Improving the Safety and Effectiveness of Parenteral Nutrition: Results of a Quality Improvement Collaboration
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What is This?
Clinical Observation

Improving the Safety and Effectiveness of Parenteral Nutrition: Results of a Quality Improvement Collaboration

Megan Boitano, MS, RD, CNSC1; Shiva Bojak, PharmD, PhD2; Shirley McCloskey, RPh, BCNSP1; David S McCaul, MD3; and Megan McDonough, MS, RD, CNSC1

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Parenteral nutrition (PN) is a high-risk nutrition support modality. This article describes the approach taken by 1 hospital to improve safety and quality of this therapy as well as the challenges and obstacles to success. Process improvement strategies included revisions to the PN order form, education of clinicians (including physicians), increased collaboration between pharmacists and registered dietitians, and initiation of PN rounds during which PN patients were reviewed by the rounding team twice weekly. These strategies were spearheaded by clinicians with advanced certifications in nutrition support. These process changes positively impacted quality and costs. Comparison of baseline and follow-up data showed improvement in compliance to mandatory safe practice standards, percentage of patients with appropriate indication for PN, adequate glycemic management, number of patients receiving PN within 10% of calorie needs, and appropriate laboratory monitoring. In addition to quality improvement, substantial cost savings were realized through decreased inappropriate PN use and timely transition to oral or enteral feeding. The average number of patients receiving PN decreased from approximately 15 to less than 5 per day. Overall, this translated into a $5.3 million decrease in PN charges. Actual pharmacy expenses decreased by $107,000. This quality improvement project demonstrated that implementing practice guidelines published by the American Society for Parenteral and Enteral Nutrition can result in quality improvement and cost savings. Clinicians with advanced certifications in nutrition support were pivotal to the success of the project. (Nutr Clin Pract. 2010;25:663-671)

Keywords: parenteral nutrition; outcome assessment; quality assurance; medical care; cost savings

When compared with enteral nutrition, patients receiving PN require a wide variety of resources that translate into increased costs.1 Nutrition support teams are used by some institutions to manage PN and control costs associated with this therapy.2 These teams consist of clinicians with advanced training in nutrition support and are assigned the responsibility of ensuring the safety and quality of this complex, high-risk nutrition support modality. Nutrition support teams also have the potential to produce cost savings by minimizing inappropriate utilization, decreasing average duration of PN, reducing the number of laboratory tests to monitor PN, and standardizing protocols and PN formulations.2–4

This article describes (1) the approach taken by Scripps Memorial Hospital La Jolla (SMH) to improve safety and quality of PN administration, and (2) the challenges and obstacles to implementation of the process improvement project. The project began in 2007 with a goal to improve the safety and effectiveness of PN. This quality improvement project was the result of clinicians with advanced certifications in nutrition support recognizing an opportunity to address the gap between current

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hospital practice and best practice. This project was exempt from review by an Institutional Review Board.

Baseline Data Review

The American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) publishes guidelines for utilization of nutrition support. One key guideline is the Safe Practices for Parenteral Nutrition, which was last published in 2004. Of the 10 mandatory safety recommendations, SMH was compliant with only 2 during a review conducted in August 2007 (Table 1). These data were presented to the Pharmacy and Therapeutics (P&T) committee in September 2007. The recommendation of the committee was to complete a medication use evaluation (MUE) focused on key safety and clinical practice parameters. Additionally, it was recommended that an education program focused on PN be offered to the medical staff.

It is important to note that, in the state of California, Registered Dietitians (RDs) are not licensed and their scope of practice is defined by the state’s business and professions code. This code precludes RDs from writing orders for medications, including PN. As such, PN orders at SMH are written by physicians or pharmacists. PN ordering and management is often delegated by the ordering physician to a pharmacist via a medical staff approved protocol. RDs assess nutrition requirements and make PN recommendations in the medical record.

Thirty charts were audited in the initial MUE which was completed in October 2007. Issues that were identified as problems were glycemic control, inappropriate utilization of PN, inadequate provision of nutrients, and suboptimal patient monitoring.

The average number of days patients received PN was 9 with a median of 7. Based on A.S.P.E.N. Guidelines, PN was appropriately provided 60% of the time. PN was used inappropriately in 10 patients who were well nourished and had hypocaloric intake for <7 days or had a functional GI tract. These results indicated a potential for cost savings by decreasing the number of patients who receive PN when it is not indicated. Baseline data from the initial MUE is presented in Table 2.

The initial MUE validated the need for improvement in PN quality and safety at SMHLJ and served to focus attention on specific problem areas. Results of the MUE

<table>
<thead>
<tr>
<th>Standard</th>
<th>Current Compliance</th>
<th>Current Form</th>
<th>Proposed Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearly written and understandable to anyone who might utilize it</td>
<td>NO</td>
<td>Base volume concept is confusing and % macronutrients not based on infused volume</td>
<td>Clearly written and understandable</td>
</tr>
<tr>
<td>Decimals and % concentrations avoided</td>
<td>NO</td>
<td>Dextrose and amino acid concentrations listed in % with decimals</td>
<td>No decimals or %</td>
</tr>
<tr>
<td>All components ordered in g/mg/mEq/mMol per day or kg per day</td>
<td>NO</td>
<td>Components listed per liter</td>
<td>Components listed per day</td>
</tr>
<tr>
<td>Contact information for person writing the order</td>
<td>NO</td>
<td>Not included</td>
<td>Contact number listed</td>
</tr>
<tr>
<td>Contact information for assistance with PN ordering</td>
<td>NO</td>
<td>Not included</td>
<td>Contact number listed</td>
</tr>
<tr>
<td>Time by which order needs to be received for processing</td>
<td>YES</td>
<td>Time listed</td>
<td>Time listed</td>
</tr>
<tr>
<td>Location of venous access device (central or peripheral)</td>
<td>NO</td>
<td>Information is not requested</td>
<td>Information required</td>
</tr>
<tr>
<td>Height, weight/dosing weight, diagnosis, PN indication</td>
<td>NO</td>
<td>Not on form</td>
<td>Information required</td>
</tr>
<tr>
<td>Hang time guidelines</td>
<td>YES</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>Information regarding potential incompatibilities</td>
<td>NO</td>
<td>Not included</td>
<td>Pharmacy to check Calcium/Phosphorus compatibility</td>
</tr>
</tbody>
</table>

A.S.P.E.N., American Society for Parenteral and Enteral Nutrition; PN, parenteral nutrition.
Improving the Safety and Effectiveness of Parenteral Nutrition

Table 2. Initial Medication Use Evaluation Data From a Parenteral Nutrition Quality Improvement Project

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Incidence</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>RD recommendations for kcal available in chart at time of PN initiation</td>
<td>21/30</td>
<td>70</td>
</tr>
<tr>
<td>Pharmacy managed PN</td>
<td>11/30</td>
<td>37</td>
</tr>
<tr>
<td>Physician managed PN</td>
<td>19/30</td>
<td>63</td>
</tr>
<tr>
<td>Ordered PN within 10% of kcal requirements</td>
<td>15/28</td>
<td>54</td>
</tr>
<tr>
<td>Pharmacy managed</td>
<td>4/9</td>
<td>44</td>
</tr>
<tr>
<td>Physician managed</td>
<td>11/19</td>
<td>58</td>
</tr>
<tr>
<td>PN dextrose initiated at &lt;2 mg/kg/min</td>
<td>16/30</td>
<td>53</td>
</tr>
<tr>
<td>Hyperglycemia in first 24 hours of PN therapy (&gt;180 mg/dL)</td>
<td>11/30</td>
<td>37</td>
</tr>
<tr>
<td>Initiated at &lt;2 mg/kg/min</td>
<td>2/11</td>
<td>18</td>
</tr>
<tr>
<td>Initiated at &gt;2 mg/kg/min</td>
<td>9/11</td>
<td>82</td>
</tr>
<tr>
<td>Hypophosphatemia (&lt;2.5 mg/dL)</td>
<td>6/30</td>
<td>20</td>
</tr>
</tbody>
</table>

PN, parenteral nutrition; RD, registered dietitian.

Improvements and Actions

In order to facilitate compliance with safe practice standards, the PN order form and policy required drastic revision. In January 2008, a revised PN policy and draft of a revised PN order form were presented to medical staff at a P&T committee meeting. Figure 1 summarizes proposed changes to the policy and order form. The policy was approved; however, the order form was not approved due to concerns regarding the change to ordering nutrients/additives per day as opposed to per liter or percent final concentration. It was felt that this was a substantial practice change for the physicians and that additional education and feedback was needed prior to approval. The forms were then presented to key medical staff committees including Special Care (intensive care unit), Trauma, and General Surgery committees to get feedback and support from key stakeholders. This was a lengthy process requiring greater than 6 months to complete. Each revision required approval by

- Parenteral Nutrition Policy revised to include the following:
  i. All IV fat emulsion doses must be run separately from the PN mixture.
  ii. Defines peripheral parenteral nutrition as ≤900 mOsm/L.
  iii. Defines pharmacist-managed PN to include macronutrient and electrolyte dosing (except for supplemental electrolyte orders), initiation of an insulin sliding scale order set, and laboratory test orders for monitoring PN. For supplemental electrolyte orders, the pharmacist will call the physician to initiate the “Electrolyte Replacement” order set.

- Practice changes reflected on the new order form:
  1) Nutrients and additives are ordered per day instead of per liter for a 24-hour supply.
  2) To comply with A.S.P.E.N. Safe Practices, macronutrients are ordered in grams per day.
  3) Fat emulsions are available only as a 20% concentration.
  4) Option for Vitamin K 10mg is eliminated since the standard “MVI Adult” includes 150 mcg of vitamin K per day, which is equivalent to normal intake.
  5) Trace element mix is changed to Trace Element-5 to include selenium.
  6) Triglyceride monitoring and maximum infusion rates are defined to comply with the Black Box Warnings for IV Fat Emulsion infusions.
  7) Phosphate is ordered in mMol instead of by mEq of potassium or sodium.
  8) General guidelines for dosing macronutrients and the addition of insulin are included on the face of the form.
  9) Laboratory orders are included on the face of the order form instead of a separate order set.
  10) Orders for IV fluid changes are included on the face of the order form.
  11) The reverse of the order form contains more extensive ordering information including electrolyte dosing for patients with normal renal function.

Figure 1. Summarized changes to parenteral nutrition policy and order form. A.S.P.E.N., American Society for Parenteral and Enteral Nutrition.
**Scripps Memorial Hospital La Jolla**
**ADULT PARENTERAL NUTRITION ORDER FORM -CENTRAL**

Boxes must be checked to activate orders. Draw a line through orders to modify.

- This form must be completed **DAILY** and scanned to the Pharmacy by **12:00 noon** to receive same day preparation.

**INDICATION:**

| Actual body weight: ____kg, Ideal body weight ____kg |

- **Pharmacy Managed Parenteral Nutrition (PN)**
- **Registered dietitian consult**

- **Bag Number:**
  - **Continue same PN written on**
  - **Date**
  - **Formulation/Rate change**
  - **Discontinue PN after this bag**

- **Discontinue IV fluids once PN starts**
- **Saline flush**
- **Change rate of IV fluids to ____ mL/hour**

- **If H2 antagonist is ordered, may add to PN and discontinue all other IV/PO H2 antagonist orders**
- **Sliding scale regular insulin**, **LOW**, **MEDIUM**, **HIGH COVERAGE**, with finger stick Q4h (must complete the sliding scale insulin order form)

- **PN solutions run over 24 hours beginning at 1800.**
- **PN MUST be administered through a dedicated infusion port and filtered with a 0.2 micron in-line filter.**
- **Fat emulsions will be infused over 12 hours separately from the PN bag Y-sited BELOW the filter of PN tubing.**
- **If PN is not available for any reason, hang D10W at the same rate.**

Contact the Pharmacy for additional information.

**RATE:**

- **__mL/hour** OR **__Liters/DAY**
- **Cycle __________ mL over ________ hours. Specify taper schedule:**

**BASE FORMULA**

| Dextrose | ____________ gram/DAY |
| Amino Acids | ____________ gram/DAY |

**FAT EMULSION 20% (2 kcal/mL)**

- **100 mL at 8.3 mL/hr over 12 hours** (adds 200 kcal) (adds 500 kcal)
- **250 mL at 20.8 mL/hr over 12 hours**

**ADDITIVES: (per DAY)**

| Sodium Chloride | ____________ mEq/DAY |
| Sodium Acetate | ____________ mEq/DAY |
| Sodium Phosphate | ____________ mM/DAY |
| Potassium Chloride | ____________ mEq/DAY |
| Potassium Acetate | ____________ mEq/DAY |
| Potassium Phosphate | ____________ mEq/DAY |
| Calcium Gluconate | ____________ mEq/DAY |
| Magnesium Sulfate | ____________ mEq/DAY |
| MVI Adult | 10 mL/DAY |
| Trace Element-5 | ____________ mL/DAY |

**MISCELLANEOUS ADDITIVES (per DAY)**

| Regular Insulin | ____________ units/DAY |
| Farnoldine | ____________ mg/DAY |
| Thiamine | ____________ mg/DAY |
| Zinc | ____________ mg/DAY |
| Other | |

**LABORATORY ORDERS:**

| Baseline (Day 1): | CMP, Magnesium, Phosphorus, CBC, Triglycerides, Pre-albumin |
| Daily (Day 2-7), then Mon-Wed-Fri: | BMP, Magnesium, Phosphorus |
| Every Monday: | CMP, CBC, Triglycerides, Pre-albumin |
| Other (specify) | |

**Physician’s Signature:**

**Pharmacist’s Signature:**

**Contact Number:**

**Date/Time:**

(continued)
GUIDELINES FOR ORDERING PARENTERAL NUTRITION

Guidelines for Use:
- Early gut feeding is essential to preserve gut integrity and function.
- The anticipated duration of Parenteral Nutrition should be at least 7 days.
- Parenteral nutrition should be used in patients with a nonfunctional or inaccessible GI tract thus requiring IV nutrition support.
- Peripheral parenteral nutrition should be administered for short-term treatment (maximum of 10-14 days), and when fluid restriction is not necessary or when central access is not feasible.

1. PROTEIN (1 gram = 4 kcal)
   - Usual daily requirements are 0.8-1 gram/kg/day in stable patients.
   - Stress and critically ill patients (e.g., sepsis, fistula, post-operative, trauma) may require high amounts in the range of 1.2-2.0 gram/kg/day unless contraindicated based on disease state.

2. CARBOHYDRATE [DEXTROSE] (1 gram = 3.4 kcal)
   - Goal rate of administration should be 2-4 mg/kg/min (3-5 gram/kg/day).
   - Initial carbohydrate load should be 150-200 gram/day to allow pancreas to adjust to insulin demand.
   - In patients with diabetes mellitus or hyperglycemia from stress, initial carbohydrate load should be lowered to 100-150 gram/day.
   - Infusions of high dextrose concentrations should not be stopped abruptly; rates should be tapered.

3. FAT (1 gram = 9 kcal)
   - Goal should be 1 gram/kg/day or <30% of total calories from lipids (including other lipid IV sources).
   - Maximum rate of lipid infusion: 2.5 gram/kg/day or 0.1 gram/kg/hr.
   - In sepsis or systemic inflammatory response syndrome (SIRS), reduce lipids to 15% of total calories.

4. TOTAL CALORIES
   - Goal is approximately 20-30 kcal/kg based on actual weight if patient is <120% of ideal body weight (IBW) or adjusted IBW if >120% of IBW.

5. FLUID
   - Usual goal rate is 30-40 mL/kg/DAY. Fluid requirements may need to be adjusted per patient's clinical status.

6. ELECTROLYTES:
   - American Society for Parenteral and Enteral Nutrition guidelines for normal electrolyte needs:
     - Sodium* (1-2 mEq/kg/day)
     - Potassium* (1-2 mEq/kg/day)
     - Phosphorus (20-40 mEq/day)
     - Calcium (10-15 mEq/day)
     - Magnesium (8-20 mEq/day)
   - *Must be individualized to patient's needs

7. VITAMINS
   - 10 mL dose of MVI Adult is recommended daily.
   - Additional vitamin supplementation may be required based on the disease state of the patient.
   - Each 10 mL dose contains

<table>
<thead>
<tr>
<th>Water Soluble Vitamins</th>
<th>Fat Soluble Vitamins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingredient</td>
<td>Dose (per 10 mL)</td>
</tr>
<tr>
<td>Vitamin C (Ascorbic acid)</td>
<td>200 mg</td>
</tr>
<tr>
<td>Thiamine (B1)</td>
<td>6 mg</td>
</tr>
<tr>
<td>Niacinamide</td>
<td>40 mg</td>
</tr>
<tr>
<td>Pyridoxine (B6)</td>
<td>6 mg</td>
</tr>
<tr>
<td>Riboflavin (B2)</td>
<td>3.6 mg</td>
</tr>
<tr>
<td>Dexamethasone</td>
<td>15 mg</td>
</tr>
</tbody>
</table>

8. TRACE ELEMENTS
   - 3 mL dose should be administered daily
   - Additional supplementation of trace elements may be required based on disease state of the patient.
   - Each 3 mL dose contains
     - 3 mg Zinc, 1.2 mg Copper, 12 mcg Chromium, 0.3 mg Manganese, 0.06 mg Selenium

9. REGULAR INSULIN
   - To be administered to keep blood glucose ≤150 mg/dL while on parenteral nutrition.
   - It is recommended that insulin be provided until euglycemia is achieved. When persistent coverage by PRN sliding scale is required, 50-60% of the past 24 hour insulin requirement should be incorporated into the 24 hour parenteral nutrition bag.

10. ELECTROLYTE CONTENT OF SOURCE SOLUTIONS
     - FreAmine III 10%: 10 mEq sodium, 99 mEq Acetate, 5 mM phosphate per liter
     - Aminosyn II 15%: 56 mEq sodium, 108 mEq Acetate per liter
     - Fat Emulsions 20%: 1.5 mM Phosphorus per 100 mL

11. PHOSPHATE CONVERSION
    - 3 mM sodium phosphate = 4 mEq sodium and 3 mM phosphate
    - 3 mM potassium phosphate = 4.4 mEq potassium and 3 mM phosphate

Figure 2. Central parenteral nutrition form (front and back).
numerous committees. Final approval for the new order form was obtained in November 2008. The revised Central PN form is shown in Figure 2.

As recommended by the P&T committee, physician education on PN was scheduled and held in March 2008. The grand round presentation was well attended by physicians, pharmacists, and RDs, and stimulated discussion on the topics of appropriate utilization and patient selection for this complex and high-risk therapy.

To further enhance and evaluate clinical practice, PN clinical rounds were initiated in January 2009. Pharmacists and RDs collaborated twice weekly to review patients requiring PN and evaluate each case for adequacy and appropriateness of PN. The goal of PN rounds was to ensure appropriate utilization of PN as well as to make sure that PN was administered in the safest manner and managed effectively. Rounds enhanced collaboration between pharmacists and RDs and offered opportunities to educate other practicing clinicians on evidence-based guidelines. The goals and operations of the team were documented to ensure uniform practice and understanding (see Figure 3). Due to budgetary constraints, additional labor hours were not allocated to this pilot program. The Lead RD and Clinical Pharmacy Manager utilized their time to implement the team. Although the team that conducted PN rounds was not a formal nutrition support team, the goals and objectives of the rounding team were similar to that of a nutrition support team and initiating PN rounds was designed as a first step towards establishing a nutrition support team.

Pharmacists and RDs enhanced their expertise by participating in numerous educational opportunities including attending medical grand rounds on nutrition support and A.S.P.E.N. teleseminars as well as studying the online Clinician’s Compendium to Nutrition Support, the A.S.P.E.N. Self Assessment program, a PN-writing CD, and key nutrition support texts. Additional staff obtained certification in nutrition support and when recruiting new staff, those with specialty certifications in nutrition support were targeted. These efforts resulted in a substantial increase in the knowledge and ability of pharmacists and RDs to manage the complexities of PN.

Outcome Data Review and Financial Impact

To assess the impact of changes to the PN policy and order form, and to evaluate the effectiveness of PN rounds, a follow-up MUE was conducted in June 2009. Results of the MUE were presented to the P&T committee in September 2009 and compared with results from the 2007 MUE.

Of the 30 patient charts reviewed in the 2009 MUE, pharmacy managed the PN 97% of the time. This compared with 37% in 2007. The revision to the PN form requiring nutrients/additives to be ordered per day resulted in many physicians deferring PN management to pharmacists. PN was indicated (based on A.S.P.E.N. guidelines) 97% of the time. This was a substantial increase from 2007 where only 60% of the patients had appropriate indication for PN. A major reason for the decrease in utilization was an increase in the expertise of both pharmacists and RDs and the resultant increase in their ability to discuss appropriate PN indications with physicians. If a patient did not have an appropriate indication for PN, a call would be placed to the physician to discuss feeding alternatives. This was the single most important change made and had the greatest impact on cost savings.

Utilization of PN for periods less than 5-7 days has not been shown to result in improved patient outcomes for any disease or condition.1,5 The follow-up MUE showed an improvement in percentage of patients receiving PN for at least 5 days from 53 to 83%. The mean duration of PN in the second MUE (8.7 days) was similar to that found in the first MUE (9 days). This was attributed to the team’s focus on transitioning patients to enteral or oral feeding in a timely manner. Having PN rounds was key to facilitating timely transition off PN.

Baseline laboratory data (complete blood count; comprehensive metabolic panel; serum levels of magnesium, phosphorus, and triglycerides) were obtained only 30% of the time in the initial MUE. The follow up MUE showed improvement to 83% of the time. The improvement can be attributed to the incorporation of the laboratory orders as part of the PN order form. Previously, laboratory orders were written on a separate form. It is important to note a distinction between ordering and obtaining laboratory data. As a result of order form changes, appropriate baseline labs were ordered 100% of the time; however, transcription of orders was not always completed. When this issue was identified, additional training was provided to transcribers.

The adequacy of calories provided from PN improved in the follow-up MUE. The number of patients receiving within 10% of their estimated calorie goal increased from 54 to 85%. This is largely due to the fact that 97% of PN orders were pharmacy managed and there was substantial daily collaboration between pharmacists and RDs, as well as twice weekly PN rounds.

In the initial MUE, hyperglycemia in the first 24 hours of PN administration occurred in 83% of patients who received >2 mg/kg/min of dextrose on the first day of PN infusion. The follow-up MUE showed improvement in the percentage of patients receiving modest dextrose provision in first bag of PN from 53% to 97%. In the initial MUE, modest dextrose provision was defined as <2 mg/kg/min of dextrose but in the follow-up MUE, it was defined as ≤150 g/day dextrose. It was difficult to compare rates of
Goals
To ensure that PN at Scripps Memorial Hospital La Jolla is utilized appropriately, given in the safest manner, and managed effectively; to provide evidence-based guidelines and education to other practicing clinicians.

Potential outcomes
- Decrease orders for inappropriate PN
- Decrease placement of unnecessary central lines
- Improve timeliness of monitoring parameters/labs
- Improve glycemic control
- Improve monitoring of fluid status

Proposed Operations
- Team meeting twice weekly for ½ hour
- Core team members (dietitians and pharmacists):
  - Clinical Nutrition Manager
  - Medication Safety Coordinator
  - Clinical Pharmacy Manager
  - Lead Registered Dietitian
  - Clinical Pharmacist
- Team members will discuss 2-3 PN patients at each meeting
- A dietitian will review the comprehensive PN list daily; on Mondays and Wednesdays, the dietitian will send a message to the pharmacy manager and Medication Safety coordinator, assigning which patients will be discussed at the next meeting
- A monitoring form will be constructed and utilized by the dietitians and pharmacists for data collection, which will occur prior to each meeting
- Role of Pharmacist
  - Come prepared for each meeting with following information:
    - Current PN order
    - Laboratory trends/current laboratory results
    - Medication list
    - Type/ordered rate of IV drips
    - Type of insulin coverage
    - Amount of electrolyte replacement given
  - On patients with the order, “PN per pharmacy,” will make changes to PN as discussed by the team. If changes in the PN order become necessary after the meeting, will document in the medical record.
  - If in the meeting it is decided that a physician needs to be contacted regarding the PN, will make call to the physician and write orders accordingly
- Role of Dietitian:
  - Come prepared for each meeting with following information:
    - Patient history/update on current status
    - MD plan of care
    - Anthropometrics
    - Vital sign results
    - Fluid status/fluid intake & output totals/current IV drip rates
    - GI function/Stool output/Drain output
    - Ventilator/respiratory status
    - Amount of nutrition received
    - Estimate of nutrition needs
  - In each PN patient’s chart, will document in the progress notes a description of topics discussed during the meeting. If needed, will also make recommendations to the attending physician.
- Evaluation of nutrition support team
  - A record will be kept of which patients are discussed at the nutrition support team meetings
  - After 3 months of holding regular nutrition support team meetings, a follow-up MUE will be conducted
  - MUE will evaluate appropriate indication for PN, length of PN, glycemic control, electrolyte abnormalities, compliance with A.S.P.E.N safe practice guidelines, and implementation of nutrition support team recommendations.
  - Data from the MUE will be compared with data collected in October 2007

Figure 3. A.S.P.E.N., American Society for Parenteral and Enteral Nutrition; MUE, Medication Use Evaluation; PN, parenteral nutrition

Pilot program: parenteral nutrition rounds.
hyperglycemia as the initial MUE defined hyperglycemia as >180 mg/dL in the first 24 hours of therapy. The follow-up MUE defined hyperglycemia as >150 mg/dL and documented any hyperglycemia that occurred during PN administration.

It is difficult to do a complete side-by-side comparison of the MUE data as they were not identical in design. This quality improvement project was not designed as a research study, but the results were striking, making it important to share the process used to make the improvements with the nutrition support community. Table 3 lists key comparable data from the 2007 and 2009 MUEs.

The average daily cost for PN is difficult to establish because there are direct costs for the product and equipment, and indirect costs for facilities and personnel who administer it. These costs will vary by institution. Hospital charges for PN may be itemized, but payment varies based on insurer payment agreements and therefore charges do not provide an accurate picture of reimbursement for this therapy. However, reviewing PN charges can provide data on utilization. Although it does not capture indirect costs, monitoring pharmacy costs to compound PN is 1 way to gauge expense.

There was a substantial decrease in utilization of PN from fiscal year (FY) 07 to 09 (FY is October through September). The average number of patients receiving PN went from approximately 15 to less than 5 per day. Overall, this translated into approximately a 6.9 million dollar decrease in PN charges. In actual pharmacy cost for PN (compounding outsourced), the decrease in PN cost was about $171,000 since 2007 (Table 4). Savings were determined by calculating the sum of the differences between FY08 and FY09 from FY07.

**Table 3.** Comparison of Medication Use Evaluation Data Before and After Implementation of a Parenteral Nutrition Quality Improvement Project

<table>
<thead>
<tr>
<th>Criteria</th>
<th>2007 (Before Implementation)</th>
<th>2009 (After Implementation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance with 10 mandatory safe practice standards from A.S.P.E.N.</td>
<td>2 of 10</td>
<td>10 of 10</td>
</tr>
<tr>
<td>Number of patients audited</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Mean duration of PN therapy (days)</td>
<td>9</td>
<td>8.7</td>
</tr>
<tr>
<td>Appropriate indication for PN</td>
<td>60%</td>
<td>97%</td>
</tr>
<tr>
<td>Received PN for &gt;5 days</td>
<td>53%</td>
<td>83%</td>
</tr>
<tr>
<td>Baseline labs ordered prior to PN initiation</td>
<td>30%</td>
<td>83%</td>
</tr>
<tr>
<td>PN initiated with modest dextrose provision</td>
<td>53%</td>
<td>97%</td>
</tr>
<tr>
<td>Symptoms of refeeding syndrome (hypophosphatemia)</td>
<td>17%</td>
<td>13%</td>
</tr>
<tr>
<td>Goal PN within 10% of estimated calorie needs</td>
<td>54%</td>
<td>85%</td>
</tr>
</tbody>
</table>

A.S.P.E.N., American Society for Parenteral and Enteral Nutrition; PN, parenteral nutrition.

**Table 4.** Financial Impact of Parenteral Nutrition Quality Improvement Collaboration

<table>
<thead>
<tr>
<th>Criteria</th>
<th>FY07</th>
<th>FY08</th>
<th>FY09</th>
<th>Savings*</th>
</tr>
</thead>
<tbody>
<tr>
<td>PN Charges</td>
<td>8.16M</td>
<td>5.53M</td>
<td>3.89M</td>
<td>5.3M</td>
</tr>
<tr>
<td>PN Compounding Expense</td>
<td>199K</td>
<td>135K</td>
<td>92K</td>
<td>107K</td>
</tr>
</tbody>
</table>
*Savings were determined by calculating the difference between FY07 and FY09. PN, parenteral nutrition; FY, fiscal year (October 1st-September 31st).

Conclusions

Guidelines to provide PN safely and effectively were available from professional organizations but were not being utilized at SMH. Staff members with advanced certifications in nutrition support saw an opportunity for improvement and brought best practice to the institution. These specialized clinicians were able to translate evidence into practice. Implementation of best practice guidelines is not always rapid and the changes described in this article took nearly 2 years to complete. A summarized timeline of key dates is presented in Table 5. Patience and perseverance were critical to success as there were setbacks and opposition.
When embarking on a major improvement project, it is important to gain the support of key stakeholders. In this project, the physician groups with the highest utilization of PN, intensivists, trauma and general surgeons, were identified as key stakeholders. A physician champion chosen from this group of physicians was important to allow for peer-to-peer education of medical staff. The grand rounds presentation was also given by a physician.

The importance of being data-driven cannot be overstated. Although the MUEs were tedious and time consuming, they provided objective data and served as evidence of need for improvement and to gauge success. One challenge encountered was the data from the initial and follow-up MUEs were not identical, making it difficult to make comparisons. Designing a PN quality review tool to allow for periodic assessment of practice and to ensure quality gains are sustained is a next step.

Catheter-related bloodstream infection rate (CR-BSI) was not measured as part of this project. Infection control is an important aspect of PN quality and safety. Addition of this indicator in future MUEs would add valuable quality and cost data as prevention of CR-BSI will result in cost savings.

PN is a high-risk nutrition support modality. This article described the approach taken by one hospital to improve safety and quality of this therapy and presented challenges and obstacles that needed to be overcome to implement a new practice. In a challenging economy, cost savings are important and when tied to improvement in quality and safety, they gain recognition. The work described in this article was recognized with the institution’s quality award. The data presented show that, with committed team members, change can be achieved and improvement in safety and quality realized.

Table 5. Key Project Dates in Implementing a Parenteral Nutrition Quality Improvement Project

<table>
<thead>
<tr>
<th>Month</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 2007</td>
<td>Compliance with safe practice standards assessed</td>
</tr>
<tr>
<td>September 2007</td>
<td>Compliance data and practice gap presented to P&amp;T Committee</td>
</tr>
<tr>
<td>October 2007</td>
<td>Initial MUE completed</td>
</tr>
<tr>
<td>November 2007</td>
<td>MUE data presented to P&amp;T committee</td>
</tr>
<tr>
<td>January 2008</td>
<td>Revised policy approved by P&amp;T committee; revised PN order forms presented</td>
</tr>
<tr>
<td>November 2008</td>
<td>Final P&amp;T approval of PN order forms</td>
</tr>
<tr>
<td>January 2009</td>
<td>PN Rounds initiated</td>
</tr>
<tr>
<td>June 2009</td>
<td>Follow-up MUE completed</td>
</tr>
<tr>
<td>Sept 2009</td>
<td>MUE data presented to P&amp;T, Quality Award application submitted</td>
</tr>
<tr>
<td>October 2009</td>
<td>Project selected for SMH’s Quality Award</td>
</tr>
</tbody>
</table>

MUE, medication use evaluation; P&T, Pharmacy and Therapeutics.

References
8. Trujillo EB, Young LS, Chertow GM, et al. Metabolic and mone-