ABSTRACT: With the development of specialized nutrition support, an interdisciplinary approach was essential to translating this medical breakthrough from the laboratory to the bedside. As this new innovation was adopted, interdisciplinary nutrition support teams were created to optimize the effectiveness and safety of this therapy. The impact of standardization and the use of an interdisciplinary team to provide specialized nutrition support have been shown to improve outcomes and safety and to have a positive financial impact on healthcare institutions. Yet many hospitals do not have nutrition support teams, and the numbers that do may have decreased. To be effective, nutrition support teams need to practice at an evidence-based level and measure their performance. Nutrition support teams include many of the components of the healthcare delivery system that are advocated for the future, and nutrition support teams should be encouraged as the preferred system of providing specialized nutrition support.

The first report of IV feeding in 1968 signaled a breakthrough in medical care. Since then, the use of specialized nutrition support has become a standard tool in the care of patients. Our knowledge of the appropriate and safe indications for specialized nutrition support and the use and administration of enteral and IV nutrition has evolved. More recently, attention has been directed beyond specific nutrition support therapies toward its association with quality of patient care and problems with the system of healthcare. This article addresses the need for a system of providing specialized nutrition support so that treatment decisions optimize patient outcome and do not compromise patient safety.

Risks of Nutrition Support

It was recognized early in the evolution of specialized nutrition support that it was of great, often lifesaving benefit to patients but also introduced potential risks of infection, glucose imbalance, fluid and electrolyte alterations, and acid-base dysequilibrium. In 1973, Goldmann and Maki reported rates of sepsis between 6% and 27% in hospitals where parenteral nutrition (PN) was used. In the hospitals with lower infection rates, it was found that formalized procedures existed for preparing PN formulas or caring for the IV access site. The authors stated in their conclusion “. . . the risk of infection can be substantially reduced if stringent infection control measures are practiced. Accordingly, the Center’s Hospital Infections Section has developed infection control guidelines for total parenteral nutrition programs.” Likewise, in 1974, Kaminski and Stolar reported the results of a survey of hospitals using PN and discovered that practices among centers often deviated significantly from established standards of care. Areas in which practices were found unacceptable included skin preparation for catheter insertion, catheter care, evaluation of fever, sterility of the infusion system, electrolyte and fluid balance, and serum glucose concentration. As a result of these deviations from standards of care, it was found that 12% of patients experienced complications related to catheter placement such as pneumothorax or hydrothorax, 42% had glucosuria, 5% became dehydrated, 28% had fluid and electrolyte abnormalities (usually hypokalemia), and 42% had fevers that could not be traced to non-PN causes. These authors recommended the following:

- Each hospital develop or adopt a set of PN procedures according to published and generally accepted guidelines.
- This protocol be developed by a joint effort of the medical, nursing, and pharmacy staffs.
- The protocol be rigidly followed.
- All personnel involved in any aspect of PN therapy receive proper training and instruction.

Although it has been 30 years since the publications of these recommendations, they reflect the importance of adhering to good standards of care.
when providing PN. These important publications were the basis for standardizing practices and using qualified clinicians to provide this important but potentially hazardous medical treatment.

Complications from specialized nutrition support are more likely to occur in critically ill patients than non–critically ill patients. A shift in the healthcare environment has resulted in increased acuity of illness in hospitalized patients, and these patients are more likely to require nutrition interventions than less critically ill patients. In addition, critical illness is associated with marked hypermetabolism and hypercatabolism that leads to dramatic nutrient alterations, including increased gluconeogenesis, glycogenolysis, and lipolysis. These metabolic effects have a significant impact on the nutrition condition of the patient and tolerance and efficacy of specialized nutrition support. Early enteral feedings have been shown to reduce septic mortality after a laparotomy and have improved outcomes in children with burns and after head injury. Advances in endoscopic and laparoscopic techniques of tube placement and the composition of enteral nutrition formulations have improved the ability to use the gastrointestinal tract for nourishment. Despite these changes, PN continues to be overused. In a recent audit at our hospital, the appropriate use of PN ranged from 16.7% to 50%. When PN was used without an appropriate indication, it was typically because it was ordered when patients had an inadequate (or no) trial of enteral tube feeding or were not severely malnourished and transitioned to an enteral diet within 5 days of therapy.

Patients who have an impaired tolerance to nutrition support are often those patients in whom the risks of therapy outweigh the potential benefits of nutrition support. For example, Chang et al found 53.3% mortality among intensive care unit (ICU) patients treated with PN. This suggests that the patients had a poor prognosis at the start of therapy. A meta-analysis found that PN in the critically ill had no effect on mortality (10%–12%) and was associated with a higher complication rate compared with no nutrition at all. It should be noted, however, that most of the studies included in this meta-analysis addressed PN as an intervention but not the system by which PN was provided. It is possible that variations in the practices used in prescribing, preparing, administering, and monitoring PN could have affected the outcomes of patients being studied.

**Nutrition Support Clinical Guidelines**

Clinical practice guidelines can help reduce the risk of complications and provide clinicians with consistent methods for carrying out patient care activities. Evidence-based practice guidelines are derived from literature. The guidelines are graded according to quality of the research supporting the practice. Prospective, randomized, double-blinded trials are considered the highest quality, followed by consensus statements derived from literature review and expert opinion and finally, expert opinion in which there is no literature support. Clinical practice guidelines are used to assist in developing a consensus about the methods used to provide patient care when large deviations in the use of treatments and procedures and costs occur. Parenteral and enteral nutrition are examples of high-cost therapies used in patients in which benefit, apart from the treatment of the primary disease, is difficult to discern. In addition, opinions differ on if, when, and by what route nutrition should be provided. Development of an evidence-based clinical guideline is a way to ensure that a nutrition support team is using safe delivery of enteral nutrition and PN and assisting in identifying problems that need to be addressed.

Appropriate use of PN at our institution was monitored before and after the development of clinical practice guidelines. PN was considered appropriate if the patient was severely malnourished and met one of the following criteria: (1) failed enteral nutrition with an appropriate tube placement; (2) enteral nutrition was contraindicated as in paralytic ileus, mesenteric ischemia, small bowel obstruction, and gastrointestinal fistula; and (3) there was an expected transition to an enteral diet in >14 days. Inappropriate PN use occurred in the following circumstances: (1) transition to an oral diet in 5–7 days, (2) inadequate documentation of failed enteral trial or contraindication to appropriate enteral tube placement, (3) cancer unresponsive to chemotherapy, (4) clinical illness precluded an appropriate response to therapy, or (5) there was an inadequate trial of medical management to treat hyperemesis gravidarum. Using these criteria, the frequency of appropriate PN use was 67%. This frequency fell to 41% when medical staff support was removed from the nutrition support service. This resulted in a 53% increase in patient days of therapy and a 36% increase in cost for PN despite the presence of clinical practice guidelines. The following actions were taken to improve appropriate PN use: (1) an executive summary of clinical practice guidelines was created, including an algorithm to make the guidelines user friendly; (2) a process was established to continually monitor guidelines compliance that identifies areas where education is needed; and (3) documentation was improved in the medical chart of the outcome of an enteral nutrition trial, the contraindication to enteral nutrition, and objective evidence of gastrointestinal dysfunction. With these efforts, appropriate use of PN was increased to 80%, resulting in a 50% decrease in the cost of PN. The next phase of the guideline implementation is to include whether patients were initiated appropriately on enteral nutrition when indicated.
Evidence Supporting Standardization and a Team Approach

Although clinical practice guidelines provide a basis for consistent care, it is possible to improve the safety of PN further by using standardized procedures and involving healthcare professionals who are knowledgeable about this complex form of therapy. Skoutakis et al. reported complication rates after implementing a detailed protocol in conjunction with a PN team and compared the results with those reported by Kaminski and Stolar (see previous discussion of this study). Complications were sepsis (<1%), electrolyte abnormalities (2.7%), and glucosuria (5%). The dramatic reductions in complications reported by these authors (compared with the earlier study by Kaminski and Stolar) prompted them to recommend the use of rigid protocols and a team approach for administering PN. Brown and Grenkoski also reported a reduction in the incidence of sepsis from 12.5% to 5.1% in a community hospital after the institution of rigid protocols for catheter insertion and care, a nursing care plan, and a metabolic flow sheet. Nehme studied clinical outcomes in patients receiving PN in 2 hospitals; one with and one without a nutrition support team. Two groups of patients receiving PN were compared in a prospective, 24-month study. A nutrition support team consisting of a properly trained physician, dietitian, nurse, and pharmacist managed nutrition in one group of 211 patients in the study hospital. A variety of physicians managed the nutrition therapy of another group of 164 patients in the control hospital. In the group being managed by the team, 3% of the patients developed sepsis, there were no patients with glucosuria, and only 3% of patients had an electrolyte imbalance. There were no deaths associated with nutrition support in the study hospital. In contrast, 10 patients in the control hospital died from complications resulting from glucose imbalance, and 36% of patients had electrolyte abnormalities. The authors concluded that a protocol strictly adhered to by knowledgeable persons is necessary to safely provide PN to hospitalized patients. Trujillo et al. also found that metabolic and monetary costs associated with PN use were reduced when it was provided by a nutrition support team vs individual clinicians prescribing the therapy. Specifically, there was better compliance (82% vs 56%) with appropriate PN use according to the American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) Guidelines for the Use of Parenteral and Enteral Nutrition in Adult and Pediatric Patients, fewer complications (34% vs 66%), and therapies with duration <5 days (16% vs 35%) between the study and control groups.

These improvements can also be seen in pediatric populations. Gurgueira et al. evaluated the impact of a nutrition support team on patient care outcomes in a pediatric ICU. They found a progressive increase in the use of enteral nutrition over PN and a reduction in mortality when enteral nutrition was chosen. The risk of death was 83% lower in patients who received enteral nutrition for more than half of their stay in the ICU. The authors conclude the nutrition support team “motivated” an increase in the use of enteral nutrition and decrease in PN usage that translated into reduced mortality in the ICU.

Nutrition Care Process and the Rationale for a Team Approach to Provide Specialized Nutrition Support

The provision of nutrition support to critically ill patients is fraught with complications; clear benefits of nutrition therapy can be difficult to discern in this population. Therefore, proper use of nutrition in the critically ill requires that practitioners have specific skills to determine the appropriate time and route of nutrient delivery. As such, it is important to consider a system of nutrition support that supports the safe and efficacious use of nutrition therapy in these patients. An interdisciplinary team provides nutrition care more effectively than individuals acting independently. Nutrition support is a collaborative responsibility between the nutrition support service and the multiple disciplines involved with the patient’s care, including at the very least physicians, dietitians, nurses, and pharmacists. Specific functions must be performed in order to assure quality nutrition outcomes (Table 1); a nutrition support team can provide all of these functions. If a nutrition support team does not exist, specially trained individuals from other disciplines may provide certain functions but usually not in a comprehensive manner of a formal team. The nutrition

Table 1

<table>
<thead>
<tr>
<th>Nutrition care functions</th>
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<tbody>
<tr>
<td>Nutritional assessment</td>
</tr>
<tr>
<td>Determine energy and protein needs</td>
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<tr>
<td>Determine the severity of malnutrition</td>
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<tr>
<td>Enteral/parenteral nutrition indicated appropriately</td>
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<tr>
<td>Assess the adequacy of access for nutrition therapy</td>
</tr>
<tr>
<td>Initiate and manage enteral and parenteral nutrition</td>
</tr>
<tr>
<td>Complete orders</td>
</tr>
<tr>
<td>Document in patient’s record</td>
</tr>
<tr>
<td>Daily patient assessment</td>
</tr>
<tr>
<td>Transition feedings: parenteral to enteral to oral</td>
</tr>
</tbody>
</table>

*Nutrition support teams consist of a nurse (RN), dietitian (RD), pharmacist (RPh), and physician (MD). If a nutrition support team does not exist, the nutrition care functions must be performed by the individual disciplines that may or may not be aware of the assignment or have the necessary skills to perform the functions adequately.*
support team also provides a gate-keeping function, assuring that the appropriate nutrition support is provided safely and only when necessary.

A.S.P.E.N. was founded in 1975 as an interdisciplinary organization advancing the use of what was then a new medical technology. From its inception, the organization has advocated an interdisciplinary team approach to providing specialized nutrition support. Their “Standards for Specialized Nutrition Support: Adult Hospitalized Patient” states that “organized nutrition support services or teams are associated with improved patient outcomes, decreased length of hospitalization, and improved cost effectiveness.” The statement further recommends, “If an institution does not have a defined nutrition support service or team, it is recommended that an interdisciplinary team provide specialized nutrition support.”16 The society has recently published an anthology of peer-reviewed articles to support this approach.17

Not much is known about the percentage of hospitals that have nutrition support teams in place. In 1995, a survey of nutrition support pharmacists reported that >65% practiced in hospitals that had a nutrition support team.18 Ebiasah et al19 reported that by 2002, this number had decreased to 49.5%, suggesting that the percentage of hospitals with formal nutrition support teams has decreased. More recently, in a study of PN practices in 3 European countries, it was reported that nutrition support teams were present in 33%–45% of the countries surveyed.20 It may be concluded then, that although nutrition support teams are not uncommon, they do not represent a standard of care in many hospitals, and the prevalence of formal nutrition support teams may be decreasing.

Organization of a Nutrition Support Team

A nutrition support team typically consists of a director (usually a physician), dietitian, nurse, and pharmacist as core members. The team is consulted to manage PN or enteral nutrition and serves the primary responsibility of assuring that the patient receives nutrition support by the appropriate route. The members of the team place and maintain nutrition support access devices and initiate and manage nutrition therapy. As healthcare environments evolved, the concept of nutrition support services has changed. Many services have had staff reallocated or reduced, and organizations have had various disciplines cross-trained to perform the functions that formal services once provided. The focus on reducing length of stay in ICUs has created challenges in continuity of nutrition care as patients are transferred between various areas of the hospital. Staff familiar with providing specialized nutrition support to complicated patients may not be available in all areas of the hospital. General healthcare providers may not be able to perform nutrition care functions to the extent or quality of that provided by a formalized nutrition support team. Although the current emphasis is on teamwork rather than teams, it is recognized that quality nutrition outcomes result from collaboration. This collaboration (and documentation) may exist without a formal nutrition support team. If a formal nutrition support team is not present, it is important to assure that staff is competent to perform nutrition support functions and a system is in place to monitor process and outcome indicators that reflect the quality of patient care being provided.

Nutrition Support Teams and Healthcare Quality

The trend toward development of interdisciplinary teams and clinical practice guidelines for nutrition support reflects increasing public concerns about the quality of healthcare in America. To address these concerns, the Institute of Medicine appointed committees to evaluate quality issues in healthcare, 2 of which relate to specialized nutrition support. The first is the Committee on Nutrition Services for Medicare Beneficiaries. In their report to Congress, titled The Role of Nutrition in Maintaining Health in the Nation’s Elderly, there is an extensive review and appraisal of the literature on the delivery of nutrition support. According to this analysis, the following recommendation for the delivery of nutrition support was made by the committee: “A multidisciplinary team approach to the provision of nutrition support is recommended for Medicare beneficiaries in the hospital setting.”21 The second is the Committee on Quality of Health Care in America. In one of their reports to Congress, titled Crossing the Quality Chasm: A New Health System for the 21st Century, recommendations for building this new health system are made. One of them is to develop effective multidisciplinary teams to provide healthcare.2 Therefore, nutrition support teams, with their rich history and evidence-based practices, are consistent with current public health policy recommendations for improving the quality of patient care.

Measuring the Performance of a Nutrition Support Team

An important principle of assuring the quality and improving the performance of any practice, including that of a nutrition support team, is establishing performance goals or aims.22 The emphasis of these goals is the expectation of patients and the clinical outcome of the patient, not the structure and process of how specialized nutrition support is provided. These goals should be stated in a way that performance can be measured. Examples of performance aims framed as measurable team performance goals include:
• Aim #1: Nutrition support should be indicated. No patient should receive expensive, potentially risky treatment unless it is clearly needed.

Goal: The team will improve the ordering system so that 100% of patient records meet predefined clinical indications before treatment begins.

• Aim #2: The route of administration should be appropriate. The improper method for providing specialized nutrition support can result in unnecessary costs and risk.

Goal: The team will improve the selection of access route so that 100% of patients who can be fed enterally are fed via this route.

• Aim #3. The patient should benefit from therapy. No patient should receive expensive, potentially risky treatment unless there is meaningful clinical improvement.

Goal: The team will improve the monitoring of nutrition therapy so that 100% of patients who receive nutrition support are shown to improve clinically according to pretreatment goals.

• Aim #4. The incidence of complications should be low. Complications are inevitable, but using proper techniques can minimize their rate.

Goal: The team will standardize ordering, preparing, and administering nutrition support so that the infection rate, glucose imbalance, fluid and electrolyte alterations, and acid-base disturbances are reduced compared with baseline frequencies.

• Aim #5. The patient should understand the risks and benefits of therapy. The choice to use expensive or risky treatment should involve the patient.

Goal: The team will improve patient education so that 100% of patients understand the risks and benefits of nutrition support before treatment is initiated, as documented by signed informed consent.

• Aim #6. The proper quantity of nutrition substrate should be ordered. Too much or too little substrate can predispose patients to harm.

Goal: The team will improve the ordering process so that no patients are over- or underfed according to clinical practice guidelines.

• Aim #7. The proper quantity of nutrition support should be administered. If nutrition support is administered incorrectly, the wrong quantities of nutrition support substrates will be given even if the order is correct.

Goal: The team will improve the method of administering nutrition support so that 100% of patients receive the appropriate quantity of nutrition support substrate.

• Aim #8. The patient should not experience a detrimental drug-nutrient interaction. Nutrition can interact negatively with other prescribed drug treatment if not properly monitored.

Goal. The team will improve the process of screening orders in the pharmacy and monitoring patients who receive nutrition support so that no patients have predictable and preventable drug-nutrient interactions.

• Aim #9. The patient should receive nutrition support in a timely manner. Nutrition therapy should be provided promptly after treatment decisions are made.

Goal. The team will reduce the time from order to start of treatment to 2 hours.

Measurement is critical to assuring and improving nutrition care so that it can be determined whether a change in practice results in an improvement. Improving the quality of nutrition support requires that the nutrition support team measure performance after goals have been established. If a goal has not been met, nutrition support practices can be changed to determine whether performance improvement results. Team goals can continually be evaluated to determine whether further changes better meet patient needs. According to the goals listed above, the following measurement tools could be used.

• Aim #1. Measure and track the percentage of patients for whom nutrition support is indicated according to predefined standards.

• Aim #2. Measure and track the percentage of patients for whom the proper route of administration is used to administer nutrition support.

• Aims #3 and #6. Measure and track the percentage of nutrition support patients with improved nitrogen balance.

• Aim #4. Measure and track the incidence of hyper- or hypoglycemia, fluid and electrolyte imbalance, and acid-base alterations in nutrition support patients.

• Aim #5. Measure and track the number of nutrition support patients who sign consents acknowledging the risks and benefits of nutrition therapy.

• Aim #7. Measure and track the number of patients who are given nutrition support that deviates from the prescribed treatment.

• Aim #8. Measure and track the number of patients who experience a detrimental drug-nutrient interaction.

• Aim #9. Measure and track the number of patients who receive nutrition support >2 hours after a treatment decision is made.

Plotting performance using a ‘‘run’’ chart (measurement of performance over time) helps nutrition support teams determine how closely they are achieving their aim. It also enables the measurement of the impact of procedural changes on the quality of care. For example, if it is decided that a nutrition support team is no longer needed to provide specialized nutrition support, the impact of such a change can be measured with a good monitoring system.
Changes in practice that can be used to improve performance can be adopted from known process improvement principles. For example, it is well recognized that standardization improves quality. This could be applied to nutrition support through the concept of a standard order form. A standard order form might be postulated to improve the safety of nutrition support because orders are easier to write and interpret. A standardized order form might affect the percentage of patients who receive therapy that deviates from prescribed treatment. It might affect the number of patients who are overfed if the standard order incorporates guidelines for selecting the proper quantity of substrate. Other change concepts that could be tested to determine if they improve nutrition support include developing treatment guidelines or critical pathways, academic detailing or education of staff, implementing a total nutrient admixture program, the use of multilumen catheters, or the use of semipermeable dressings.

Summary

Nutrition support is a potentially lifesaving treatment. It is also expensive and risky, particularly in the hands of untrained health care providers. The evidence-based standard for optimizing treatment outcomes for administering nutrition support effectively and safely is the interdisciplinary team approach. Fewer complications result when this method is in place. It has yet to be demonstrated that clinicians using standardized clinical guidelines can achieve the same clinical performance as a nutrition support team. It is likely that specialized nutrition support administered by a nutrition support team is superior to that provided by individual clinicians with no special training in the use of this treatment. The measurement of clinical performance and use of the principles of continuous quality improvement are essential to assuring that patients receive the optimal benefit from this important but risky form of treatment.

References