

Intestinal Failure and Rehabilitation

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KEYWORDS

- Intestinal failure • Intestinal rehabilitation • Short bowel syndrome
- Home parenteral nutrition • Intestinal adaptation

KEY POINTS

- Following a massive enterectomy, the intestine hypertrophies over time and segmental absorption improves.
- Medication malabsorption occurs in patients with intestinal failure.
- Diarrhea control in patients with intestinal failure may involve the use of several medications at unconventional dose.
- Development of hyperphagia and a high complex carbohydrate diet is critically important in patients with residual colon on continuity with small bowel, but has little role in patients with a jejunostomy.
- Teduglutide, a GLP-2 analog, may be useful to enhance intestinal adaptation, enhance nutrient and fluid absorption, and help wean patients from parenteral nutrition when conventional methods have been unsuccessful.

INTRODUCTION TO INTESTINAL FAILURE

Intestinal failure has been defined as a condition that “results from obstruction, dysmotility, surgical resection, congenital defect, or disease-associated loss of absorption and is characterized by the inability to maintain protein-energy, fluid, electrolyte, or micronutrient balance.”¹ Not all patients who have undergone intestinal resection, or even have developed short bowel syndrome (SBS) will develop intestinal failure and, of course, there are causes for intestinal failure other than SBS. This article addresses the management of those patients with SBS and intestinal failure, a group that has been defined as “type 2,” referring to those patients who may require intravenous nutrition and/or fluid and electrolyte supplementation for a period of weeks to months, or “type 3” wherein intestinal failure may require years to reverse, if at all.² SBS may develop as a consequence of mesenteric thrombosis (venous or arterial), mesenteric embolism (arterial), resections for Crohn disease, volvulus,

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intussusception, polyposis, aganglionosis, radiation enteritis, necrotizing enterocolitis, trauma, or surgical misadventures. SBS also may be congenital in the form of jejunal or ileal atresia, gastroschisis, or omphalocele.

Normally in adults, intestinal length varies between approximately 275 and 850 cm.³ In general, intestinal failure results when there is less than 35 cm of residual small bowel with a jejunoileal anastomosis when the colon is intact and in continuity; less than 60 cm with a jejunocolonic anastomosis and an intact colon; or less than 115 cm when there is an end-jejunostomy. From an energy-absorptive perspective, approximately half of the colon is roughly equivalent to 50 cm of small intestine. This article focuses on the adult, although applicable data from children are cited and described. Children have all the same issues as adults, but also some unique issues that are important in adaptation and weaning of parenteral nutrition (PN), such as different macronutrient and micronutrient requirements, and food aversion if they have received PN since birth or a very early age, which is not discussed here.

INTESTINAL REHABILITATION AND ADAPTATION

Intestinal rehabilitation is defined as the restoration of lost intestinal function. Specifically, that refers to increased macronutrient and micronutrient as well as fluid absorption. This process begins immediately following an intestinal resection and is mediated by various interactive factors, including presence or absence of an ileocecal valve, comorbid conditions, age, blood flow, dietary elements, gastrointestinal secretions, cytokines, and hormone/growth factors.⁴ The intestine increases slightly in length, but more importantly increases in overall surface area via longer villi (and increased crypt depth), likely resulting in more efficient absorption per square centimeter.⁵⁻⁸ This process is thought to take up to 1 to 2 years in humans, although there are few instructive data.^{3,9,10} There are isolated experiences of patients gaining weight while on PN and being weaned after many years. Minimal, if any adaptation occurs in patients with an end-jejunostomy.⁴ One series of 28 children with less than 20 cm of small bowel showed that nearly half were able to become nutritional independent within 2 years, although those with an intact colon in continuity were more likely to achieve nutritional autonomy.¹¹ In general, in adults, intestinal adaptation will be suboptimal in those with less than 75 to 100 cm of healthy residual small bowel.^{9,12} Most macronutrients are absorbed within the initial 100 to 150 cm of jejunum.¹³ If residual colon remains in continuity with the small bowel, unabsorbed carbohydrates may be salvaged by colonic bacteria and fermented to short-chain fatty acids (SCFAs), an energy source.¹⁴ Therefore, less small residual small bowel is required in the presence of colon. Patients with radiation enteritis, an increasingly greater percentage of the population of patients with intestinal failure, generally have blunted adaptation, although an observational study from France has suggested upward of as many as two-thirds may be successfully weaned from PN.¹⁵ The degree to which the intestine “adapts” and PN can be weaned may be highly individualized, although a plasma citrulline concentration of less than 20 $\mu\text{mol/L}$ predicted the presence of permanent intestinal failure in a study of 57 patients (sensitivity 92%; specificity 90%).^{16,17}

PARENTERAL NUTRITION

The first step in intestinal rehabilitation is to determine the patient’s fluid and macronutritional and micronutritional requirements to avoid the provision of excessive amounts. In general, fluid requirements for adults average approximately 35 mL/kg body weight, although slightly less if age is >60 years.¹⁸ Diseases such as renal failure, cirrhosis, or congestive heart failure obviously lead to decreased requirements.

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