Nutrición Hospitalaria
ISSN: 0212-1611
info@nutriciónhospitalaria.com
Grupo Aula Médica
España

Nutrición Hospitalaria

Nutr Hosp. 2011;26(4):834-842
ISSN 0212-1611 • CODEN NUHOEQ
S.V.R. 318

Original

Long-term nutritional assessment of patients with severe short bowel syndrome managed with home enteral nutrition and oral intake

V. Chaer Borges[1], M.ª de L. Teixeira da Silva[2], M.ª C. Gonçalves Dias[3], M.ª C. González[4] and D. Linetzky Waitzberg[1,3]

[1,2]GANEP. Nutrição Humana. Sao Pauo. Brazil. [3]University of Sao Paulo. School of Medicine. Department of Gastroenterology. LIM 35. Digestive Surgery Division. Sao Paulo. Brazil. [4]Post Graduation Program in Health and Behavior from the Catolic University of Pelotas. Adjunct Professor of the Catholic University of Pelotas. Rio Grande do Sul. Brazil.

Abstract

Background: **Parenteral nutrition (PN) is used to control the nutritional state after severe intestinal resections. Whenever possible, enteral nutrition (EN) is used to promote intestinal rehabilitation and reduce PN dependency. Our aim is to verify whether EN + oral intake (OI) in severe short bowel syndrome (SBS) surgical adult patients can maintain adequate nutritional status in the long term.**

Methods: **This longitudinal retrospective study included 10 patients followed for 7 post-operative years. Body mass index (BMI), percentage of involuntary loss of usual body weight (UWL), free fat mass (FFM), and fat mass (FM) composition assessed by bioelectric impedance, and laboratory tests were evaluated at 6, 12, 24, 36, 48, 60, 72, and 84 months after surgery. Energy and protein offered in HPN and at long term by HEN+ oral intake (OI), was evaluated at the same periods. The statistical model of generalized estimating equations with p < 0,05 was used.**

Results: With long term EN + OI there was a progressive increase in the UWL, a decrease in BMI, FFM, and FM (p < 0,05). PN weaning was possible in eight patients. Infection due to central venous catheter (CVC) contamination was the most common complication (1.2 episodes CVC/patient/year). There was an increase in energy and protein intake supply provided by HEN+OI (p < 0.05). All patients survived for at least 2 years, seven for 5 years and six for 7 years of follow-up.

Conclusions: In the long term SBS surgical adult patients fed with HEN+OI couldn't maintain adequate nutritional status with loss of FM and FFM.

(*Nutr Hosp.* 2011;26:834-842)

DOI:10.3305/nh.2011.26.4.5153

Key words: *Short bowel syndrome. Long-term nutritional outcome. Home parenteral nutrition. Home enteral nutrition. Oral intake.*

Correspondence: Viviane Chaer Borges.
GANEP-Beneficência Portuguesa de São Paulo.
Rua Maestro Cardim 1236.
CP: 01323-001 São Paulo. Brazil.
E-mail: viviane@ganep.com.br

Recibido: 25-XI-2010.
Aceptado: 28-XI-2010.

EVALUACIÓN NUTRICIONAL A LARGO PLAZO DE PACIENTES CON GRAVE SÍNDROME DE INTESTINO CORTO CONTROLADA CON NUTRICIÓN ENTERAL E INGESTIÓN ORAL

Resumen

Antecedentes: **La nutrición parenteral (NP) se emplea para controlar el estado nutricional después de resecciones intestinales extensas. Siempre que sea posible, se empleará la nutrición enteral (NE) para favorecer la rehabilitación intestinal y reducir la dependencia de la NP. Nuestro propósito fue verificar si la NE + ingesta oral (IO) en el síndrome del intestino corto (SIC) grave en pacientes adultos quirúrgicos puede mantener un estado nutricional adecuado a largo plazo.**

Métodos: **Este estudio longitudinal retrospectivo incluyó 10 pacientes seguidos durante 7 años tras la intervención quirúrgica. Se evaluaron el índice de masa corporal (IMC), el porcentaje de pérdida involuntaria del peso corporal habitual (PCH), la masa grasa libre (MGL) y la composición de la masa grasa (MG) mediante impedancia bioeléctrica, así como los datos de laboratorio a los 6, 12, 24, 36, 48, 60, 72 y 84 meses tras la cirugía. Se evaluaron en los mismos periodos la energía y las proteínas aportadas con la NPD y a largo plazo con la NED + ingesta oral (IO). Se utilizó un modelo estadístico de ecuaciones estimativas generalizadas con una p < 0,05.**

Resultados: **Con la NE + IO a largo plazo hubo un aumento progresivo del PCH, una descenso del IMC, la MGL y la MG (p < 0,05). La retirada de la NP fue posible en ocho pacientes. La complicación más frecuente fue la infección por contaminación del catéter venoso central (CVC) (1,2 episodios CVC/paciente/año). Hubo un aumento en el consumo de energía y proteínas proporcionadas por la NED + IO (p < 0,05). Todos los pacientes sobrevivieron al menos dos años, siete durante 5 años y seis durante los 7 años de seguimiento.**

Conclusiones: los pacientes adultos con SIC quirúrgico nutridos a largo plazo con NED + IO no pudieron mantener un adecuado estado nutricional con una pérdida de MG y de MGL.

(*Nutr Hosp.* 2011;26:834-842)

DOI:10.3305/nh.2011.26.4.5153

Palabras clave: *Síndrome del intestino corto. Resultado nutricional a largo plazo. Nutrición parenteral domiciliaria. Nutrición enteral domiciliaria. Ingesta oral.*

Introduction

Severe short bowel syndrome (SBS) after massive small bowel resection is due to the loss of massive absorptive surface area do to intestinal resection and is associated with serious nutritional consequences. Severe SBS may occur with 50-75 cm of residual short bowel remaining depending upon the presence of the colon.[1] The initial approach regarding severe SBS patients involves control of hydroelectrolitic disturbances. Parenteral nutrition (PN) is started early in order to prevent nutritional status degradation and is maintained until intestinal rehabilitation is complete.[2,3,4,5,6,7,8]

Introduced in the 1960s, PN —and later applied at home (HPN)— has proven to be essential for long-term survival of patients with severe SBS.[9,10,11] However PN is a highly complex procedure that may be associated with mechanical, metabolic, and infectious complications that reduce its cost efficiency relationship.[7,12,13,14] In a series of 124 SBS patients followed for ten years, those dependent on PN had a mortality rate of 53%.[15] Among the causes of death are sepsis, liver failure, and consequences of deep vein thrombosis.[12]

Some severe SBS under HPN may develop systemic recurrent infections upon central vein catheter contamination, thrombosis of two or more central veins, and hepatic malfunction,[16] thus these patients may be referred for small bowel transplantation. Recent data from the Intestinal Registry indicate a 47.5% 5 year mortality.[17]

Small bowel transplantation is not available in every country, and effort should be made to postpone the morbid conditions that lead to its indication. This includes the early weaning from PN to avoid PN complications caused by its prolonged use and the feeding using the digestive tract (enteral nutrition and oral intake) as much as possible.[2,3,4]

EN has been used since the 1980s as an alternative means of nutritional therapy in patients with SBS in an attempt to stimulate intestinal rehabilitation and to reduce or eliminate PN . Early studies indicated satisfactory results, in the short and medium term, with the use of continuous EN by high viscosity enteral formula or nightly cycles.[18,19] Early experience with EN used in SBS patients to reduce or eliminate PN exhibited satisfactory results. Among the resources available are the utilization of EN at home (HEN), and the provision of an iso-osmolar hypercaloric oral diet in a fractionated form, addition of soluble fibers, restriction of lipids, lactose, and calcium oxalate when necessary, use of oral rehydration, vitamin and mineral supplements, as well as the use of anti-diarrhea medications and acid secretion blockers.[8,16]

There are studies exploring the use of EN in patients with SBS to increase the nutrition through the digestive tract in an attempt to reduce or discontinue PN.[34,35] However there is no data available on the long-term nutritional status of patients with severe SBS who have used EN+OI as their preferred method of treatment.

Our clinical hypothesis was that SBS patients on the long term could maintain their normal nutrition status with EN+OI as the main feeding source.

Methods

This long-term retrospective clinical study comprised ten patients with severe SBS after intestinal surgical resection admitted to the HPN program of GANEP – Human Nutrition and to the AMULSIC-Outpatient ambulatory SBS at the Gastroenterology Department of FMUSP- University of São Paulo from the period 1986 to 2004. The Ethics Committee of the São Paulo School of Medicine – the Federal University of São Paulo approved this study. Patients or their next of kin signed appropriate consent forms during the study.

Adults aged 18 to 70 years old were included in the study. The length of the residual small bowel (RSB) after the Treitz angle was between 0 and 70 cm with the colon entirely or partially present. All subjects had no chronic conditions such as kidney, liver, pancreatic, or heart disease, lung failure, cancer including metastases, or functional digestive illness which could negatively affect intestinal absorption (Crohn's disease, non-specific ulcerative rectocolitis). The patients had body mass index (BMI) on admission to the study between 18.5 and 29.9 kg/height/m^2.

The patients were examined periodically at 6, 12, 24, 36, 48, 54, 60, 72, and 84 ± 4 months after the intestinal resection.

Standard techniques were used for nutritional assessment.[20,21] Body weight (kg) and height (meters) were measured with a FILIZOLA® platform weight gauge (Industriais Filizola S.A., São Paulo, Brazil). The BMI and percentage of involuntary loss of usual body weight (%UWL) were calculated by means of standardized equations.[22,23,24] The basal energy expenditure (BEE) of patients was estimating using Harris and Benedict's equation and body weight checked throughout the study.[25] All patients' %UWL was calculated, except in one patient, the number six whose body weight was within the obesity range. A value of %UWL 20% represents severe loss of body weight and nutritional status.[24]

Electrical bioimpedance was performed in 9 patients with the Quantum BIA-101 Q® (RJL Systems, Michigan, USA) and the Bodystat 1500® (Bodystat Ltd., Isle of Man, UK). From the impedance value (Z), either calculated directly or from resistance (R) and reactance (X),[26] fat free mass (FFM) was calculated in kg.[27] Fat mass (FM) in kg was obtained by subtracting the FFM calculated from the body weight. In order to interpret patients' FFM (kg) and FM (kg) values over time, standard values found in a healthy Caucasian population according to sex and age were used.[28] Thus, FFM (kg) and FM (kg) values of each patient were subtracted from standard averages for the same age and sex range

Table I
Clinical data from 10 patients with short bowel syndrome

Patient no./sex	*Condition for SBR*	*Remaining small bowell (cm)*	*Ileo-cecal valve*	*Remaining colon-rigth*	*Remaining colon-left*	*Sigmoid Rectum*	*Anastomosis*
1/W	MI	0	A	A	P	P	D-C
2/W	MI	12	A	A	P	P	J-C
3/M	FP	12	A	P	P	P	J-C
4/M	MI	20	A	A	P	P	J-C
5/M	MI	30	A	A	P	P	J-C
6/M	MI	20	A	P	P	P	J-C
7/W	MI	50	A	A	P	P	J-C
8/W	MI	40	A	P	P	P	J-C
9/M	MI	35	P	P	P	P	J-IC
10/M	AC	70	P	P	P	P	J-IC
M and P		25 (12-42.5 th)					

SBR: small bowel resection; MI: mesenteric infarction; FP: firearm projectile; AC: appendectomy complication; A: absent; P: present; D-C: duodenocolic; J-C: jejunocolic; J-I: jejunoileocolic; all patients had the stomach and transverse colon; M: median; and P; percentiles 25-75th.

and divided by the respective standard deviation, establishing a standard FFM and FM value for each patient for the entire study. FFM (kg) and FM (kg) values were considered to be seriously altered when they were two times the standard deviation or less (percentage 5) of normal average values (percentage 50) as proposed by Schutz et al.[28]

Laboratory dosage was considered altered when total protein was < 6.0 g/dL; albumin < 3.5 g/dL and total lymphocyte count of 1,199 cel/mm^{3}[29].

Eight patients were trained by the GANEP nutritional support team to use HPN following the appropriate guidelines. PN was infused via tunneled central venous subcutaneous catheters. PN formulation was made up of amino acids, glucose, fat emulsions, minerals, micronutrients, and vitamins. Two patients received PN as dayly ambulatory outpatients due to social economic difficulties. PN infusion technique was initially continuos for 24 hours and subsequently cyclical. All patients were trained to use HEN, following well-established current guidelines.

The amount of energy (E) provided by HPN and HEN was calculated daily using the volume received by the patient. The average daily amount per month was calculated for each period assessed.

Patients were taught to use an oral diet low in fat (≤ 30% of E), rich in complex carbohydrates (≥ 50% of E), and protein (≥ 20% of E).[30,31] The quantity of food intake was estimated by using home measurements. The patients kept a 24 hour record of what they had eaten. The data was analyzed by the Nutritional Support Program of the São Paulo Federal University Department, Health IT Section ("NutWin", version 1.5.2.45, 2004). For each period of the study the average value obtained after analysis of 3 days of oral intake was established.

The intake of energy and protein through the digestive system (HEN + OI) corresponded to the sum of the average value of oral ingestion and HEN average in a month. The ingestion of 200% of basal energy expenditure (BEE) and 1.5 to 2 g/kg/per day of protein[16,32] was considered appropriate.[6]

Catheter-related infection was diagnosed when catheter colonization and blood culture were positive for the same organism.[33] Deep venous thrombosis (DVT) was diagnosed by means of Doppler color ultrasonography. Diagnosis of atrial thrombosis and heart valve vegetation was made by transesophageal echocardiogram. Bone disease was diagnosed by bone density testing, and the presence of cholelithiasis diagnosed by ultrasonography.

In order to evaluate variables over time we used the statistic generalized estimating equations (GEE) 34. Differences were considered significant with a p-value < 0.05. Data were expressed by mean and standard deviation, with the exception of the RSB and survival rate, which were measured by median and quartiles.

Results

Patients' general characteristics

In the SBS patients the average age was 47±12 years, height 167±10 cm and average BMI at admission (6 months) was 24.0 ± 3.5 kg/m^2. Intestinal mesenteric thrombosis was the major cause for intestinal resection. The RSB varied between 0 and 70 cm, with a median of 25 cm and percentiles of 12 and 42.5 cm (p25-p75). Jejunocolic anastomosis was found in 7 patients, duodenal-colic in 1 patient, and jejunoileocolic in 2 patients (table I).

Table II
Analysis of anthropometric variables, body mass composition, and laboratory tests. Mean and standard deviation at different periods of the study from 10 short bowel syndrome patients

Period of study (mo) *Variable (means ± SD)*	*6*	*12*	*24*	*26*	*48*	*60*	*72*	*84*
BEE (kcal/day)	1,508.49 ± 311,37	1,453.88 ± 289.94*	1,363.09 ± 269.43**	1,342.25 ± 294.13*	1,304.17 ± 236.66*	1,331,12 ± 257.92*	1,318.63 ± 310.01*	1,274.5 ± 295.88*
BMI (kg(m^2)	24.01 ± 3.51	22.65 ± 2.97	21.28 ± 2,94*	21.08 ± 3.38*	19.70 ± 2.66*	20.75 ± 2.63*	20.45 ± 2.83*	20.04 ± 2.96*
Weight (kg)	68.8 ± 17.10	64.84 ± 15.27	58.98 ± 14.70	57.80 ± 16.45	55.28 ± 12.50	59.20 ± 11.92	58.33 ± 14.74	55.40 ± 14.29
%UW loss	7.84 ± 8.66	12.68 ± 9.15*	18.50 ± 11.68*	18.36 ± 9.87*	19.85 ± 9.99*	16.59 ± 10.84*	18.73 ± 12.50*	22.66 ± 13.08*
Fat free mass (kg)	54.81 ± 12.73	53.08 ± 11.78	50.21 ± 11.19*	49.63 ± 11.12*	46.70 ± 10.01*	47.93 ± 9.56*	48.09 ± 10.98*	46.48 ± 9.81*
Fat mass (kg)	15.51 ± 5.76	13.14 ± 4.89	9.88 ± 4.62*	9.57 ± 6.76*	8.77 ± 4.41*	11.27 ± 4.50*	10.24 ± 4.29*	8.82 ± 5.10*
Serum protein g/dL	7.51 ± 0.96	7.16 ± 0.53	7.20 ± 0.45	7.20 ± 0.42	6.57 ± 0.53*	6.88 ± 0.50*	7.06 ± 0.73	6,82 ± 0.90
Serum albumin g/dL	4.13 ± 0.51	3.86 ± 0.55	3.89 ± 0.40	3.79 ± 0.48	3.61 ± 0.45*	3.68 ± 0.46	3.77 ± 0.55	3.60 ± 0.97
Lymphocyte mil/mm^3	1,737.13 ± 533.81	2,119.88 ± 1,146.89	2,201.22 ± 1,103.99	2,240.50 ± 1,048.28	1,756,67 ± 365.50	2,218.50 ± 892.75	1,931.20 ± 703.69	1,819.33 ± 688.69

BEE: basal energy expenditure (based on Harris and Benedict); BMI: body mass index; %UW loss: percentage of involuntary usual weight loss; *P < 0.05 when compared with the initial value at 6 months.

Body mass composition and laboratory measurements

There was a progressive decrease in energy expenditure estimation based on actual body weight ($p < 0.0001$) and BMI ($P < 0.05$). There was a significant and progressive increase in %UWL ($p < 0.05$) rising to 20% of body weight loss by the end of the period of observation.

The share of body composition expressed as FFM (kg) and FM (kg) decreased significantly ($p < 0.05$), the latter after only 24 months of observation (table II). FFM and FM expressed as standardized values remained below the 50 percentile, but did not, on average, reach the 5 percent level, which is considered in this study to represent a serious alteration (fig. 1). Serum albumin, total protein, and total lymphocyte count measurements were also within normal ranges and did not present any significant changes throughout the different phases of the study (table II).

Removing patients from total parenteral nutrition

All of the patients except two continued their activities work away from home. HPN was withdrawn in eigth patients, permanently in five cases (patient number 4, 7, 8, 9, and 10) and temporarily in three (patient number 2, 3, and 6) (table III). For patient number two HPN was reintroduced permanently after 42 months due to severe body weight loss and a deteriorating nutritional condition. HPN was reintroduced intermittently for patients 3 and 6 over a period of an year after 36 and 72 months, respectively, due to relative body weight loss and hydroelectrolitic imbalances. This procedure was a valuable nutritional aid for these three patients. Withdrawal of HPN was not possible for patients 1 and 5 as they were unable to continue HEN; these two patients died (table III).

The most frequent complications arising from HPN being infection resulting from contamination of the

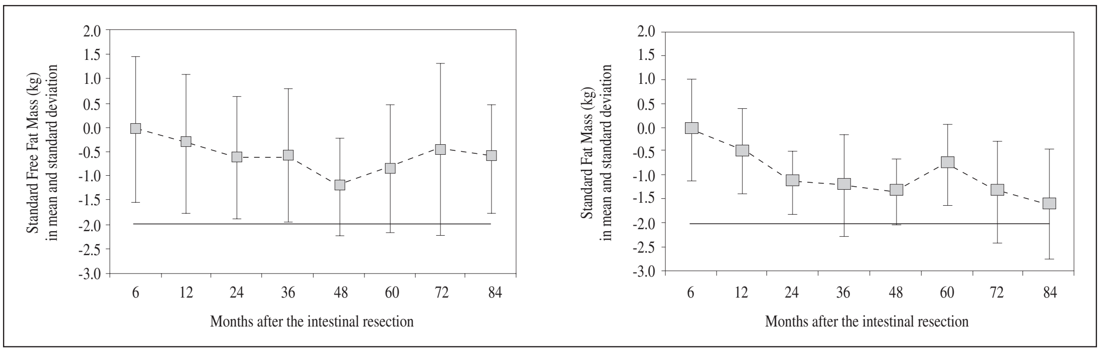

*Fig. 1.—Standard Free Fat Mass and Fat Mass (kg) in mean and standard deviation at different time points after intestinal resection (p < 0.0001). * = two times standard deviation or less of the normal average values.*

Table III
Use of Home Parenteral Nutrition (HPN) and Home Enteral Nutrition (HEN) by 10 patients with short bowel syndrome

Patient number	HPN removed (mo. after SBR)	HEN started (mo. after SBR) route	EN by orl intake (ml/h)	Infusion by pump (ml/h)	Method of HEN infusion	HEN stopped (mo. after SBR)	HPN restored (mo. after SBR)	Evolution
1	no	36/tubeF and 38/OI	100	40	ID	no	no	D
2	9	24/OI and/or tubeF	250	60	ID	36	42*	D
3	24	3/OI e 30G	200	70	ID and CN	NO	36†	D
4	9	12/OI	130		ID	no	no	A
5	no	6/OI	150		ID	9	no	D
6	36	6/OI and 48/G	200	75	ID and CN	no	72†	A
7	36	30/OI	200		ID	no	no	A
8	18	3/OI	250		ID	no	no	A
9	6	9/tubeF and 24/OI	250	85	ID	no	no	A
10	18	12/OI and 24/G	230	60	ID and CN	no	no	A

mo: months; SBR: short bowel resection; ID: intermittent during the day; CN: cyclic nocturnal; tubeF: tube feeding; OI: oral intake; G: gastrostomy; *: permanent; †: sometimes; D: dead; A: alive.

CVC (1.2 episodes per catheter per patient per year of HPN). Of a total of 30 instances of CVC contamination, 20% were of fungal origin and 80% bacterial, notably Alcaligenes sp, Escherichia coli, Enterobacter cloacae, Enterobacter sp, Klebsiella oxytoca, Micrococcus, Proteus mirabilis, Pseudomonas cepacea, Sphingobacterium multivorum, and Staphyloccocus epidermides. The fungi detected were Candida guilhermondis, Candida sp, and Cryptococcus sp.

Bone disease was found in seven patients (number 1, 2, 3, 6, 7, 9, and 10), deep vein thrombosis was present in three patients (number 6, 9, and 10). Chronic calculous cholelithiasis was present in five patients (number 1,6,7, 8, and 10) and cholecystectomy was performed on 4 patients. None of the patients presented with any significant liver complication. Energy input by HPN is shown in table IV.

HEN was administered in the form of an oral supplement exclusively in four cases. In the other cases it was used in combination with oral supplements and a nasoenteral feeding tube or gastrostomy (table III). The infusion technique of HEN involved a nightly cycle using an infusion pump in three patients, intermittent gravitational feeding by day in three cases, and by slow ingestion during the day in four patients. The formula used with seven patients was an isoosmolar polymeric diet (normocaloric, normoproteic, normolipidic), whereas isoosmolar oligomeric diet (normocaloric, normo- or hyperproteic, hypolipidic) was used with the remainder.

HEN was well tolerated by seven patients. All of the patients suffered at least one complication resulting from HEN. All ten patients had an increased number of bowel movements, four patients had excessive bacterial growth, two patients suffered leakage of fluids at the gastrostomy outlet . The nasoenteral tube feeding of three patients became blocked. All of these complications were corrected by standard procedures.

The supply of energy and proteins by EN expressed as kcal/day and by g/day were progressively increased and this increase became significant after 24 months ($p < 0.05$). The maximum energy value was 1,007.7 ± 229.9 kcal/day (table IV) and the maximum protein value was 43.33 ± 11.72 g of proteins/day.

One year after surgery, significant increases in energy and protein enteral intake were observed with HEN + OI (table IV). With respect to energy, sufficient uptake was achieved 60 and 84 months post operation. With respect to protein (g/kg body weight/day), sufficient uptake was achieved 12 months post operatively throughout the period of observation.

Patient progress and survival

Four patients died during the course of the study (number 1, 2, 3, and 5). This occurred at 60, 84, 36, and 30 months, respectively, after surgery for intestinal resection.

All patients survived for 2 years, seven for 5 years, and six for 7 years or beyond the end of the study (July 2007). The average life expectancy after operation for the patients who eventually died was 4.5 years, with percentiles of 2,9 and 6,6 years (25th-75th).

Table IV
Analysis of variables related to energy and protein intake and nutritional therapy. Mean and standard deviation at different periods of the study from ten short bowel syndrome patients

Period of study (mo) *Variable (means ± SD)*	*6*	*12*	*24*	*26*	*48*	*60*	*72*	*84*
HPN kcal/kg/day	20.35 ± 7.02	17.85 ± 12.56	24.75 ± 18.61	18.55 ± 15.44	18.70 ± 21.75			
HPN g aa/kg/day	0.92 ± 0.26	0.82 ± 0.50	0.91 ± 0.52	0.80 ± 0.54	0.66 ± 0.79			
HEN kcal/day	337.48 ± 101.74	510.21 ± 318.48	677.71 ± 364.77*	766.29 ± 344.30*	915.71 ± 407.77*	945.40 ± 406.52*	1,007.67 ± 229.93*	973.00 ± 274.22*
HEN g P/day	14.21 ± 3.44	22.41 ± 16.24	26.34 ± 13.83*	31.25 ± 12.35*	37.14 ± 13.96*	38.00 ± 14.83*	43.33 ± 11.72*	36.20 ± 7.50*
HEN+OI kcal%BEE	102.62 ± 37.21	154.06 ± 97.62*	146.48 ± 49.21*	187.44 ± 68.81*	187.23 ± 37.67*	215.58 ± 79.67*	163.29 ± 62.56*	200.47 ± 66.60*
HEN+OI kcal/kg/day	23.08 ± 9.32	35.61 ± 23.86*	34.55 ± 12.80*	44.63 ± 16.90*	45.15 ± 11.31*	48.87 ± 18.76*	37.31 ± 15.06*	47.69 ± 19.95*
HEN+OI g P/kg/day	1,17 ± 0.58	1.57 ± 0.99	1.48 ± 0.72	2.04 ± 0.75*	2.01 ± 0.46*	2.01 ± 1.10*	1.88 ± 1.11	2.23 ± 1.01*

HPN: home parenteral nutrition; kcal/kg/day: kilocalories per kilogram per day; aa/kg/day: amino acid in grams per kilogram per day; kcal/day; kilocalories per day; P/day: protein in grams per day; HEN: home enteral nutrition; OI: oral intake; P/kg/day: protein in grams per kilogram per day; $^{*}P < 0.05$.

The causes of death of the four patients referred to was as follows: chronic urinary infection, pneumonia, and sepsis (patient no.1); urinary infection, chronic renal failure, and sepsis (patient no.2); sepsis due to CVC contamination and acute chronic renal failure (patient no.5); severe hypophosphatasemia, unresponsive to treatment (patient no.3). Of the six patients who survived until the end of the study, only one (patient no.6) returned to occasional HPN treatment after 72 months of the study, 180 days a year via short term CVC.

Discussion

In patients with severe surgical SBS, implementation of PN during the post operative period is essential in controlling hydration and preventing degradation of nutritional status. In this situation, PN may be maintained in the medium to long term, depending on how well the patient's digestive system function rehabilitates. Successful home PN (HPN) requires an experienced multiprofessional nutritional support team, but also relies on a patients' favorable social, economic, and cultural condition. In Brazil, The Health Ministry considers HPN a highly complex procedure. The public health care system currently does not have the capacity for home visitation of PN patients on a regular basis as there are few multiprofessional teams properly trained for the program implementation.

The HPN technique used in our study is based on patient self-care. We trained the patient and/or family members to administer PN via central vein catheters by infusion pump for 8 to 16 hours (nightly cycle). However, two of our patients could not be trained due to lack of proper housing, poor sanitary conditions, and an incapacity to fully understand the technique. Sepsis due to CVC contamination was the most frequent cause of death, a factor exacerbated by prolonged PN use.[7,13,14]

Messing at al., in a study of patients 124 patients with SBS for 10 years, showed a mortality of 53% in 60 subjects went on to develop intestinal failure. In this group the death was related to HPN in 22% of which in 7 patients were related to use of PN and in 5 resulted from sepsis due to CVC contamination. The mortality rate in 64 patients witch HPN was withdrawn was only 12,5%.[15]

All of the patients in our study suffered from some form of CVC contamination with a frequency rate of 1.2 episodes per catheter per patient per year of HPN treatment. CVC was treated with an antibiotic seal when indicated by the presence of bacterial contamination in an attempt to prevent it from having to be removed, as recommended in the literature.[35,36]

Three patients presented with deep vein thrombosis. Another complication of long-term use of HPN that affected seven patients was bone disease. Among the causes of bone disease, the use of cyclic HPN, which replaced continuous 24-h HPN, stands out as it may contribute to urinary calcium loss.[37] An alternative treatment for severe SBS patients with a high complication rate would be intestinal transplantation, but this is currently not available in Brazil. Due to the significant rate of complication observed with long-term use of HPN, as well as the high cost, every effort should be made to maximize the use of HEN combined with oral diet.

In the present study three out of ten patients (number 2,4, and 9) were off HPN by the end of their first postoperative year. Our results diverge from Gouttebell et al.., who was able to wean patients off PN within the first six months after operation in 59% of patients.[38]

It is notable that the duration of PN correlates significantly with the length of the RSB. All patients in our study exhibited a very short remnant small intestine. In the Goutebell study, RSB ranged between 5-140 cm (with total or partial colon) and 25-150 cm (without colon). In addition to the RSB, other important factors may contribute to the successful weaning from HPN, such as the amount of energy and protein supplied via PN, use of EN, age, body weight and height, BEE of patients, oral intake, and the presence of hyperphagia, in addition to the etiology of the SBS itself.[39]

The introduction of oral diets in patients with postoperative SBS should be slow and progressive once hydroelectrolitic losses are controlled[2,4]. Later nutritional recommendations should be based on the anatomy of the RSB. There is no benefit to restriction of lipids or oxalate if there is no colon.[40] In the presence of total or partial colon, which applies to all patients in our study, the recommended and adopted diet was low in fat and rich in carbohydrates.[41]

Hyperphagia is one of the important compensating mechanisms available to overcome malabsorption in SBS, defined as 1.5-2.0 times BEE.[6,39] In our study, only one patient exhibited hyperphagia throughout the study, and three patients presented with it during two or more periods of this study. The presence of bacterial overgrowth, nausea, flatulence, lack of appetite, and fear of eating outside their home were most likely some of the factors affecting SBS patients' oral intake.

Considering that intestinal absorption in SBS patients comprises up to 50% of the diet offered via the enteral route, it may be that patients should be fed 84-168% of BEE in order to be weaned from PN. If the intake by patients who absorb 25-50% of diet via the enteral route were 168-336% of BEE[6] we can assume that the intestinal absorption of patients in our study was lower than 50% and thus they most likely required an enteral energy intake higher than 2 BEE to compensate for malabsorption and preserve nutritional status, which is not what happened.

Polymeric and oligomeric[31,42] low or moderate osmolarity diets were used in our study in an attempt to achieve progressive increase in the HEN supply. However, we were unable to exceed an average of 1,000 kcal and 43 g of protein/day for the following reasons: difficulty in increasing the infusion rate (changing volume or infusion rate) or in increasing the amount of enteral diet per mouth, refusal to have a gastrostomy by five patients, acceptance of enteral diet by mouth, but refusal to use nasoenteral tube by three patients, difficulty in extending the infusion period in cyclic nocturnal HEN for more than 12 hours by the three patients with gastrostomy who worked part time, and finally the non-availability of portable infusion devices to administer EN over 24 hours including time at work. The exclusive use of the enteral route (EN+OI) has proven feasible for at least 50% of patients with less than 50 cm of jejunoileal remnant and continuous colon.[5,16]

In our study, long term administration of EN+OI achieved the energy recommendations defined as minimally adequate only at two periods of the study, which might have led to an energy deficit. We observed a progressive increase in %UWL rising to 20% of body weight loss by the end of period of observation which is too much. This lost resulting in acute and immediate loss of FM and less acutely, although progressively, loss of FFM. The standardized values from FFM and FM remained below the 50 percentile, but in the long term did not, on average, reach the 5 percent level, which was considered in this study a serious alteration.

Total protein, albumin levels, and total lymphocyte count did not change significantly and did not reach, on average, values that might suggest severe degradation of the protein compartment during the course of this study. The interpretation of these results, together with observations of changes in body composition may indicate a chronic marasmic malnutrition condition where bowel proteins may be preserved.

All of our patients survived for 2 years after intestinal resection surgery, 70% for 5 years, and 60% for 7 years or longer . Our results are comparable to probabilities of survival found in 124 patients with SBS in France, of 94%, 86%, and 75%, respectively, at 1, 2, and 5 years after intestinal resection.[15] Despite the limitation of being a retrospective study, our findings appear to be relevant regarding important aspects of the management of patients with severe chronic intestinal insufficiency and possible intestinal failure. Our inability to use EN exclusively in severe SBS may be related to an insufficient intestinal absorption area, even with hyperphagia , making it critical to distinguish between intestinal insufficiency and intestinal failure.[6] Nowadays new resources can be used for this purpose, an example being the fasting citrulline concentration in the plasma.[6,43] However, alternative resources were not available in our Institution. In our study, patients who could be weaned from PN, or have it reduced, survived for a longer period, indicating both better quality of life and the inherent risks of HPN. We found that HEN has advantages, although there are difficulties in implementing it properly.

Efforts should be made to help patients adapt to HEN. The improvement in absorption of nutrients[44,65] and availability of technologies in this field, such as the use of a portable infusion pump for EN, could increase the amount of energy absorbed in the day and should be more widely used.[45]

The use of intermittent PN throughout the year as a nutritional aid should be considered for patients unable to maintain a satisfactory nutritional condition over a period of time when strictly feeding via the digestive tract, bearing in mind the complications and limitations of prolonged PN.

Conclusion

In adult patients with severe SBS for whom HPN was replaced or associated with EN+OI, the following was observed: 1) The preferred combination of HEN+OI failed to maintain patients' body composition, 2) The energy provided by HEN+OI was insufficient to maintain patients' long term nutritional well-being, 3)

Patients' nutritional status deteriorated due to the loss of FM and FFM, with preservation of bowel proteins, 4) In patients who survived, the use of HEN+OI led to a reduction in the number of complications arising from prolonged use of PN and considerably enhanced the quality of life for these patients, 5) The treatment we followed allowed surviving patients to have a greater life expectancy than what is currently obtained by those who undergo intestinal transplants, 6) The intermittent use of PN is a valuable nutritional aid for some patients, and finally, 7) In cases of severe SBS, when it is not possible to reach a minimum of 2x BEE by means of EN+OI, the intermittent addition of HPN should be undertaken in order to preserve nutritional well-being and avoid the consequences of prolonged HPN.

Acknowledgments

Farmoterápica-Sao Paulo, Brazil.

HospPharma-Sao Paulo, Brazil.

Compound pharmacies specialized in compounding and delivering parenteral nutrition solutions for hospital, outpatient clinic and home use.

Hospital da Real e Benemérita Sociedade de Beneficência Portuguesa de São Paulo-Brazil.

Pró-Reitoria de Pós-Graduação e Pesquisa-Nutrição da Universidade Federal de São Paulo-UNIFESP. www.unifesp.br/pg/nutricao.

References

1. Messing B, Pigot F, Rongier M et al. Intestinal absorption of free oral hyperalimentation in very short bowel syndrome. *Gastroenterology* 1991; 100: 1502-1508
2. Sundaram A, Koutkia P, Apovian CM. Nutritional management of short bowel syndrome in adults. *J Clin Gastroenterol* 2002; 34 (3): 207-220.
3. Dibaise JK, Young RJ, Vanderhoof JA. Intestinal rehabilitation and the short bowel syndrome. *Gastroenterology* 2004; 99: 1386-1395.
4. Buchman AL. The Clinical Managment of the short bowel syndrome: steps to avoid parenteral nutrition. *Nutrition* 1997; 13 (10): 907-913.
5. Buchman AL. Etiology and initial management of short bowel syndrome. *Gastroenterology* 2006; 130: S5-S15.
6. Jeppesen PB, Mortensen PB. Intestinal failure defined by measurements of intestinal energy and wet weight absorption. *Gut* 2000; 46: 701-706.
7. Dionigi P, Alessiani M, Ferrazi A. Irreversible intestinal failure, nutrition support and small bowel transplantation. *Nutrition* 2001; 17: 747-750.
8. Jeejeebhoy KN. Management of short bowel syndrome: avoidance of total parenteral nutrition. *Gastroenterology* 2006; 130: S60-S66.
9. Dudrick SJ, Wilmore DW, Vars HM et al. Long-term total parenteral nutrition with growth development and positive nitrogen balance. *Surgery* 1968; 64: 134-42.
10. Wilmore DW, Dudrick SL. Growth and development of an infant receiving all nutrients exclusively by vein. *JAMA* 1968; 203: 860.
11. Jeepesen PB, Langholz E, Mortensen PB. Quality of life in patients receiving home parenteral nutrition. *Gut* 1999; 44: 844-52.
12. Sukhotnik I, Coran AG, Kramer A, Shiloni E, Mogilner JG. Advances in short bowel syndrome: an updated review. *Pediatr Surg Int* 2005; 21: 947-953.
13. Van Gossum A, Vahedi K, Abdel-Malik M et al. ESPEN-HAN Working Group: Clinical, social and rehabilitation status of long-term home parenteral nutrition patients: results of a European multicentre survey. *Clin Nutrition* 2001; 20 (3): 205-10.
14. Planas M, Castellá M, León M et al. Parenteral nutrition at home: NADYA register for the year 2000. *Nutr Hosp* 2003; 18 (1): 29-33.
15. Messing B, Crenn P, Beau P, Boutron-Ruault MC et al. Long-term survival and parenteral nutrition dependence in adult patients with short bowel syndrome. *Gastroenterology* 1999; 117: 1043-1050.
16. Wilmore DW, Robinson MK. Short bowel syndrome. *World J Surg* 2000: 24: 1486-1492.
17. Intestinal Transplant Registry, 1985-2003. http://www.intestinaltransplant.org/(accessed 22 August 2005).
18. Rodrigues DJ, Clevenger FW. Successful enteral refeeding after massive small bowel resection. *West J Med* 1993; 159: 192-194.
19. McIntyre PB, Wood SR, Powell-Tuck J, Lennard-Jones JE. Nocturnal nasogastric tube feeding at home. *Postgraduate Medical Journal* 1983; (59): 767-769.
20. Heymsfield SB, Baumgartner RN, Pan SF. Nutritional assessment of malnutrition by anthropometric methods", in SHILS, M.E. Modern Nutrition in Health and Disease. Baltimore, Maryland, Williams and Wilkins, 1999 (9a ed.).
21. National Institutes of Health. NIH Tecnology Assessment Conference Statement: Bioeletrical impedance analysis in body composition measurement. *Am J Clin Nutr* 1996; 64: 524S-532S.
22. Bray GA. Definition, measurement and classification of the syndromes of obesity. *Int J Obesity* 1978; 2 (2): 99-122.
23. Garrow JS, Webster J. Quetelet's index (W/H2) as a measure of fatness. *Int J Obesity* 1985; 9: 147.
24. Studley OH. Percentage of weight loss. A basic indicator of surgical risk in patients with chronic peptic ulcer. *JAMA* 1936; 106: 458.
25. World Health Organization. WHO Expert Committee on Physical Status: the use and interpretation of anthropometry physical status. Geneva: World Health Organization; 1995 (WHO Technical Report Series, vol. 854).
26. Lulaski HC, Johnson PE, Bolonchuk WW, Lykken GI. Assessment of fatfree mass using bioelectrical impedance measurement of the human body. *Am J Clin Nutr* 1985; 41: 810-7.
27. Kotler PD, Burastero S, Wang J, Pierson Jr RN. Prediction of body cell mass, fat-free mass, and total body water with bioelectrical impedance analysis: effects of race, sex, and disease. *Am J Clin Nutr* 1996; 64 (Suppl.):489S-97S.
28. Schutz Y, Kyle UUG, Pichard C. Fat-free mass index and fat mass index percentiles in Caucasians aged 18-98 y. *International Journal of Obesity* 2002; 26: 953-960.
29. Blackburn GL, Bistrian BR. Nutritional and metabolic assessment of the hospitalized patient. *JPEN* 1977; 1: 11-32.
30. Byrne T, Wilmore DW, Iyer K, Dibaise J et al. Growth hormone, glutamine and an optimal diet reduces parenteral nutrition in patients with short bowel syndrome. *Annals of Surgery* 2005; 242 (50): 655-661.
31. Scolapio JS, Fleming CR. Short bowel syndrome. *Clinical Nutrition* 1998; 27 (2): 467-479.
32. Dudrick JS, Latifi R, Fosnocht DE. Management of the short bowel syndrome. *Surgical Clinics of the North America* 1991; 71 (3): 625-643.
33. Souweine B, Traore O, Aublet-Cuvelier B, Badrikian L et al. Dialysis and central venous catheter infections in critically ill patients: Results of a prospective study. *Critical Care Medicine* 1999; 27 (11): 2394-2398.
34. Hardin JW, Hilbe JM. Generalized Estimating Equations. London, Chapman and Hall/CRC, 2003.
35. Messing B, Pietro-Cohen S, Debure A. Antibiotic lock technique. A new approach to optimal therapy for catheter-related

sepsis in home parenteral nutrition patients. *JPEN. Journal of Parenteral and Enteral Nutrition* 1988; 12: 185-189.
36. Waitzberg DL, Bertevello PL, Silva MLT, Borges VC et al. Conservative Management of Septic Parenteral Nutrition Catheters. *JPEN. Journal of Parenteral and Enteral Nutrition* 1995; 428-429.
37. Matuchansky C, Messing B, Jeejeebhoy BK, Beau P, Beliah M, Allard JP. Cyclical parenteral nutrition. *Lancet* 1992; 340: 588-92.
38. Gouttebel MC, Saint-Aubert B, Astre C, Joyeux H. Total parenteral nutrition needs in different types of short bowel syndrome. Digestive Diseases and Sciences 1986; 31 (7): 718-723.
39. Creen P, Morin MC, Penven S, Thuillier F, Messing B. Net digestive absorption and adaptive hyperphagia in adult short bowel patient. *Gut* 2005; 53: 1279-1286.
40. Woolf GM, Miller C, Kurian R, Jeejeebhoy KN. Nutritional absortion in short bowel syndrome. Evaluation of fluid, calorie, and divalent cation requirements. *Digestive Diseases and Sciences* 1987; 32 (1): 8-15.
41. Nordgaard I, Hansen BS, Mortensen PB. Colon as a digestive organ in patients with short bowel. *Lancet* 1994; 343: 373-376.
42. Nightingale JM. Management of patients with short bowel. *Nutrition* 1999; 15: 633-7.
43. Crenn P, Coudray-Lucas C, Thuillier F et al. Postabsorptive plasma citrulline concentration is a marker of absorptive enterocyte mass and intestinal failure in humans. *Gastroenterology* 2000; 119: 1496-505.
44. Jeppesen PB, Hartmann B, Thulesen J et al. Glucagon-like peptide 2 improves nutrient absorption and nutritional status in short-bowel patients with no colon. Gastroenterology 2001; 120: 806-815.
45. Goulet O, Ruemmele F, Lacaille F, Colomb V . Irreversible intestinal failure. 32. Intestinal Transplant Registry, 1985-2003. http://www.intestinaltransplant.org/ (accessed 22 August 2005). Journal of Pediatric Gastroenterology and NLL.