and injection site reactions may also occur.

Restoration of intestinal continuity and relief of strictures — Restoration of intestinal continuity, such as re-anastomosis of small intestine with colon, should be performed whenever possible. A residual small bowel length of at least 75 cm, even if anastomosed to only part of the colon, leads to a high likelihood of parenteral nutrition independence after one year of follow-up [44]. This surgery generally has low morbidity and mortality and is associated with high rates of discontinuation from parenteral nutrition.

Patients with SBS, especially those with small intestinal bacterial overgrowth, commonly have anastomotic strictures. Further resection of an already shortened small intestine may be avoided by using tapering enteroplasty, strictureplasty, or serosal patching [45,46]. This may occasionally produce a dramatic clinical improvement in patients with bacterial overgrowth provided that the patient has preserved small bowel motility.

Autologous gastrointestinal reconstruction — Autologous gastrointestinal reconstruction procedures are reserved for patients with persistent intestinal failure due to SBS [47]. Autologous gastrointestinal reconstruction procedures should be performed only after maximal adaptation has been achieved and when the rate of progression in oral/enteral calories is slow.

Autologous gastrointestinal reconstruction for SBS is technically challenging and should only be performed by highly experienced surgeons in carefully selected patients. Patients with advanced liver disease should be referred for intestinal transplantation [48]. (See 'Intestinal transplantation' below.)

- **Choice of procedure** – The choice of surgery is based on the existing bowel length, function, and caliber [49].
  - **Patients with poor motility and dilated bowel** − Segmental dilation of the small bowel with poor peristalsis is largely seen in children with SBS. Autologous gastrointestinal reconstruction procedures (eg, longitudinal intestinal lengthening and tailoring, and serial transverse enteroplasty procedure) can increase bowel length and absorptive area. These procedures are described in detail separately. (See "Management of short bowel syndrome in children", section on 'Intestinal lengthening procedures'.)
  - **Patients with fast intestinal transit without bowel dilatation –** Segmental reversal of the small bowel involves interpositioning of reversed segments of small bowel or colon to slow the delivery of nutrients through the small intestine, and creation of valves that produce a partial obstruction to disrupt the normal flow of contents. Success has been reported in some adult patients [50], but procedures to slow transit are contraindicated in patients with small bowel bacterial overgrowth [45,50].

Intestinal transplantation — Small bowel transplantation is reserved for SBS patients with a lifelong need for parenteral nutrition and irreversible complications of parenteral nutrition (eg, impending or overt liver failure, thrombosis of major central venous channels, frequent central line-related sepsis) or an inability to manage hydration/nutrition status despite parenteral nutrition. Small bowel transplantation replaces the missing or diseased intestine and offers the potential for return to normal activities and intestinal function. Indications, donor selection, surgical transplantation, and postoperative complications are discussed in detail separately. (See "Overview of intestinal and multivisceral transplantation".)

OTHER INTERVENTIONS WITH UNCLEAR ROLE

- **Growth hormone** – The beneficial effect of growth hormone (GH) as an aid to wean parenteral nutrition in SBS is controversial and a considerable amount of skepticism surrounds the long-term benefits of this approach [51]. We do not generally recommend its use in our patients with SBS.

- **Efficacy** – Early open-label reports have suggested that the combination of glutamine, growth hormone, glutamine, and a diet optimized to the short bowel patient's residual bowel anatomy enhanced the adaptation process and allowed enteral nutrition in patients who had been dependent upon parenteral nutrition (PN) and allowed successful, long-term weaning of PN. A subsequent prospective, randomized, controlled study of recombinant human GH (0.10 mg/kg/d) and an optimized diet with or without glutamine in 41 PN-dependent SBS patients (most with colon-in-continuity) found a significant reduction in PN requirements (the primary endpoint) in all groups studied at the end of the four-week inpatient treatment period. The extent of reduction was greatest in the group receiving GH in addition to the diet and glutamine. The PN reduction remained significantly reduced 12 weeks later in the GH with glutamine group only.

- **Adverse effects** – Side effects of GH include peripheral edema, arthralgias, and carpal tunnel syndrome. There is also concern about a potential increased risk of colorectal cancer in patients receiving GH if required to be administered over an extended period of time.

- Glutamine – We do not use glutamine in our SBS patients. In contrast to the combination with growth hormone, a double blind, crossover study of oral glutamine administration alone to eight patients with SBS demonstrated no benefit in terms of intestinal adaptation/absorption.

- **Bile acid binders and pancreatic enzymes** – Given the already diminished bile acid pool in SBS, the use of bile acid sequestrants (eg, cholestyramine) may actually worsen steatorrhea and fat-soluble vitamin losses in the patient with SBS and should generally be avoided. Pancreatic enzyme secretion is reduced in SBS only when there is no concomitant enteral/oral diet. Although there may be concern about a mismatch of pancreatic enzymes mixing with ingested nutrients due to the alterations in anatomy and faster small intestinal transit, evidence supporting the usefulness of pancreatic enzyme supplementation in SBS is lacking.

PROGNOSIS

SBS occurs in approximately 15 percent of adults undergoing intestinal resection; nearly 75 percent result from a single massive resection and the other 25 percent from multiple resections [52]. Approximately 70 percent of those with newly acquired SBS are eventually able to be discharged from the hospital [53]. Two-year and five-year survival rates for SBS are at over

80 and 70 percent, respectively [54,55]. Survival rates were lowest in the end-jejunostomy and ultra-short small bowel groups. Other factors affecting survival in SBS include the patient's age, primary disease process, comorbid diseases, presence of chronic intestinal obstruction, and the experience of the team managing the patient [56].

Approximately 50 percent of adults with SBS are able to be weaned completely from parenteral nutrition within five years of diagnosis [57,58]. However, the probability of eliminating parenteral nutrition use is <6 percent, if not successfully accomplished in the first two years following the individual's last bowel resection [57].

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Short bowel syndrome".)

SUMMARY AND RECOMMENDATIONS

- **Definition** – Short bowel syndrome (SBS) is a condition that results from surgical resection or congenital disease of the small intestine which is characterized by the inability to maintain protein-energy, fluid, electrolyte, or micronutrient balances when on a conventionally accepted, normal diet. The physiologic course of SBS is divided into two phases:
  - Acute phase – The acute phase is characterized by high intestinal losses and the metabolic derangement. It starts immediately after resection and generally lasts for three to four weeks.
  - Adaptation phase – The adaptation phase is characterized by structural and functional changes to increase nutrient absorption and slow the gastrointestinal transit. The adaptive phase usually lasts for one to two years.
- **Acute phase management**
  - **Intravenous fluids and nutritional support** – Management of SBS in the acute phase primarily involves close monitoring of stool and urine output, and parenteral replacement of fluid and electrolyte losses. Parenteral nutrition should begin promptly once the patient stabilizes after intestinal resection. Enteral nutrition should also be attempted after the stool losses become controllable. The duration of parenteral

nutrition support depends on the length of the small bowel resected, the site of resection, and the presence of an intact ileocecal valve and colon-in-continuity with the small bowel. (See "Pathophysiology of short bowel syndrome", section on 'Initial determinants of intestinal function'.)

- **Acid suppression** – We recommend administering acid-suppressing medications (ie, H2 blockers or proton pump inhibitors) to patients with SBS during the first three to six months after intestinal resection in order to reduce gastric secretion and enteral fluid losses (**Grade 1B**). Measures to reduce intestinal motility and secretions include the use of antidiarrheals (eg, loperamide, codeine sulfate). Restoration of intestinal continuity, such as re-anastomosis of small intestine with colon, should be performed whenever possible.

- **Adaptation phase management**

  - **Oral diet and medication precautions** – Patients with SBS should be transitioned to oral feedings in a slow and stepwise manner over a period of weeks to months. Enteral nutrition requires constant reassessment of the absorptive state that changes as adaptation continues. Patients with SBS may be at risk for impaired absorption of enteric-coated drugs and timed/delayed-release medications. When feasible, alternative methods for medication delivery (eg, liquid, transdermal, suppositories) should be used and medication levels should be monitored. (See 'Management in adaptation phase' above and 'Precautions for orally administered medications' above.)

  - **Fluid management** – Patients with SBS remain at risk for dehydration and require careful monitoring for signs and symptoms of dehydration and electrolyte abnormalities. Measures to decrease intestinal fluid loss include avoidance of hypertonic and hypotonic fluids and the use of an oral rehydration solution to maintain hydration. We reserve the use of octreotide and clonidine in SBS patients who continue to have high fluid losses (eg, end-jejunostomy patients). (See 'Pharmacologic therapy to reduce fluid loss' above and 'Additional management for patients with high fluid losses' above and 'Fluid management' above.)

  - **Patients with persistent intestinal failure** – We reserve the use of the intestinotrophic factor, teduglutide, in SBS in those patients who are unable to be weaned from parenteral nutrition despite aggressive use of the more conventional measures, particularly in those who have developed significant complications or describe severe impairment in quality of life related to parenteral nutrition use. Autologous gastrointestinal reconstruction procedures are reserved for patients with

persistent intestinal failure due to SBS and only after the period of maximal intestinal adaptation. Indications for small bowel transplantation include a lifelong need for parenteral nutrition and irreversible complications of parenteral nutrition (eg, impending or overt liver failure, thrombosis of major central venous channels, frequent central line related sepsis) or an inability to manage hydration/nutrition status despite parenteral nutrition. (See 'Patients with persistent intestinal failure' above.)

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GRAPHICS

Diet and fluid recommendations in short bowel syndrome

	Colon present	Colon absent
Carbohydrate	50 to 60% of caloric intake	40 to 50% of caloric intake
	Complex carbohydrates	Complex carbohydrates
Fat	20 to 30% of caloric intake	30 to 40% of caloric intake
	Ensure adequate essential fats	Ensure adequate essential fats
	MCT/LCT	LCT
Protein	20 to 30% of caloric intake	20 to 30% of caloric intake
Fiber	Net secretors	Net secretors
	Soluble	Soluble
Oxalate	Restrict	No restriction needed
Fluids	ORS and/or hypotonic	ORS
	Avoid hyperosmolar	Avoid hyperosmolar

MCT: medium-chain triglycerides; LCT: long-chain triglycerides; ORS: oral rehydration solution.

Graphic 115221 Version 1.0

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