PHYSICIAN COMPLIANCE WITH REGISTERED DIETITIAN RECOMMENDATIONS IN TOTAL PARENTERAL NUTRITION PATIENTS

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ABSTRACT

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The purpose of this study was to determine physician compliance with registered dietitian (RD) recommendations for total parenteral nutrition (TPN) patients and its effect on patient length of hospital stay, days of TPN administration, body weights, albumin and prealbumin levels, and mortality rates. Closed medical charts, from a 350-bed acute care hospital, were reviewed for 202 patients who had received TPN during 2007. Data was analyzed using the non-parametric chi square test of association and one-way analysis of variance. Patients had increased lengths of hospital stay ($p < .01$), increased days of TPN administration ($p = .066$), and higher albumin levels at time of hospital discharge ($p < .05$), when physicians complied with RD recommendations. However, physician compliance did not have a significant effect on patients' weights or mortality. Additional research should be conducted in other hospitals to evaluate the frequencies and outcomes of physician compliance with RD TPN recommendations.

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CHAPTER I

INTRODUCTION

As many as 40% of adult patients are severely malnourished at the time of their hospital admission, and about two thirds experience deterioration of their nutritional status during their hospital stay.[1] Malnutrition is associated with increased complication rates, infections, length of stay, costs, and mortality in inpatients. Thus, nutrition support has become a major component in the treatment of such patients in an acute care setting.[2] Many multidisciplinary teams play an essential part of nutrition support management of these patients, ensuring that suitable nutrition support strategies are chosen, any problems or risks are identified early, the individual patient's needs are met, and inadequate or excessive feeding is avoided.[3]

When a patient cannot get enough nutrition orally, enteral and/or parenteral nutrition (PN) are used for nutrition support. Enteral nutrition (EN) is the delivery of nutrients by tube into the gastrointestinal tract. Parenteral nutrition is the administration of nutrients intravenously, ideally utilized when the gut is nonfunctional.[4] While partial parenteral nutrition supplies only part of daily nutritional requirements, total parenteral nutrition (TPN) provides amino acids, lipids, and dextrose in addition to electrolytes, vitamins, and minerals. TPN is designed to meet the complete nutritional needs of a patient. In the acute care setting, physicians are usually responsible for ordering and monitoring TPN.[5] Unfortunately, because physician expertise is typically not nutrition,

patients receiving TPN are victims of inadequate nutrition, overfeeding, or unnecessary TPN.[1]

COMPLICATIONS OF UNDERFEEDING

The body has a normal adaptive response to starvation, but starvation is not tolerated for more than a few days without deleterious side effects.[6] Underfeeding can lead to the loss of lean body mass and reduced function of skeletal muscle.[7] Increased complications, such as infections and increased days of antibiotic treatment, as well as length of mechanical ventilation and intensive care unit (ICU) stay, are often accompanied by underfeeding. A strong association is also found between negative energy balance and adult respiratory distress syndrome, sepsis, renal failure, pressure ulcers, and need for surgery.[6] Underfeeding will undoubtedly compromise the immune response and patient's nutritional status, which is a recognized cause of prolonged hospital stay.[8] Therefore, increased rates of mortality and morbidity are significant issues with underfeeding.[9]

COMPLICATIONS OF OVERFEEDING

Overfeeding can be just as detrimental to a patient as underfeeding.[10] Overfeeding, which can easily occur with TPN, may result in complications such as sepsis, fever, and high carbon dioxide production.[11] Hyperglycemia and dyslipidemia are serious potential side effects as well.[12] Overfeeding of protein can cause azotemia, which may be seen as an increase in blood urea nitrogen, and may compromise a patient's renal function.[9]

If a patient's TPN solution is too high in glucose or contains more kilocalories than necessary, excess carbon dioxide is produced and the work of breathing increases.[13] This is a clinically significant problem when a patient has underlying respiratory problems, and weaning from the ventilator may be prolonged.[14]

A long-term consequence of overfeeding is hepatic steatosis, resulting from excessive carbohydrate calories or excessive overall calories from parenteral nutrition.[9] Excessive calories are stored in the form of fat in hepatocytes.[10] Consequently, 15-40% of adult patients receiving long-term TPN therapy may develop end-stage liver disease.[15]

THE NUTRITION SUPPORT TEAM

Due to the complications associated with underfeeding and overfeeding in PN patients, the administration of TPN should be assessed carefully and individually approached.[16] The establishment of a nutrition support team has proven to aid in reducing the frequency of inadequate nutrition, overfeeding, complications from TPN and inappropriate/preventable TPN.[1] Nutrition support teams (NST) integrate dietitians, physicians, pharmacists, and nurses to form a multidisciplinary unit, with the team members often certified and/or trained in nutrition support.[17]

The NST became a common addition to many hospital staffs in the late 1970s when the field of nutrition support was relatively new.[5] Nonetheless, in many hospitals, which have yet to develop nutrition support teams, registered dietitians (RDs) serve as the leading experts in nutrition support.[7] Oftentimes, however, physicians do not respond to the support and recommendations offered by registered dietitians. Therefore,

underfeeding and overfeeding remain significant issues, and, consequently, increased complications are present.[5]

Previous studies have revealed the benefits of a nutrition support team in the monitoring of patients receiving nutrition support, including TPN.[5] Additionally, intervention by a registered dietitian in the assessment and management of nutrition support patients has also proven to be significant.[7] However, no studies were found in which physician compliance with RD recommendations in nutrition support was researched. It is vital for physicians to fully utilize the expertise of the registered dietitian for optimal nutrition care of the nutrition support patients. The purpose of this study is to determine physician compliance with RD recommendations for total parenteral nutrition and its effect on patient length of hospital stay (LOS), days of TPN administration, body weights, albumin and prealbumin levels, and mortality rates.

HYPOTHESIS

It is hypothesized, for this study, that physician compliance with registered dietitian TPN recommendations will be poor when a nutrition support team is not present. Also, it is hypothesized that poor physician compliance with registered dietitian recommendations in TPN patients will be significantly associated with decreased lengths of stay, decreased days of TPN administration, desirable weights, improved albumin and prealbumin levels, and decreased mortality rates.

CHAPTER II

REVIEW OF LITERATURE

THE PREVALENCE OF MALNUTRITION

Since the first report in 1936, the negative influence of malnutrition on patients' morbidity and mortality rates has been amply documented in different studies. However, despite the immense increase of nutritional awareness since, malnutrition continues to be highly prevalent in hospitalized patients and significantly affect patient outcomes.[18] Korfali et al.[19] found in a large study of 29,139 Turkish patients that, unsurprisingly, the highest prevalence of nutrition risk occurred among intensive care unit patients, 52%. Even at the time of hospital admission, a significant 15% of patients were already considered nutritionally at risk. These statistics are consistent with other similar studies of malnutrition.[1,18] To correlate the nutritional status of hospitalized patients with their morbidity, mortality, length of hospital stay, and costs, Isabel, Correia, & Waitzberg[20] conducted a retrospective cohort study review of 709 adult patients from randomly selected Brazilian hospitals. The study found that length of hospital stay was significantly shorter in the well-nourished patients (10.1 $\pm$ 11.7 days, median of 6 days) vs. the malnourished patients (16.7 $\pm$ 24.5 days, median of 9 days). Nutritional status also influenced hospital mortality, with only a 4.7% death occurrence in well-nourished patients compared to 12.5% in that of malnourished patients. Additionally, analysis of

costs revealed a 60.5% increased expense for malnutrition. Malnutrition was indeed an independent predictor of outcome.

Serum albumin levels have been the most commonly employed indicator for protein-energy malnutrition. The half-life of serum albumin in a stable, healthy patient is approximately 20 days. However, when a patient is suffering with an acute illness such as sepsis, trauma, burn, or following an extensive operative procedure, the serum albumin concentration significantly decreases.[21] Serum albumin levels are also affected by hydration and renal function, and the level typically takes about 14 days to replete to normal.[22] Therefore, in a hospitalized, critically ill patient, albumin would not serve as an accurate marker of nutritional status. Prealbumin, on the other hand, has a half-life of only 1.9 days, making it more reflective of short-term changes in nutritional status than albumin. Although prealbumin levels decrease promptly if an adult fasts or is malnourished, the level normalizes rapidly after the patient receives adequate nutrition support.[23]

One prospective, nonrandomized study compared albumin and prealbumin levels in postoperative patients given adequate nutrition support.[24] All surgery patients included in the study were at least 18 years of age and required parenteral nutrition. Of the 86 patients evaluated, only 16 met all criteria for study entry. Blood for albumin and prealbumin concentrations was drawn within 48 hours of each patient initiating parenteral nutrition and then redrawn weekly for albumin and biweekly for prealbumin. Albumin levels increased from 2.00 +/- 0.35 to 2.21 +/- 0.42 g/dl., while prealbumin levels increased from 11.97 +/- 6.31 to 17.29 +/- 8.93 mg/dl ($p = 0.017$). All but one prealbumin

concentration was in the normal range when parenteral nutrition was discontinued. None of the albumin concentrations were ever in the normal range. Conclusively, this study revealed that prealbumin is a better indicator than albumin of nutrition status in the postoperative patient.

ADEQUACY OF NUTRITION IN ARTIFICIALLY FED PATIENTS

Nutritional support can be vital in critically ill patients, either to treat existing malnutrition or to prevent development of nutritional deficiencies. However, when either enteral or parenteral nutritional support is present, clinicians run the risk of providing inadequate or excessive nutrition to the patients, which can have detrimental effects.[7] In a prospective, observational study conducted by Reid, [8] the occurrences of underfeeding and overfeeding in mechanically ventilated intensive care unit (ICU) patients were researched. ICU clinical dietitians calculated patients' estimated energy requirements (EER) using the Scofield equation. The adequacy of the nutritional support (EN and PN) provided was then examined in relation to the dietetic prescribed regimen. Overall, patients received an average of only 79% and 61% of their estimated energy and protein requirements, respectively. Unfortunately, the incidence of underfeeding and overfeeding in relation to PN could not be analyzed due to small numbers (only 13.5% of the 312 feeding days were PN only). However, results from the study did suggest that both underfeeding and overfeeding do occur, regardless of whether the feeding route is enteral or parenteral. Additionally, patients receiving nutritional support from a combination of routes (i.e. EN plus PN) were more likely to be overfed than patients receiving nutrition via only one route ($p < 0.001$). In a similar study by McClave et al.,[25] 213 patients from

Vencor Hospital System, a group of long-term acute care facilities, were evaluated to determine if their nutritional needs were adequately met according to their caloric requirements. All of the patients included in the study were on mechanical ventilation and received total enteral nutrition. Indirect calorimetry was used to establish patients' resting energy expenditures (REE), and 10% for nursing care activity was added to the REE to calculate total energy expenditures. On the basis of physician orders, the majority of patients (58.2%) were overfed, presumably receiving >110% of required calories, and 12.2% were underfed, receiving <90% of caloric needs. The accuracy of feeding had a noticeable impact on respiratory function. Significantly increased minute ventilation was seen in patients who received <100% of their caloric requirements, and significant decreases in minute ventilation were seen in patients whose needs were exceeded up to 300%. Interestingly, the potential for cost savings was evaluated by extrapolating study results across the Vencor system for one year. On average, approximately 1,208 patients (68% of total patient census) in the Vencor acute care hospitals receive EN each day. Of those patients on tube feedings, on the basis of study results, 703 (58.2%) would be overfed. With the average cost of excess formula in the study being $5.19 per patient per day, this cost extrapolated over 703 patients for 365 days would total $1,331,728. Overall, both of these studies reveal that inaccurate or inappropriate feeding is common, and the cost to the hospitals is extravagant.

ADEQUACY OF NUTRITION IN TPN PATIENTS

Although TPN is necessary and vital for patients unable to tolerate EN, underfeeding and overfeeding are frequent occurrences. In a study published by Nardo et

al.,[26] the adequacy of meeting patients' nutritional needs via TPN, without the assistance of a nutrition support team, was researched. The energy needs of the patients in this study were calculated using a recommended target of 110% of the Harris-Benedict formula, with increased adjustments only being made for fever. Adequate intake of energy was then considered between 90% and 110% of the recommended target. The weight used for calculating energy and protein needs were ideal body weight in obese subjects (BMI $\geq$ 30) and actual body weight for all other subjects. Results showed that although the reason for TPN use was justified in the majority of the 200 patients reviewed, the TPN formula was often inadequate to meet the patients' nutritional needs. Energy supply was only adequate in 31.5% of the patients. Overfeeding was more frequently observed than underfeeding: 52.0% of the patients received an energy supply >110% of the recommended target, leading to a mean excess of 228 $\pm$ 13 kcal/patient/day. Similarly, an adequate supply for protein was only observed in 21% of the patients. Again, a majority of the patients (65.5%) received an excess protein supply >110% of the recommended needs. When both calorie and protein were used as criteria, the total number of patients receiving adequate nutrition dropped to 14%. Clearly, this study demonstrates that the management of total parenteral nutrition can be suboptimal, and overfeeding and underfeeding of patients is commonly observed.

Inappropriate ordering of TPN is likely related to lack of physician knowledge and awareness regarding the proper indications for total parenteral nutrition. A study conducted by Vanek, Sharnek, Snyder, Kupensky, & Rutushin[27] assessed the knowledge and skill base of attending and resident physicians in the ordering of parenteral nutrition.

The study included nine physicians, 32 residents, and seven medical students specializing in Family Medicine, Internal Medicine, or General Surgery from St. Elizabeth Health Center in Ohio. The physicians were given detailed case studies of three mock patients, in which laboratory values and all vital clinical data were provided. They were then asked to determine if PN was appropriate for that patient, and, if so, to write orders for parenteral nutrition and intravenous fluids. The clinically appropriate responses for each case study were established by the members of the Nutrition Support Team, based on recommendations in the medical literature. Members of the NST then scored the physicians' assessments based on a scale of 0 to 100, with 100 being the goal. The physicians' mean total score was 48.6 ± 20.8. Although physicians did relatively well in determining when TPN was appropriate, only 29% ordered adequate amounts of nonprotein energy, and only 11% ordered adequate protein. When the physicians were asked about their nutrition education background, 17% indicated they had no general nutrition lectures and 37% had no parenteral nutrition lectures during medical school. Due to the minimal nutrition knowledge that most physicians obtain, the registered dietitian and/or nutrition support team are vital for appropriate care of TPN patients.

THE NUTRITION SUPPORT TEAM

Many studies have been carried out to evaluate the efficacy and assure the necessity of nutrition support teams in the management of artificial feeding. In a study conducted by Saalwachter et al.,[5] the use of parenteral nutrition by surgeons and the benefits of the assistance of a nutrition support team were evaluated. The study included 577 patients admitted into the University of Virginia Hospital, and the NST consisted of

3 surgical nutritionists, one surgical resident, and two board-certified surgeons with nutrition support certification. In the first 11 months of the study, when the NST was not involved in patient care, the number of inappropriate TPN orders was 62/194 (32.0%). However, once the NST was granted permission to change nutrition support orders if necessary, the number of inappropriate TPN orders decreased to 22/168 (13.1%) in the second 11 months ($p<0.001$). This number further declined to 17/215 (7.9%) in the final 12 months of data collection. Additionally, there was a significant increase in TPN orders for severe malnutrition or catabolism with inability to enterally feed $\geq$5 days once the NST was established and involved. With trained nutritionists consulting on each surgical patient requiring nutrition support, more malnourished patients may have been identified and diagnosed and thus able to receive appropriate treatment. The daily cost of TPN at this hospital was $235 at the time of the study. Assuming an average duration of TPN administration to be 7 days, the cost savings from the NST recognizing inappropriate ordering of TPN was $74,025 per study period of 11 months. This can be extrapolated to a savings of about $81,000 per year. A similar study by Fisher and Opper[28] revealed comparable results. To determine the impact of the NST at Winthrop University Hospital, a 600-bed teaching hospital in New York, prospective data collection was initiated. Here, the NST consisted of a gastroenterologist, a gastroenterology fellow, a certified nutrition support dietitian, a certified nutrition support nurse, and two certified nutrition support pharmacists. Patient outcomes were compared from before (1990) and after (1992 and 1993) the establishment of the NST. Results revealed a significant decrease in patients receiving inadequate nutrition: 24.7% prior to the NST vs. 0.8% with NST consultation

($p<0.001$). Also, the NST dramatically reduced the metabolic abnormalities of TPN. With the NST's daily monitoring of electrolytes and laboratory values, uncorrected hyper- or hypoglycemia decreased from 24.7% to 0.9% ($p<0.001$). Previously uncorrected hyper- or hyponatremia (19.5%), hyper- or hypophosphatemia (11.7%), and hyper- or hypomangnesiumia (6.5%) all decreased significantly to 0% between 1992 and 1993. Both of these studies demonstrate a continued success with NST involvement in ordering TPN.

THE REGISTERED DIETITIAN

Nutrition support registered dietitians (RDs) can offer expertise in nutritional support that is pertinent to the care of the critically ill patient. They are the primary professionals focused on providing recommendations regarding the route, timing, and access of nutritional support. The registered dietitian completes assessments of patients' macro- and micronutrient needs and monitors fluid and electrolyte balance issues and the achievement of optimal blood glucose control. Adjustments to the nutrition care plan are made by the RD with changes to the patient's disease state and/or condition.[29]

As highly, specifically trained, and qualified providers of dietetic services, registered dietitians are accountable and responsible for their practice and service. The American Dietetic Association (ADA) leads the dietetics profession by developing standards from which the quality of practice and performance of registered dietitians can be evaluated. The Standards of Practice in Nutrition Care are formatted to the four steps of the Nutrition Care Process: 1. Nutrition Assessment, 2. Nutrition Diagnosis, 3. Nutrition Intervention, and 4. Nutrition Monitoring and Evaluation.[30]

Standards of Professional Practice have also been established: 1. Provision of Services, 2. Application of Research, 3. Communication and Application of Knowledge, 4. Utilization and Management of Resources, 5. Quality in Practice, and 6. Continued Competence and Professional Accountability. Specifically, Provision of Services implies that the RD develops, implements, and promotes quality service based on patient expectations and needs. In a clinical setting, this ensures that goals and objectives are established for the patient and that patient energy and nutrient needs are met. The six Standards of Professional Practice, along with the four Standards of Practice in Nutrition Care set the benchmark for dietetics practice and professional performance.[30]

Dietitians in Nutrition Support, an American Dietetic Association practice group, has worked with the American Society for Parenteral and Enteral Nutrition (ASPEN) to develop standards of practice specifically for nutrition support dietitians. These ASPEN standards coincide closely with the ADA standards for RD general practice but provide detailed descriptions exclusively for nutrition support. For instance, in nutrition intervention, the ASPEN standard of practice is not only to determine patient energy and macronutrient needs but to also establish the parenteral formula and volume, recommend placement for parenteral nutrition access devices, and to order laboratory tests or other monitoring methods necessary for evaluating and adjusting the nutrition support therapy plan of care. Additionally, during monitoring and evaluation, the nutrition support dietitian is expected to document whether the parenteral formula (i.e. TPN) progresses towards or meets the energy and nutrient goals of the patient and to recommend alterations in the nutrition support therapy regimen as necessary.[31]

In a study conducted by Roberts et al.,[7] a retrospective review of 50 patient medical records in the ICU at Baylor University Medical Center, a 1000-bed tertiary care hospital in Dallas, Texas, was completed. Patients included in the study stayed in the ICU 3 days or more and received nutrition support during their ICU stay. The percentages of patients fed enterally, parenterally, or via both routes were 70%, 12%, and 18%, respectively. The dietitian assessed 66% of the patients within the first 3 days of their ICU stay. Consequently, intervention by an RD within the first 3 days resulted in a trend toward a shorter ICU stay ($p=0.10$). Additionally, the length of stay in the ICU was shorter for patients who had sufficient energy intake ($p<0.05$). A statistically significant positive correlation was also found between the percentage of protein needs met and the number of days of mechanical ventilation ($p<0.05$). Conclusively, this study suggests that nutritional attention from an RD in ICU patients is important. Also, patients assessed earlier by an RD are more likely than patients assessed later either to already be receiving nutrition support or to receive more appropriate and adequate nutrition support, when a nutritional support team is not present.

In the past two decades, the practice and expertise of registered dietitians in the clinical arena has significantly evolved. Additionally, the benefits of the involvement of registered dietitians in the care of nutritional support patients have been well documented.[25] However, oftentimes the RD's nutritional expertise and skill may not be utilized by the physician, especially when a nutritional support team is not present.[5] Unfortunately, this increases the risk of malnutrition among patients, as physicians frequently prescribe inadequate nutrition or delay the initiation of nutritional therapy. It is

vital, then, for the multidisciplinary team to work together, in order to optimize the nutritional care of critically ill patients and reduce the risk of malnutrition.[1]

CHAPTER III

MATERIALS AND METHODS

PARTICIPANTS

The medical charts reviewed in this study consisted of all patients who received TPN at a 350-bed acute care hospital from January 1, 2007 to December 31, 2007. Exclusions from the study included: patients who received TPN but currently had open charts; patients who received only intradialytic parenteral nutrition (IDPN); and patients who received PN, but not TPN (i.e. receiving amino acids and dextrose but no lipids).

STUDY DESIGN

This study involved a quantitative, exploratory approach. Closed chart reviews from patients who received TPN in the hospital were completed to obtain the data used in this study. Approvals from Texas Woman's University's Institutional Review Board and from the hospital where the chart reviews were completed were obtained prior to conducting research.

DATA COLLECTION

Closed chart reviews were conducted by the researcher. The following questions were answered for each patient reviewed:

- What was the patient's gender, age, and hospital diagnosis?
- Did the RD make TPN recommendations?
- What was the reason for the RD making TPN recommendations?
- Did the physician order the TPN recommendations made by the RD?

- What was the patient's length of stay?
- How many days did the patient receive TPN?
- What were the patient's weights while on TPN?
- What were the patient's albumin levels while on TPN?
- What were the patient's prealbumin levels while on TPN?
- Did mortality occur during the patient's hospital stay?

Due to hospital policy, all patients' energy needs were previously assessed by an RD using the Harris-Benedict Equations, with added activity and stress factors:

Men: B.E.E. = 66.5 + (13.75 x kg) + (5.003 x cm) - (6.775 x age)

Women: B.E.E. = 655.1 + (9.563 x kg) + (1.850 x cm) - (4.676 x age)

B.E.E. defined as basal energy expenditure.

Protein needs were determined by an RD based upon the nutritional assessment of the patient, including: disease state, weight loss, appetite, percent ideal body weight, and malnutrition. Due to hospital policies and procedures, TPN recommendations were made by the RD for underfeeding, when <90% of a patient's estimated caloric and/or protein needs were being provided. RD TPN recommendations were made for overfeeding when >110% of a patient's estimated caloric and/or protein needs were being provided.

DATA ANALYSIS

The percentage of patients who received adequate TPN without RD recommendations, and the percentages of physician compliance and non-compliance with RD recommendations were initially calculated. Additionally, statistical analyses were

conducted to determine the significance of: 1) adequate TPN prior to RD recommendations, 2) physician compliance with RD recommendations, and 3) physician non-compliance with RD recommendations, on TPN patients' lengths of stay, prealbumin and albumin levels, weights, number of days on TPN, and mortality rates. Non-parametric chi square test of association tested whether the frequency of physicians who complied was statistically less than the frequency of physicians who did not comply with the RD recommendations. One-way analysis of variance (ANOVA) was conducted to test for differences between the group of patients who were treated by physicians who complied and those who had not complied with RD recommendations on patients' lengths of hospitalization, days receiving TPN, albumin and prealbumin levels, body weight changes, and mortality rates.

Additionally, crosstab analysis using Pearson's chi-square and Cramer's *V* tests were conducted to examine the relationships between the categorical independent variables. Pearson's product moment correlations were conducted to examine the relationships between length of stay, days of TPN administration, albumin levels, and percentage weight change. Finally, multiple regression analyses were completed with all variables of the study.

CHAPTER IV

PHYSICIAN COMPLIANCE WITH REGISTERED DIETITIAN RECOMMENDATIONS IN TOTAL PARENTERAL NUTRITION PATIENTS

A paper to be submitted to American Dietetic Association Journal

ABSTRACT

Purpose: The purpose of this study was to determine physician compliance with registered dietitian (RD) recommendations for total parenteral nutrition (TPN) patients and its effect on patient length of hospital stay, days of TPN administration, body weights, albumin and prealbumin levels, and mortality rates.

Methods: Closed medical charts, from a 350-bed acute care hospital, were reviewed for 202 patients who had received TPN during 2007. Data was analyzed using the non-parametric chi square test of association and one-way analysis of variance.

Results: Patients had increased lengths of hospital stay ($p < .01$), increased days of TPN administration ($p = .066$), and higher albumin levels at time of hospital discharge ($p < .05$), when physicians complied with RD recommendations. However, physician compliance did not have a significant effect on patients' weights or mortality.

Conclusions: Physician compliance with RD TPN recommendations seems to be insufficient, especially when a nutrition support team is not present. This can, consequently, have negative effects on patient outcomes. Additional research should be

conducted in other hospitals to evaluate the frequencies and outcomes of physician compliance with RD TPN recommendations.

INTRODUCTION

As many as 40% of adult patients are severely malnourished at the time of their hospital admission, and about two thirds experience deterioration of their nutritional status during their hospital stay.[1] Malnutrition is associated with increased complication rates, infections, lengths of stay, costs, and mortality in patients. Thus, nutrition support has become a major component in the treatment of such patients in an acute care setting.[2]

When a patient cannot get enough nutrition orally, enteral and/or parenteral nutrition (PN) are used for nutrition support. Enteral nutrition (EN) is the delivery of nutrients by tube into the gastrointestinal tract. Parenteral nutrition is the administration of nutrients intravenously, ideally utilized when the gut is nonfunctional.[3] Total parenteral nutrition (TPN) provides amino acids, lipids, and dextrose, in addition to electrolytes, vitamins, and minerals and is designed to meet the complete nutritional needs of a patient.[4]

Registered dietitians (RDs) serve as the leading experts in nutrition support.[5] In the acute care setting, however, physicians are usually responsible for ordering and monitoring TPN, and, oftentimes, do not respond to the support and recommendations offered by registered dietitians.[4] Unfortunately, because physicians do not typically have expertise in nutrition, many patients receiving TPN are victims of inadequate nutrition, overfeeding, or unnecessary TPN, resulting in increased complications.[1] The purpose of this study was to determine physician compliance with RD recommendations for total

parenteral nutrition and the effect on patient length of hospital stay (LOS), days of TPN administration, body weights, albumin and prealbumin levels, and mortality rates.

MATERIALS AND METHODS

Participants

The medical charts reviewed in this study included all patients who received TPN at a 350-bed acute care hospital from January 1, 2007 to December 31, 2007. Exclusions from the study included: patients who received TPN but currently had open charts; patients who received only intradialytic parenteral nutrition (IDPN); and patients who received PN, but not TPN (i.e. receiving amino acids and dextrose but no lipids). No nutrition support team was present in the hospital.

Study Design

This study involved a quantitative, exploratory approach. Closed chart reviews from patients who received TPN in the hospital were completed by the researchers to obtain the data used in this study. Approvals from the Texas Woman's University Institutional Review Board and from the hospital where the chart reviews were completed were obtained prior to conducting this research.

Data Collection

Closed chart reviews were conducted by the researcher to answer the questions listed in Table 1. Due to hospital policy, all patients' energy needs were previously assessed by

an RD using the Harris-Benedict Equations, with added activity and stress factors:

Men: B.E.E. = 66.5 + (13.75 x kg) + (5.003 x cm) - (6.775 x age)

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B.E.E. is defined as basal energy expenditure.

Protein needs were determined by an RD based upon the nutritional assessment of the patient including disease state, weight loss, appetite, percent ideal body weight, and malnutrition. Due to hospital policies and procedures, TPN recommendations were made by the RD for underfeeding when <90% of a patient's estimated caloric and/or protein needs were being provided. RD TPN recommendations were made for overfeeding when >110% of a patient's estimated caloric and/or protein needs were being provided.

Data Analysis

The percentage of patients who received adequate TPN without RD recommendations, and the percentage of physician compliance and non-compliance with RD recommendations were initially calculated. Additionally, statistical analyses were conducted to determine the significance of: 1) adequate TPN prior to RD recommendations, 2) physician compliance with RD recommendations, and 3) physician non-compliance with RD recommendations, on TPN patients' lengths of stay, prealbumin and albumin levels, weights, number of days on TPN, and mortality rates. Non-parametric chi square test of association tested whether the frequency of physicians who complied was statistically less than the frequency of physicians who did not comply with the RD recommendations. One-way analysis of variance (ANOVA) was conducted to test for differences between the group of patients who were treated by physicians who

complied and those who had not complied with RD recommendations on patients' lengths of hospitalization, days receiving TPN, albumin and prealbumin levels, body weight changes, and mortality rates.

Additionally, crosstab analysis using Pearson's chi-square and Cramer's *V* tests were conducted to examine the relationships between the categorical independent variables. Pearson's product moment correlations were conducted to examine the relationships between length of stay, days of TPN administration, albumin levels, and percentage weight change. Finally, multiple regression analyses were completed with all variables of the study.

RESULTS

Description of Sample

A total of 202 patient charts were reviewed. Demographic characteristics of the TPN patients are displayed in Table 2. Patients ranged in age from 22 to 90 years, with a mean of 64.93 years (SD=14.51). Approximately half of the patients were female (52.0%, $n = 105$) and the remaining half were male (48.0%, $n = 97$). Participants were categorized into six hospital diagnosis categories: GI, Heart, Respiratory, Sepsis, Renal failure, and Other. The majority of TPN patients had hospital diagnoses related to gastrointestinal disorders (53.5%, n=108).

The frequencies and means of the variables used in this study appear in Table 3. Patients' length of hospital stay ranged from 1 day to 200 days, with a mean of 20.18 (*SD* = 18.53). The number of days that total parenteral nutrition was administered varied from 1 day to 123 days, with a mean of 9.29 days (*SD* = 11.13). Patient weights (in pounds)

at hospital admission ranged from 83 to 434, with a mean of 172.85 (*SD* = 52.72), and patients' weights at discharge ranged from 86 to 401, with a mean of 170.01 (*SD* = 48.66). Percentage weight changes from admission to discharge ranged from -46.16 to 32.48, with a mean of -0.63 (*SD* = 10.12).

RD Recommendations

Registered dietitians offered TPN recommendations for the majority of the patients reviewed (63.4%). The reasons for RD recommendations were underfeeding (63.5%), overfeeding (20.6%), unnecessary TPN (15.9%), or new TPN patient orders (1.6%).

A significant association was found between reason for RD recommendation and gender ($\chi^2(2) = 7.44$, $p < .05$, Cramer's $V = .24$). RDs made recommendations for a greater percentage of males due to underfeeding (74.1%) than females (54.4%), while a greater percentage of females had RD recommendations for overfeeding (29.4%) than males (10.3%).

Patients who were 60 years of age or older had more RD recommendations ($\chi^2(8) = 14.02$, $p = .081$, Cramer's $V = .33$) for TPN due to underfeeding than those ≤ 59 years. Additionally, more patients who were under 50 years old had TPN recommendations by the RD due to overfeeding (45.0%) than patients ≥ 50 years.

Physician Compliance

Of the 128 patients who had TPN recommendations by a registered dietitian, there was a significantly greater number of physicians' non-compliance than compliance with the RD recommendations (77 *vs* 51), $\chi^2 = 5.28$, $p < .05$.

Length of Hospitalization

Physician compliance did have an effect on the number of days individuals were in the hospital, $F(1, 126) = 7.08$, $p < .01$. Patients spent more days in the hospital when the physician complied with RD recommendations for TPN administration ($M = 28.12$) than when they did not comply with RD recommendations ($M = 18.38$).

Length of hospital stay was significantly positively correlated with the number of days of TPN administration ($r = .852$, $p < .01$), indicating that the critically ill required increased days of TPN administration and LOS. Additionally, longer hospitalizations tended to result in greater percentages of positive weight change in patients ($r = .225$, $p < .01$).

TPN Administration

Physician compliance had a marginal effect on the number of days individuals received TPN, $F(1, 126) = 3.45$, $p = .066$. Patients received more days of TPN administration when physicians complied with RD recommendations ($M = 13.35$) than when they did not ($M = 9.12$), resulting in higher albumin levels at discharge. Additionally, a significant positive correlation was found between albumin change and percentage weight change (lbs), ($r = .262$, $p < .01$), demonstrating that patients with a greater change in albumin during hospitalization also had a higher percentage of weight change. Only 25 (12.4%) of the 202 patients reviewed had prealbumin data.

Mortality

Fifty-three (26.2%) of the 202 patients reviewed died during their hospitalization, and 149 (73.8%) patients survived during their hospital stay. Although physician

compliance with RD recommendations did not have a significant effect on patient mortality, it should be noted that only 17.6% of patients died when physicians complied with RD recommendations vs. 29.9% of patients who died when physicians did not comply with RD recommendations.

DISCUSSION

This study investigated the effects of physician compliance with RD recommendations in patients receiving total parenteral nutrition. The research findings revealed that a majority of the physicians did not comply with RD recommendations, despite registered dietitians serving as the nutrition experts within this hospital setting. Reasons why physicians did not utilize RD recommendations were not investigated, but previous studies, such as Leslie & Thomas[6] and Vanek et al[7] have reported on the lack of nutrition education within the medical school curriculum. It is possible that lack of nutrition support knowledge and skill among physicians is the reason for inadequate or inappropriate TPN orders.

In this study, patients' lengths of hospital stay and number of days of TPN administration were increased when physicians complied with TPN recommendations made by the RD. This is congruent with the fact that majority of RD recommendations were made when patients were being underfed and, consequently, malnourished. The length of hospitalization for malnourished, critically ill patients has been reported to be longer than that of well-nourished adults.[2] As for TPN administration, the longer the hospital stay, the greater the probability of the patient receiving TPN for a longer period of time. Saalwachter et al[4] reported that the number of inappropriate TPN orders

decreased with the involvement of a nutrition support team (NST) while the total number of appropriate TPN orders significantly increased. With trained dietitians consulting on each patient requiring nutrition support, more malnourished patients may have been identified and diagnosed and thus able to receive appropriate treatment. Therefore, increased length of hospital stay and increased days of TPN administration may actually be more beneficial to improve a patient's nutritional status.

This study also revealed that ordering of prealbumin by physicians for patients receiving TPN in this facility is minimal. The half-life of serum albumin in stable, healthy patients is approximately 20 days. However, when a patient is suffering with an acute illness such as sepsis, trauma, burn, or following an extensive operative procedure, the serum albumin concentration significantly decreases.[8] Therefore, albumin is not an accurate indicator of a hospitalized, critically ill patient's nutritional status. Prealbumin, on the other hand, has a half-life of only 1.9 days, making it more reflective of short-term changes in nutritional status than albumin. Although prealbumin levels decrease promptly if an adult fasts or is malnourished, the level normalizes rapidly after the patient receives adequate nutrition support.[9] Based on the data from this study, physicians should utilize prealbumin testing more frequently in the acute setting, especially in nutrition support patients, thus malnutrition can be detected easily and the nutritional needs of the patients can be met appropriately. Due to data collection from only one hospital in this study, it is unknown whether physicians who work in other hospitals utilize prealbumin levels on a more frequent basis than the physicians considered in this research. In this study, patients' albumin levels at discharge were significantly higher

when physicians complied with RD recommendations, indicating that a patient's nutritional status is better maintained during hospitalization with the support of an RD in TPN orders.

Physician compliance with RD TPN recommendations did not significantly affect patients' weights or weight changes. However, in the hospital setting, weight can be complicated by many factors, other than just nutritional intake. It can vary with fluid retention, medications, and protein and electrolyte intake.[9] Therefore, it is not surprising that this variable was insignificant to the study findings. Physician compliance with RD recommendations in TPN patients also did not have a significant effect on patient mortality (17.6% of patients died when physicians complied with RD recommendations vs. 29.9% of patients who died when physicians did not comply with RD recommendations). Although previous studies have shown malnutrition to be an independent predictor of mortality, other variables, besides nutritional status of the patient, significantly influence and contribute to patient mortality rates. These may include the patient's disease, the presence of comorbidities, age, clinical treatment, psychological factors, and incidence of complications.[10]

There were several limitations for this research study. One possible limitation was that patients from only one hospital were evaluated therefore, the findings and results may not be applicable to other hospital settings. The size, policies and protocols, and traditionalism vs. modernism of a hospital are all factors that could play a significant role in affecting patient outcomes. Also, because this study was conducted by a registered dietitian employed by the hospital reviewed, bias and conflict of interest may be

additional limitations. Furthermore, estimated nutritional needs of the patients in this study were calculated by registered dietitians using the Harris-Benedict equation. The Harris-Benedict equation often underestimates the nutritional needs of a patient and could, therefore, serve as a limitation of the study. Indirect calorimetry remains the only accurate method to determine the energy needs in critically ill patients, yet this method of measurement would not be feasible within the acute clinical setting.[11] Finally, the lengths of stay, days of TPN administration, weights, albumin and prealbumin levels, and mortalities of TPN patients are most likely affected by factors other than solely providing adequate nutrition support. It is difficult to conclude, then, that physician compliance with RD total parenteral nutrition recommendations will inevitably affect each of these variables.

SUMMARY

The national nutritional agenda is changing, and feeding patients appropriately in hospitals has now been identified as an area of concern. Furthermore, total parenteral nutrition can lead to a variety of complications if not properly administered.[4] The overall goal of the nutrition support team or the registered dietitian is to prevent underfeeding, overfeeding, and unnecessary total parenteral nutrition in patients within the acute care setting. However, this study reveals that physician compliance with RD TPN recommendations seems to be insufficient, especially when a nutrition support team is not present. This can, consequently, have negative effects on patient outcomes. Therefore, physicians should recognize the benefits of utilizing RD expertise in meeting the nutritional needs of TPN patients. Furthermore, additional research should be

conducted in other hospitals to evaluate the frequencies and outcomes of physician compliance with RD TPN recommendations.

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Table 1

Chart Review Questions

	Questions
1.	What were the patient's gender, age, and hospital diagnosis?
2.	Did the RD make TPN recommendations?
3.	What was the reason for the RD's TPN recommendations?
4.	Did the physician order the TPN recommendations made by the RD?
5.	What was the patient's length of stay?
6.	How many days did the patient receive TPN?
7.	What were the patient's weights while on TPN?
8.	What were the patient's albumin levels while on TPN?
9.	What were the patient's prealbumin levels while on TPN?
10.	Did mortality occur during the patient's hospital stay?

Table 2

Demographic Characteristics of TPN[a] patients, N=202

	n	%
Age (mean = 64.93 ± 14.5 yr)		
Under 50 years	33	16.3
50-59 years	33	16.3
60-69 years	43	21.3
70-79 years	59	29.2
80+ years	34	16.8
Gender		
Male	97	48.0
Female	105	52.0
Diagnosis categories		
GI	108	53.5
Heart	20	9.9
Respiratory	22	10.9
Sepsis	19	9.4
Renal failure	4	2.0
Other	29	14.4

[a]TPN = Total parenteral nutrition

Table 3

Hospital Stay, TPN[a] administration, and Albumin Levels for TPN Patients

	n	%
LOS[b] (days)		
< 10	44	21.8
10 to 21	93	46.0
≥ 22	65	32.2
TPN administration (days)		
≤ 3	51	25.2
4 to 7	60	29.7
8 to 14	57	28.2
≥ 15	34	16.8
Prealbumin levels		
None	177	87.6
Any	25	12.4
Albumin levels at admission (g/dL)		
< 3.00	109	60.9
3.00 to 3.499	32	17.9
≥ 3.50	38	21.2
Albumin levels at discharge (g/dL)		
< 3.00	143	90.5
3.00 to 3.499	13	8.2
≥ 3.50	2	1.3

[a]TPN = Total parenteral nutrition
[b]LOS = Length of hospital stay

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