Evaluation of Patient Characteristics, Indications, and Effectiveness of Home Parenteral Nutrition (HPN) Therapy in Obese Adult Patients

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Abstract

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Background: Home parenteral nutrition (HPN) involves the administration of parenteral nutrition (PN) therapy outside of the institutional setting. Recipients of HPN are generally patients who do not have acute medical conditions and require long-term nutritional support. The use of HPN has increased in the US. Historically, most patients receiving HPN were underweight or malnourished. However, in response to the rapidly increasing adult obesity rate, nutrition support clinicians are now encountering a substantial number of obese HPN patients in their practice. Unfortunately, research in HPN use in obese patients is essentially nonexistent, and there is no consensus or established guidelines on nutrition care for obese HPN patients. The aims of the study were to evaluate patient characteristics and clinical indications for HPN among obese adult HPN patients, and to investigate the effectiveness of HPN, defined as the attainment of predefined weight goal for them.

Methods: This study analyzed data drawn from Sustain^{TM}, the national HPN registry in the US. The data were collected between August 2011 and February 2014. Obese adults were included.

Variables that were relevant to the study aims were assessed. In addition, ideal body weight (IBW) and adjusted body weight were calculated using established methods. This study used a descriptive approach to evaluate patient characteristics and clinical indications for HPN. Effectiveness of HPN, defined as meeting the pre-defined goal in weight changes, was determined by comparing the patient's baseline weight with the weights at follow-up visits. Excel and paired Student's *t*-test were used for data analysis.

Results: Of the 1,251 patients available in the registry, a total of 154 obese adult HPN patients were included in the study. The cohort included 39 (25%) men and 115 (75%) women; the mean age was 52.77 years. The majority of the study cohort was Caucasians. The mean actual body weight at baseline was 99.76 kg with a mean body mass index (BMI) of 35.80 kg/m^2. The most common diagnosis was bariatric surgery, and the most common indication for HPN was gastrointestinal (GI) fistula. The mean serum albumin concentration was low at 2.97 g/dL, but other laboratory results related to renal and hepatic functions were within the normal range at baseline. The mean daily caloric provision was 20 kcal/kg (actual body weight) or 29 kcal/kg (adjusted body weight) and the mean protein intake was 1.2 g/kg (actual body weight) or 1.7 g/kg (adjusted body weight) at baseline. The primary initial goal for the majority of these patients (66%) was to lose weight. Longitudinal data were available for 54 of the 154 patients to assess whether their pre-defined goal in weight change was achieved. The attainment of a pre-defined weight goal was assessed in three sub-groups according to their pre-defined weight goals at baseline, including "weight loss" (WL), "weight maintenance" (WM), and "weight gain" (WG). Patients in the WL group achieved their weight goals with an average weight loss of 5.83 kg ($p = 0.001$) at the first follow-up. Patients in the WM group had a slight decrease in weight by 0.87 kg at the first follow-up, but the difference in weights was not statistically significant ($p = 0.66$). Patients in the WG group achieved their weight goal with an average weight gain of 1.50 kg at the first follow-up. There were no statistically significant differences in nutrient provision between baseline and the first follow-up for each group.

Conclusion: The clinical characteristics that are unique for obese adult HPN patients include the most common diagnosis of bariatric surgery and normocaloric HPN regimen. In addition, HPN is effective among obese adult HPN patients in achieving the pre-defined weight goal.

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Introduction

Parenteral nutrition (PN) is a nutrition provision that provides nutrients intravenously, bypassing the gastrointestinal (GI) tract. PN is indicated when the GI tract is not functional, or enteral nutrition (EN) is not tolerated. PN is also indicated when a patient cannot obtain appropriate amounts of nutrients through the GI tract, including oral diets or EN.[1] The administration of PN was initiated in the United States in 1966; the first known case of a patient who received PN and was discharged while still on PN occurred in 1968. We now call this practice home parenteral nutrition (HPN).[1]

HPN describes a PN therapy that is self-administered outside of the institutional setting. HPN is applied when PN is needed longer than two weeks and the patient is clinically stable.[1, 2] With optimal use—including careful candidate selection, appropriate patient education and support, and close monitoring—HPN seems to have positive effects on patients' physical, social, and psychological well-being, which can improve their quality of life.[3, 4] Another benefit of HPN is to reduce patients' exposure to hospital-borne pathogens by minimizing the length of hospital stay.[5] With these benefits, the use of HPN has significantly increased nationwide.[5]

Data regarding the exact frequency of HPN use are not widely available and have not been extensively published.[6] Thus, the only large source to quantify the number of patients receiving HPN in the US is Medicare.[7] The Oley foundation collected HPN patient records through the North American Home Parenteral and Enteral Nutrition (HPEN) Patient Registry in cooperation with Medicare between 1989 and 1992.[7] The data showed that the number of HPN recipients doubled in three years. With the inclusion of patients who were not covered by Medicare, the data indicated that approximately 40,000 patients appeared to receive HPN in 1992.[7] Although more current nationwide HPN data in the US are not available, the use of HPN is expected to be much higher than it was in 1992 because the knowledge and techniques in administering HPN have improved in the past decade and HPN is considered as a cost-effective intervention.[8]

The common indication for HPN is generally GI failure related to fistula, obstruction, bowel dysmotility, surgical resection, or secondary complication, severe malabsorption, followed by underlying diseases.[9, 10] In 1978, it was reported that 63% of HPN recipients had Crohn's disease or ischemic bowel and only 17% of HPN patients were cancer patients. However, mirroring the

trend of an overall increase in cancer diagnosis since the late 1980s, cancer has become the most common underlying diagnosis among HPN patients in the US for this period.[7, 11] Most patients with the diagnosis of Crohn's disease, ischemic bowel, or cancer were underweight (BMI less than 18.5 kg/m^2) and malnourished due to decreased appetite, impaired nutrient absorption, cachexia, catabolism, or complications from these diseases that affect their nutritional intake or utilization.[12, 13] Thus, historically, the initial weight goals for HPN recipients were weight gain or weight maintenance, which could be achieved by a daily energy intake of 20 to 35 kcal/kg and a protein intake of 0.8 to 1.5 g/kg.[14] These nutrition requirements are also consistent with the current nutrition provision requirements for Medicare reimbursement.[15]

The prevalence of adult obesity in the US has drastically increased over the past 20 years and obesity has become a major public issue in the US. While 15.6% of US adults were obese in 1995,[16] more than one-third (34.9%) of US adults were obese in 2011 and 2012.[17, 18] In addition, the American Medical Association (AMA) estimated that, with this trend of increasing obesity, 50% of adults in the US become obese by 2040.[17] In response to the obesity epidemic, nutrition support clinicians are now encountering in their practice a substantial number of obese patients who receive HPN. For example, recent studies[18, 19] showed a positive correlation between obesity and increased incidence of Crohn's disease, which is one of the most common underlying diagnoses among HPN patients. Moreover, an increase in the number of patients who undergo bariatric surgery also contributes to the increasing number of obese HPN patients because HPN may be necessary for some patients who have significant postoperative complications after bariatric surgery. According to Beebe and Crowley[20], an average of 179,000 bariatric surgeries are conducted in the US each year, and up to 16% of these patients undergo HPN due to complications. These findings suggest an increase in the number of obese HPN patients in the US is expected.

In 2013, the American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) published the guidelines for obese patients receiving nutrition support.[21] This document provided information that is more specific towards the care of obese patients, including the expected clinical outcomes among patients at different levels of obesity, the effectiveness of hypocaloric high-protein diet, and consideration of malnutrition among obese patients. However, these guidelines focus on hospitalized patients whose nutritional requirements and clinical conditions may be different

from patients receiving HPN. Despite the upward trend in the number of obese patients who are indicated for or receiving HPN, research on HPN use in obese patients is essentially nonexistent. The clinical characteristics of these patients are unknown. The underlying primary diagnoses and indications leading to HPN use in obese HPN patients have not been established. The goals of HPN in obese patients are also unclear, as it seems unlikely that weight gain or weight maintenance would be the primary goal of initial intervention. These patients may need different approaches to care or treatment than those used with underweight and malnourished HPN patients because there is a concern of overfeeding and its side effects among obese HPN patients.[10] Finally, the effectiveness of HPN in these patients has not been investigated. Thus, nutrition support clinicians are now facing challenges with nutrition care for obese HPN patients, and fundamentally important questions should be studied to develop a safe and effective HPN therapy for obese HPN patients.

The overall goal of this study was to fill the gap in knowledge of nutrition care for obese HPN patients, and contribute to providing safe and effective HPN therapy in obese adults. The objective was to create a comprehensive profile of obese adult HPN patients and investigate the effectiveness of HPN therapy for them. Specifically, to achieve this goal and objective, the aims of the study were to: (1) understand the patient characteristics of obese adult HPN patients, (2) identify the indications and weight goals for HPN among the obese patients, and (3) assess attainment of the patients' pre-defined weight goals and aspects of nutrition provision.

Methods

Source of Data

This study used data obtained from Sustain™, a web-based HPN patient registry in the US. It was developed by A.S.P.E.N. and launched in 2011. The study data were collected between August 2011 and February 2014 from 29 sites, including hospitals (68%) and home infusion providers (32%).[22, 23] Patients in long-term care or other institutional settings, or receiving intradialytic parenteral nutrition (IDPN) were excluded from the registry. A cross-sectional approach was used to obtain the baseline data and a longitudinal approach was used to collect the follow-up data. The patients' information was entered by trained staff at each site.[1]

Study Group Selection and Procedures

Since the study cohort is obese adults, patients under the age of 18 years old or with body mass index (BMI) under 30 kg/m^2 were excluded. The characteristics of these obese adult HPN patients were analyzed for Aims 1 and 2. For Aim 3, only those who had followed-up visits and with complete records at follow-ups, including specific pre-defined weight goals at baseline and weight records, were included for analysis. The weight achievement and changes in nutrition provision were assessed by comparing the average weight and nutrition provision at baseline with those at the first follow-up.

Variables

The data contained a wide range of variables, including patients' living situations, education levels, insurance coverage, primary caregiver, daily living activities (e.g., ability to work or living independently), and other clinical information. Among these options, the variables that are commonly used to assess nutrition status[24]—patient demographic information (age, sex, and ethnicity), height and weight, underlying diagnoses, medications, laboratory values, HPN regimen, diet status, indications for HPN, and weight goals—were selected for Aims 1 and 2. Weight and HPN regimen at follow-ups were further assessed to evaluate achievement of pre-defined weight goals for Aim 3.

Based on patient height and actual body weight, new variables, such as ideal body weight (IBW) and adjusted body weight, were developed for the study. The original Sustain dataset contains the actual body weights of the patients. Unlike the practice for typical patients (underweight, healthy weight, or overweight), using actual body weight for obese patients often leads to overestimating the patients' nutrition requirements, which may result in overfeeding. Therefore, in many practices, adjusted body weight is often used to predict nutrition needs for obese patients who have equal or greater than 130% of the IBW.[6] IBW was used for calculating adjusted body weight, and the Devine formula, which is the most commonly used equation in clinical practice in determining IBW in adult patients, was used for calculating IBW in this cohort.[25] Adjusted body weight was calculated with a 25% correction factor (i.e., IBW + 0.25 × (Actual body weight – IBW).[26, 27] The nutrition provision records were adjusted on a kilogram basis, which is more comparable in practice.

Statistical Analysis

This study used a descriptive approach and two tools were used to describe the results; one was Excel 2013 (Microsoft Corporation, Redmond, Washington, USA) and the other was paired Student's *t*-test using STATA 14 (Stata Corporation. Stata Statistical Software: Release 14. College Station, TX, USA). Excel was used to calculate continuous variables for the mean, median, and standard deviation. It was also used to assess categorical variables with the count and percentage. A paired Student's *t*-test was used for statistical analyses of patients' weight averages and nutrition provision between baseline and follow-up. A 95% significance level was chosen, and a *p* value less than 0.05 indicated a statistically significant difference between those two groups.

Results

A total of 1,251 patients receiving HPN were registered in the Sustain National HPN Patient Registry between August 2011 and February 2014. Eight-five percent (n=1,064) of these patients were adults. Of these adult patients, 154 (18%) were obese, and this initial target study group, whose BMI was 30.0 kg/m^2 or more, was included for final analysis of this study.

Aim 1 *– Understand the patient characteristics of obese adult HPN patients.*

The study cohort consisted of 39 (25%) men and 115 (75%) women, with a mean age of 52.77 ± 13.23 years. Caucasian was the most predominant ethnicity with 101 (66%) patients, followed by 26 African-American (17%), and 2 Hispanic (1%). Fourteen patients (9%) chose "other" as their ethnicity. The mean height of the study cohort was 166.52 ± 9.59 cm. The mean actual body weight was 99.76 ± 20.87 kg. The mean BMI of the study group was 35.80 ± 5.54 kg/m^2, with 82 (53%) patients in the class I obesity (BMI = 30 – 34.9 kg/m^2) category. The mean IBW and adjusted body weights of the group were 59.42 ± 10.06 kg and 69.51 ± 11.60 kg, respectively. Since the average percentage of IBW (%IBW) is around 169%, evaluating nutrition requirements by considering their adjusted body weight seemed reasonable for this study group (Table 1).

The most common diagnosis among these obese adult HPN patients was bariatric surgery (24%). This was followed by cancer (19%), short bowel syndrome (12%), and gastromotility/pseudo-obstruction disorder (10%). Unfortunately, the underlying diagnosis in 49% of this cohort was indicated as "other," but the specific diagnoses were not identified (Table 2).

Aim 2 *– Identify the indications and weight goals for HPN among obese patients.*

The most common indication for HPN among this group was GI fistula (26%). This was followed by GI obstruction (13%), short bowel syndrome (12%), bowel dysmotility (10%), and intractable vomiting (10%). In 24% of the patients, the indication of HPN was entered as "other reason," but those reasons were not specified (Table 2).

Sixty-eight percent of the study cohort were receiving medications that affected their GI tract. These medications included anti-emetics, gastric acid suppressing agents, prokinetics, antacid, anti-diarrheal drugs, cathartics, digestants, anti-flatulent agents, cholelitholytic, and lipotropic

agents. About half the patients (46%) were taking pain medication. One-third of the patients in the study group (33%) were taking vitamin supplements at baseline. The diagnoses, indications, and medications among obese HPN patients are listed in Table 2.

Laboratory results related to renal and hepatic functions were within the normal range at baseline with the exception of hypoalbuminemia. Not all patients had baseline laboratory data. The number of patients whose records were available is summarized in Table 3 along with their respective laboratory results.

With regard to access for HPN, peripherally inserted central catheter (PICC) was the most frequently used intravenous (IV) access (66%) followed by tunneled catheter (28%). A subcutaneously implanted port was the least used IV access among the study group (Table 4).

In terms of nutrient provision, the mean caloric intake of these patients at baseline (n=137) was 20 kcal/kg (actual body weight) or 29 kcal /kg (adjusted body weight), and the mean protein intake of these patients at baseline (n=151) was about 1.2 g/kg (actual body weight) or 1.7 g//kg (adjusted body weight). The mean total HPN volume infused to this group of patients (n=153) was 24 mL/kg (actual body weight) or 34 mL/kg (adjusted body weight). Forty-six percent (n=70) of our patients received no oral nutrient intake by mouth, followed by 26 (17%) of the study cohort who were allowed oral intake ad-libitum (as desired) (Table 4).

With regard to the goal weight, weight loss (WL) was the initial goal in 66% of the study cohort, whereas weight maintenance (WM) and weight gain (WG) were the initial goals in 18% and 1% of the cohort, respectively. The pre-defined goal for weight management was not specified in 14% of the study cohort, and one patient had goal to both gain and maintain weight, which was indicated as “other” (Table 5). The predominant underlying diagnoses among patients who had goals to lose weight were bariatric surgery (32%), cancer (15%), and short bowel syndrome (13%), and those among patients who had goals to maintain weight were cancer (32%), short bowel syndrome (14%), and Crohn’s disease (11%). The patients who had goals aimed to gain weight were patients with gastromotility or other.

Aim 3 *– Assess attainment of the patients' pre-defined weight goals and aspects of nutrition provision.*

To assess the attainment of the patients' pre-defined weight goals and aspects of nutrition provision, the patient's average weight and nutrition provision at baseline were compared with those at the first follow-up. Among 154 obese adult patients receiving HPN, 113 patients had been followed-up. Only 54 of them, however, had the complete records needed for Aim 3, which included specific pre-defined weight goals and weight records at follow-ups. The patients were assessed according to sub-groups of their pre-defined weight goals at baseline. There were 39 patients (72%) in the "weight loss" (WL) group, 13 patients (24%) in the "weight maintenance" (WM) group, and 2 patients (4%) in the "weight gain" (WG) group.

The mean weight of the WL group decreased by 5.83 kg at the first follow-up, and the difference of the mean weights between baseline and the first follow-up was statistically significant with a *p* value of 0.001. The mean weight of the WM group slightly decreased by 0.87 kg, but the difference was not statistically significant with a *p* value of 0.66, meaning that they maintained their weight. For the WG group, there was a slight weight gain of 1.50 kg at the first follow-up. Overall, the results showed that each group achieved its pre-defined weight goal at the first follow-up (Table 6) (Figure 1). There were no statistically significant differences in nutrient provision between baseline and first follow-up in each group (Table 6).

Discussion

With the increased prevalence of obesity in the United States, it is estimated that there will be an increasing number of patients receiving or requiring HPN therapy. There is, however, little or no published research and established practice guidelines on nutrition care of HPN patients who are obese. Thus, the overall goal of this study was to fill the gap in knowledge of nutrition care for obese HPN patients, and contribute to providing safe and effective HPN therapy in obese adults. The ultimate objective was to create a comprehensive profile of obese adult HPN patients and investigate the effectiveness of HPN therapy for them. To our knowledge, this is the initial study with this population, and we believe that our results could encourage future research on obese HPN patients.

In addressing Aim 1, compared to historical data, our results found that adult obese HPN patients only share certain clinical characteristics. The most common underlying diagnosis among the study group was bariatric surgery, which is not a common diagnosis among the typical HPN patients. This may be because HPN has been used as an effective treatment for patients who experience postoperative complications after bariatric surgery, and the number of patients with bariatric surgery has been low until the recent obesity epidemic.[20,28] HPN use is often necessary and can be lifesaving in patients with GI failure because of their inability in meeting nutrition needs by mouth.[29]

Cancer was the second most common diagnosis among the study group, which was consistent with the predominant diagnosis among the typical adult HPN patients.[9] Most of the evidence shows that obesity is associated with increased risks of cancer,[30, 27, 31] and a study indicated that obesity contributes to about 20% of all cancer cases.[32] Therefore, the obesity epidemic may also partially contribute to the cancer diagnosis in this cohort. In addition, the cancer types that have been known to frequently lead to the use of HPN, such as gynecologic malignances (ovary, uterus, primary peritoneal carcinomatosis) and GI malignancies (esophagus, gastric, colon), are cancers that are closely related to obesity.[13] Several studies have reported a positive correlation between colon cancer and obesity.[33] Moreover, obesity is associated with higher risk for Barrett's esophagus and esophageal cancer.[34, 35] Our study results, together these published

findings, suggest a likely connection between the high prevalence of cancer patients among obese HPN patients.

Aim 2 of our study sought to identify both indications and weight goals for HPN among the study cohort. The results showed that the common indications for HPN among the study group were comparable to those for typical HPN patients. In addition, the indications for HPN among obese HPN patients were not different from those among typical PN patients in the hospital settings, which is intestinal failure, typically caused by obstruction, dysmotility, or surgical resection.[10]

This study showed that the laboratory results related to renal and hepatic functions among the study group were within the normal range, with the exception of a slightly low serum albumin concentration. Serum albumin is a negative acute phase protein. The serum concentration decreases in the presences of infection, trauma, or surgical stress, and usually does not return to normal until recovery. Low albumin concentration among obese adult HPN patients may be attributed to that fact that many of these patients had their PN initially started while being hospitalized for surgery or other acute illness. The serum concentration therefore was a more accurate reflection of their recovery status rather than nutritional status.[36] In addition, obesity as a chronic inflammatory status may also have an effect in leading to low serum albumin concentration.[17]

The use of peripherally inserted central catheters (PICCs) was common among the study group. This finding was consistent with the increase use of PICC among typical HPN patients.[23, 37, 38] Historically, subcutaneously implanted port (Port-a-Cath) or tunneled catheter, were frequently used among HPN patients and also advised to use for HPN patients.[2, 39] Recent studies have suggested the potential benefits of the use of PICCs among HPN patients over tunneled catheters. Studies showed no difference in the incident rate of overall complications between tunneled catheters and PICCs.[37, 38, 40] Moreover, it was investigated that the occurrence of pneumothorax, hemothorax and accidental arterial puncture was less common among patients with PICCs compared with patients with tunneled catheters.[38] The use of PICCs has therefore significantly increased among HPN patients. In addition, Cotogni et al[37] reported the successful use of PICCs among cancer patients receiving chemotherapy and/or HPN with low incidence of

severe complications. Furthermore, in a study conducted in Canada[41] that compared clinical characteristics of HPN patients between 2005–2008 and 2011–2014, the results showed a decrease in the use of tunneled catheters and an increase in the use of PICCs in 2011–2014. The research suggested that the increased use of PICCs might be related to the increased number of cancer patients among HPN patients. Since cancer is one of the most common underlying diagnoses among obese HPN patients, it was not surprising that the use of PICCs was the most frequently used catheter type among obese HPN patients.[2, 37]

Optimal nutrient provision is critical for patients receiving nutrition support. Excess caloric provision leads to overfeeding, , while underfeeding can result in deterioration of nutritional status or delayed recovery.[42] Ławiński et al.[42] stated that the Ireton-Jones equation and the 20 kcal/kg/day ESPEN/A.S.P.E.N recommendations seem to be the most appropriate estimation of nutrition needs for patients receiving HPN when indirect calorimetry is not available. It has been showed that obese patients receiving nutrition support are susceptible to experience complications associated with overfeeding; these complications include insulin resistance, hyperlipidemia, hyperglycemia, and fatty liver disease. Thus, A.S.P.E.N. and the Society of Critical Care Medicine (SCCM) have recommended the use of hypocaloric high-protein nutrition provision in both critically and non-critically ill obese patients.[20]

A hypocaloric high-protein regimen is generally defined as providing less than 14 kcal/kg of daily caloric based on actual body weight, or less than 20 kcal/kg per day based on adjusted body, and a daily protein intake of at least1.2 g/kg (actual body weight) or 2-2.5 g/kg (IBW). With the exception of patients who have significant renal or hepatic dysfunction, a hypocaloric high-protein feeding regimen is often used for obese patients in the acute care setting with the goal to minimize endocrinological and infection complications.[21] The clinical outcomes from observational and controlled trials have been mixed.[43, 44, 45] These studies, however, were conducted in hospitalized patients, and the outcomes and results may not be applicable to HPN patients.

Our study group received a normocaloric regimen. Their weight-adjusted energy intake was comparable to that of typical, non-obese HPN patients although the protein intake was notably higher. It is possible that the current nutrient intake criteria for Medicare and other insurance

reimbursement was a driving factor for the daily calorie intake as prescribed. Since there has been no research on the efficacy of the hypocaloric regimen for obese HPN patients, research on nutrition provision for obese HPN patients seems essential. Most of all, providing appropriate amounts of nutrients and close monitoring is a fundamental strategy to provide effective care for obese HPN patients.

Aim 2 of our study also included identifying weight goals for HPN patients. There is no known study that evaluates clinical outcomes related to weight goals among obese HPN patients. Results of our study showed that the goal for almost two-thirds (66%) of the study cohort was to lose weight. Unexpected recent weight loss among hospitalized obese patients can increase the risk for malnutrition and significant muscle loss.[6] Weight loss among obese patients with close monitoring, however, does not appear to increase adverse outcomes.[46]. Studies on obese HPN patients who had bariatric surgeries, however, showed a high prevalence of "weight loss" as a weight goal.[20, 29] According to the finding form this study, obese HPN patients seemed to be prescribed to lose weight as other obese patients. However, a total of 57% of the patients had revised their weight goals during follow-ups, and most patients did not specify their following weight goals. Thus, future investigation on indications for the specific weight goal (weight gain, weight loss, or weight maintenance) and when to revise the pre-defined weight goals among obese HPN patients seems needed.

Aim 3 was to assess the attainment of patients' weight goals and aspects of nutrition provision. This study showed that each group (WL, WM, WG) ("weight loss," "weight maintenance," and "weight gain") achieved its pre-defined weight goal. There was no difference, however, in nutrition provision of HPN between visits and between groups. Several studies have evaluated weight changes and nutrition provision. Choban et al.[47] showed no difference in weight changes between a hypoenergetic nutrition support group and the control group among obese hospitalized patients. Hamilton et al.,[29] however, reported weight loss with a hypocaloric HPN regimen among obese patients who had bariatric surgery. The cohort in the current study included obese patients with a variety of underlying in which may have characteristics, severity of illness, or activity levels different from hospitalized patients or patients with a history of bariatric surgeries. These obese HPN patients may therefore have different characteristics that alter their metabolic

response to nutrients and the achievement of their weight goals. The specific factors that play significant roles in the achievement of weight goals warrant further investigations.

Limitations and Strengths of Study

Since the Sustain HPN patient registry was launched in 2011, and registration in Sustain is voluntary,[1, 22] there may be additional obese HPN patients who have not yet been registered. In addition, because of missing records and the reduced number of patients during follow-ups, more comprehensive research on obese adult HPN patients was not possible in this study.

Nonetheless, this study used a recent dataset from the National HPN Patient web-based Registry in the US. Since more than 80% of patients receiving HPN in the US are managed by individual physicians, small groups of HPN professionals in community practice, and home infusion companies,[9] it becomes very challenging to collect HPN data in the US. Thus, despite its limitations, this dataset may be the most current source of a nationwide HPN registry that can contribute to a comprehensive picture of the HPN patients in the US.

Future Research

In the present study, we evaluated weight achievement as one part of the effectiveness of HPN among our study group. Future investigations could involve the assessment of the effectiveness of HPN by evaluating other clinical outcomes, such as HPN-related complications, weaning off of HPN, or the survival rate of HPN patients.

Conclusions

Our investigation and analysis showed that obese adult HPN patients have a different underlying diagnosis from the typical HPN patient. The most common pre-define weigh goal is weight loss. At the first follow-up the majority of the patients met their goal weight while continued to receive HPN.

List of Tables and Figure

Table 1. Patient demographic information and weight distribution of obese adult HPN patients (n=154)

Characteristic		n	%
Gender			
	Male	39	25
	Female	115	75
Ethnicity			
	White	101	66
	Black	26	17
	Hispanic	2	1
	Other	14	9
	Not indicated	11	7
Obesity Classification			
	Class I Obesity (BMI 30 – 34.9kg/m^2)	82	53
	Class II Obesity (BMI 35 – 39.9 kg/m^2)	43	28
	Class III Obesity (≥ BMI 40 kg/m^2)	29	19

	Mean ± SD	Median
Age (year)	52.77 ± 13.23	52.81
Height (cm)	166.52 ± 9.59	165.00
Actual Body Weight (kg)	99.76 ± 20.87	95.00
Ideal Body Weight (kg)	59.42 ± 10.06	56.91
Adjusted Body Weight (kg)	69.51 ± 11.60	66.72
Body Mass Index (kg/m^2)	35.80 ± 5.54	34.10

Table 2. Diagnoses, indications for HPN, and medications among obese adult HPN patients

Category	n	%
Underlying Diagnoses		
Other	75	49
Bariatric surgery	37	24
Cancer*	30	19
Short bowel syndrome	18	12
Gastromotility/Pseudo-obstruction disorder	16	10
Major depression	10	6
Crohn's disease	8	5
Anxiety disorder	7	5
Mesenteric ischemia	5	3
Pancreatitis	5	3
Non Crohn's inflammation bowel disease	4	3
Hyperemesis gravidarum	1	1
Radiation enteritis	1	1
Indications for HPN		
Other	37	24
GI fistula	40	26
GI obstruction	20	13
Short bowel syndrome	18	12
Bowel dysmotility	16	10
Intractable vomiting	16	10
Non short bowel diarrhea	6	4
Active inflammatory bowel disease	3	2
Mesenteric ischemia	3	2
Pancreatitis	3	2
Intractable diarrhea	2	1
Chemotherapy associated GI dysfunction	2	1
Congenial bowel defect	1	1
Radiation enteritis	1	1

Medications			
Other[**]		8	5
GI[***]		105	68
	Anti-emetics	49	32
	Gastric acid suppressants	40	26
	Prokinetics	31	20
	Antacid	15	10
	Anti-diarrheal drugs	11	7
	Cathartics	11	7
	Digestants	5	3
	Anti-flatulent agents	4	3
	Cholelitholytic	1	1
	Lipotropic agents	1	1
Pain		71	46
Cardiovascular		57	37
Central nervous system agents		45	29
Hormones		39	25
Anti-infective		34	22
Electrolytic		14	9
Anti-neoplastic		6	4
Vitamins[****]		51	33

HPN, home parenteral nutrition

GI, gastrointestinal

Note: Multiple options were available

[*]Cancer includes gastrointestinal (GI) cancer (n= 22, 14%) and gynecological tumor (n=8, 5%)

[**]Patient with "Not selected" in the dataset was indicated as "Other"

[***]Gastrointestinal (GI) medications include anti-emetics, gastric acid suppressants, prokinetics, antacid, anti-diarrheal drugs, cathartics, digestants, anti-flatulent agents, cholelitholytic, and lipotropic agents.

[****]"Vitamins" option was included in the medication category in the dataset

Table 3. Laboratory investigations among obese adult HPN patients

Laboratory Test	n	Mean ± SD	Median
Albumin (g/dL)	139	2.97 ± 0.61	3.00
ALT (U/L)	90	39.04 ± 47.10	25.00
AST (U/L)	131	34.59 ± 48.56	23.00
Direct Bilirubin (mg/dL)	40	0.31 ± 0.47	0.20
BUN (mg/dL)	141	24.97 ± 15.33	21.00
Creatinine (mg/dL)	140	0.90 ± 0.80	0.70
Platelet (10^3 cells/mL)	133	284.31 ± 128.35	259.00
INR	53	1.23 ± 0.31	1.20

Table 4. HPN regimen among obese adult HPN patients

Variable	n	%
Catheter Type (n=154)		
Peripherally Inserted Central Catheter (PICC)	101	66
Tunneled Catheter	43	28
Subcutaneously Implanted Port	10	6
Catheter Lumen (n=154)		
Single Lumen	101	66
Double Lumen	47	30
Triple Lumen	6	4
Diet Type (n=154)		
Nil Per Os (NPO)	70	46
Food Intake ad-libitum	26	17
Liquids or Oral Rehydration Only	19	12
Restricted Therapeutic Diet	19	12
Food and/or Beverage for Comfort Only	11	7
Other	9	6

Nutrition Provision				
Category	**Assessment Approach**	**n**	**Mean ± SD**	**Median**
Total Calorie (kcal/kg)	Actual Body Weight	137	20.41 ± 5.66	19.65
	Adjusted Body Weight		28.75 ± 7.38	29.13
Protein (g/kg)	Actual Body Weight	151	1.19 ± 0.26	1.19
	Adjusted Body Weight		1.69 ± 0.33	1.70
Total Volume (mL/kg)	Actual Body Weight	153	24.06 ± 6.45	23.81
	Adjusted Body Weight		34.21 ± 8.82	33.95

Table 5. Pre-defined weight goals at baseline among obese adult HPN patients (n=154)

Goal	n	%
Weight Loss	102	66
Weight Maintenance	28	18
Weight Gain	2	1
Not Specified	21	14
Other*	1	1

*Other: weight gain + weight maintenance

Table 6. Average weights and nutrition provision between baseline and the first follow-up among obese adult HPN patients

Goal	n	Baseline	1st follow-up	Comparison
Weight Loss				
Average Weight (kg)	39	96.79	90.96	$\Delta = -5.83$ ($P = 0.001$)*
Calorie (kcal/kg)	8	21.68	20.95	$\Delta = -0.73$ ($P = 0.71$)
Protein (g/kg)	17	1.20	1.29	$\Delta = +0.09$ ($P = 0.32$)
Weight Maintenance				
Average Weight (kg)	13	96.60	95.74	$\Delta = -0.87$ ($P = 0.66$)
Calorie (kcal/kg)	6	18.53	16.47	$\Delta = -2.06$ ($P = 0.09$)
Protein (g/kg)	7	1.20	1.08	$\Delta = -0.12$ ($P = 0.30$)
Weight Gain				
Average Weight (kg)	2	77.00	78.50	$\Delta = +1.50$ (P = N/A)
Calorie (kcal/kg)	0	-	-	-
Protein (g/kg)	0	-	-	-

*A p value less than 0.05 indicated statistical significance

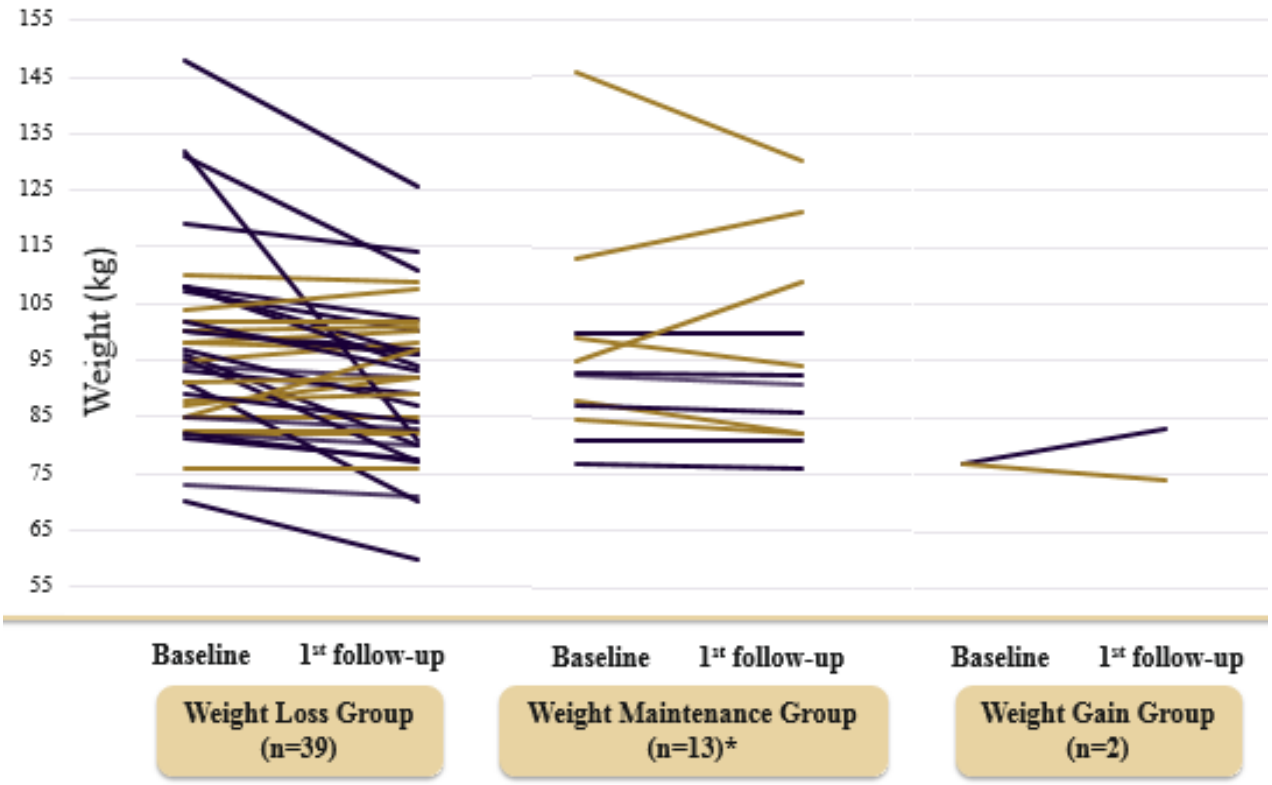

Figure 1. Individual weight goal achievement

A total of 54 patients, who had complete records for Aim 3, were divided into three sub-groups according to their pre-defined weight goals at baseline. Individual weight goal achievement was described by lining weight change between baseline and the first follow-up. The majority of the patients in each group achieved their pre-defined weight goals at the first follow-up. No value that significantly deviated the pattern was observed for each group.

*Two patients with the same weights (100kg) had the same amounts of weight change

Note: The duration between baseline and the first follow-up was not indicated in the follow-up dataset.

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