Enteral nutrition and gastrointestinal intolerance. When should we be concerned?

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Feature article

Enteral nutrition and gastrointestinal intolerance. When should we be concerned?
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Introduction

Enteral nutrition (EN) is a common medical therapy delivered in both the hospital and home setting. The importance of establishing enteral access, initiating EN early, and maintaining EN therapy has been well supported in a number of clinical investigations, especially in the intensive care unit (ICU).1

The signs and symptoms of gastrointestinal (GI) intolerance associated with enteral feeding include nausea, vomiting, bloating, and diarrhea. These symptoms play a major role in the clinical decision of when to initiate EN or when to hold or terminate EN therapy once it has been initiated. In clinical practice, the delivery of EN is often interrupted by perceived intolerance to tube feeding.2 Unfortunately, there is no consistent symptom assessment tool that would aid the clinician in deciding when it is appropriate to withhold tube feeding because of these GI symptoms.

The physiology of gastric and intestinal responses to enteral feeding

To understand the GI symptoms sometimes associated with gastric versus small bowel feeding, one must understand the physiology of the gut and its response to enteral feeding. Wright et al perfused the human duodenum with a nutrient mixture and demonstrated subsequent secretion of water and electrolytes into the jejunum.3 This led to the concept that stimulation of the proximal small intestine results in a response in the more distal small intestine.4 Subsequent studies demonstrated the importance of nutrient osmolality and intraluminal tactile stimulation of the duodenum for the initiation of jejunal water and electrolyte secretion.5 Post-pyloric feeding into the proximal small bowel results in an increase in small bowel motor activity. There is a concurrent increase in available colonic inflow volumes, creating a downstream reservoir for the forward-moving nutrients and fluids.6 In these same studies, during intragastric feeding, both small bowel motility and colon inflow volumes remained unchanged. This seems to underscore that enteral feeding into the proximal small bowel is better able to initiate small bowel motility (increased migrating motor complexes) and increase colon compliance than tube feeding infused into the stomach.7 Clinically, this would suggest better tolerance of small bowel feedings than gastric feedings in patients with GI intolerance symptoms, such as bloating, nausea, and vomiting.

The intolerance symptoms

GI intolerance to EN is sometimes defined by the physician and, at other times, by the patient, depending on the specific symptoms and the neurological status of the patient. This often leads to tremendous variation in the definition of intolerance among clinicians.

Nausea and vomiting

Patients who are conscious are able to express symptoms of nausea. Visceral afferent nerves from the GI tract (vagus or sympathetic nerves) inform the brainstem of GI distention or mucosal irritation. These receptors are most prominent in the proximal small bowel, especially the duodenum. There are also afferent nerves from outside the luminal gut, such as in the bile duct and peritoneum. Vomiting is demonstrated by the active regurgitation of food substances out of the oral cavity either in conscious or comatose patients. Nausea and vomiting have a number
of etiologies including GI pathology, such as peptic ulcer disease, gastric outlet obstruction, small bowel obstruction, colon obstruction, and ileus (Table 1). In addition, medications, fever, or active tissue inflammation from any disease process may also lead to symptoms of nausea and vomiting.

In the gastric-fed patient, it is believed that monitoring of gastric residual volumes (GRV) will allow the clinician to predict who will experience vomiting or regurgitation of tube feeding. This practice is based on the theory that increased gastric residuals lead to increased intragastric pressures resulting in regurgitation and vomiting.9 This theory would hold true for a ‘fixed’-volume container. However, the stomach is a distensible container that has the ability to hold liters of fluid. This use of GRV measurements to determine tube-feeding tolerance does not take into account the 1,500 mL of saliva and 2,000 mL of gastric secretions produced each day. Fluctuations of 10% to 20% in the production of these secretions would be expected to significantly impact the validity of GRV as a marker of tube-feeding tolerance. Clinically, it is further hypothesized that preventing regurgitation and vomiting in the tube-fed patient population will reduce the incidence of aspiration pneumonia.10 In reality, the aspiration of enteral formula is associated with a low morbidity (1% to 4% of patients require antibiotics) and an even lower mortality.11

The threshold level of GRV tolerated by clinicians is a point of great debate. It is certainly of no clinical significance at volumes <200 mL.9 More recently, McClave et al evaluated 40 ventilated ICU patients who were receiving gastric enteral feedings containing fluorometric beads.12 Over 1,000 oral and tracheal aspirates were collected and analyzed for the presence of fluorometric beads (defined as aspiration). The mean frequency of aspiration was 22.1%, with a mean GRV for aspiration of 30.6 mL. There was no difference in aspiration events when GRV was increased to 400 mL. There was also no difference in aspiration events if patients were fed through a nasogastric (NG) tube or a percutaneous endoscopic gastrostomy (PEG) tube.

In those patients with a high GRV (>400 mL) or who demonstrate GI intolerance, small bowel feedings can be attempted. A recent randomized clinical trial demonstrated a significant reduction in gastroesophageal regurgitation and pulmonary microaspiration in patients fed into the small bowel compared with those fed into the stomach.13 A meta-analysis of prospective studies evaluating the development of pneumonia in critically ill patients who were gastric-fed or small bowel-fed demonstrated a small reduction in pneumonia events for the small bowel-fed patients.14

The clinical significance of small bowel feeding versus gastric feeding for the prevention of tube-feeding aspiration remains a topic of much debate. We do know that obtaining small bowel access is often more difficult than obtaining gastric access and may result in a delay in initiating EN.15 However, it is clear that small bowel feeding, rather than parenteral nutrition, should be initiated in patients with gastric-feeding intolerance.

Practice guidelines have been developed to educate clinicians and change practice habits regarding the use of GRV as a major determinant for the use of EN. The clinical advantages of using enteral feeding protocols that recognize increased GRV were demonstrated by Spain et al. Their 400-mL GRV enteral feeding protocol resulted in an increase in overall EN calories delivered to patients and a more rapid attainment of tube feeding goal rates.16 The Canadian Clinical Practice Guideline Group noted that currently there are insufficient data from published randomized trials to recommend the use of a feeding protocol in critically ill patients.17 However, their own prospective observational survey noted that 70% of 59 surveyed ICU sites utilized EN feeding protocols. Compared with sites that did not use EN feeding protocols, these sites had improved initiation and delivery of EN.

Table 1. Common causes of acute nausea and vomiting in enteral nutrition patients

<table>
<thead>
<tr>
<th>Cause</th>
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<tbody>
<tr>
<td>Bacterial or viral gastroenteritis</td>
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<tr>
<td>Medications</td>
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<tr>
<td>Fever</td>
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<tr>
<td>Severe gastroparesis</td>
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<td>Ileus</td>
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<td>Gastroesophageal reflux disease</td>
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<td>Peptic ulcer disease</td>
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<td>Cholecystitis</td>
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<td>Pancreatitis</td>
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<tr>
<td>Peritonitis</td>
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<tr>
<td>Gastric outlet obstruction</td>
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<tr>
<td>Small bowel or colon obstruction</td>
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<td>Gut volvulus</td>
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Diarrhea

Alterations in fecal output are common in patients receiving EN. This includes both diarrhea and constipation, although diarrhea is more common. Numerous methods have been employed to clinically document the characteristics of diarrhea, including stool frequency, stool consistency, and stool weight. As a result, the clinical definition of diarrhea associated with EN varies tremendously from institution to institution.
The etiologies of diarrhea are numerous. Most diarrheas can be categorized into a secretory or malabsorptive etiology (Table 2). In general, diarrhea with tube feeding is believed to be most often secondary to either an infectious cause (eg, *Clostridium difficile* enterocolitis), concurrent medication use (eg, sorbitol-containing elixirs), or malabsorption from small bowel mucosal disorders.

Malabsorptive etiologies of diarrhea generally require significant disease of the small intestine. The human intestine has a tremendous capacity to increase its absorptive function in the healthy patient. For example, a Greek cyclist flew 72 miles in a pedal-powered aircraft. He consumed a nutrient solution containing fructose, glucose, and glucose oligomers providing 7,000 kcal/d (seven times the normal carbohydrate intake). He experienced no diarrhea. This demonstrates the tremendous capability of the healthy human intestine to tolerate large volumes and large osmotic loads.

The most common etiology of diarrhea associated with EN is best explained by three published experiments. Breath-test studies have shown that breath hydrogen is increased markedly in postsurgical patients just prior to an episode of diarrhea. This is most likely the result of malabsorbed small intestinal carbohydrates spilling over into the colon causing an osmotic diarrhea. Microorganisms in the colon ferment malabsorbed enteral diet carbohydrates to short-chain fatty acids (SCFA). These SCFA stimulate colon mucosal cell hypertrophy, thereby increasing colonic water and electrolyte absorption. It is believed that the use of antibiotics in tube-fed patients decreases colonic microorganisms, thereby reducing the production of SCFA, resulting in a net colon wasting of sodium and water.

In clinical practice, an increase in a patient’s stool output may be documented as ‘diarrhea’. Using the term diarrhea suggests that a threshold for the clinician has been reached and that the patient requires some evaluation or medical intervention. The overall incidence of tube feeding-related diarrhea reported in the literature ranges from 2% to 95%. In these reports, there were over 33 different definitions of diarrhea. This includes an increase in stool frequency, stool consistency, stool weight (>300 g/day), and multiple combinations of the above. This lack of definition, clarity, and clinical relevance makes clinical studies of tube feeding-related diarrhea difficult to perform and interpret. The use of verbal and pictorial descriptions of diarrhea is only slightly more reliable than a subject’s verbal description alone. Recently, Whelan et al developed a standardized scoring system of stool frequency, stool consistency, and stool weight using a standardized chart for data tabulation. This chart provided significant intraobserver reproducibility for describing clinical diarrhea. This consistency in diarrhea reporting will help to adequately determine the true incidence of tube feeding-related diarrhea and will also assist in determining which interventions are effective for controlling tube feeding-related diarrhea.

Most diarrheas associated with tube-fed patients are treatable and should not result in withholding of EN. This would include diarrheas related to *Clostridium difficile* enterocolitis, the use of diarrhea-causing medications, bacterial overgrowth, and pancreatic insufficiency. The use of anticholinergic agents, such as loperamide, is appropriate to decrease bowel transit time and improve the chances of nutrient and water absorption. Some physicians will treat patients empirically with metronidazole or a quinolone antibiotic in the hope that altering the patient’s gut flora will improve the patient’s diarrhea. Pancreatic enzymes may be helpful in the patient with pancreatic insufficiency and steatorrhea. EN should be held for clinically significant diarrhea that worsens with tube feeding and improves upon withholding of tube feeding. Clinically significant diarrhea includes episodes that result in volume depletion, weight loss, decubitus ulcer formation, or worsening abdominal pain.

Current algorithms for the treatment of diarrhea in the tube-fed patient include changing the tube feeding to a more readily absorbed tube-feeding product, such as an elemental or semi-elemental tube-feeding formula. A prospective analysis of 40 patients with multiple comorbid disease processes at a subacute medical center used a Malabsorption Index that was applied to individual patients to predict which class of enteral formula should be initiated to avoid GI intolerance, specifically the development of diarrhea (Figure). The scoring system took into account multiple clinical parameters, including the patient’s medical condition, serum albumin level, and nutritional

<table>
<thead>
<tr>
<th>Table 2. Common causes of diarrhea in enteral nutrition patients</th>
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<tbody>
<tr>
<td><strong>Malabsorptive</strong></td>
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<td>Laxatives</td>
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<tr>
<td>Magnesium-containing antacids</td>
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<td>Antibiotics</td>
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<td>Dietetic foods or drinks (sorbitol)</td>
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<tr>
<td>Pancreatic insufficiency</td>
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<tr>
<td>Small bowel injury (radiation, irritable bowel disease)</td>
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<td>Small bowel motility disorders</td>
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<tr>
<td>Short bowel syndrome</td>
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<tr>
<td><strong>Secretory</strong></td>
</tr>
<tr>
<td>Medications</td>
</tr>
<tr>
<td>Bacterial or viral infections</td>
</tr>
<tr>
<td>Gastrointestinal hormones</td>
</tr>
</tbody>
</table>

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Malabsorption Index

Malabsorption can occur as a result of certain disease states or a number of clinical conditions. This worksheet will assist in identifying individuals with malabsorption, and provide guidance in the selection of enteral diets.

Instructions: Check the box next to the answer that best applies to each question.

1. Stool Frequency and Consistency:
   - How frequently does the individual experience diarrhea* and/or loose stools?
     - Yes (3 points)
     - No (0 points)

2. Medication:
   - Is the individual on a sorbitol-containing medication or other medications that promote rapid intestinal transit time and/or is the individual on a medication to control stools?
     - Yes (3 points)
     - No (0 points)

3. Nutritional Status:
   - Is weight loss occurring despite the provision of a reasonable level of calories and protein (e.g. 25-35 kcal/kg with >1.0 g protein/kg/day)?
     - Yes (3 points)
     - No (0 points)

4. Medical Diagnoses:
   - Have any of the following diagnoses been documented in the individual’s medical record over the last year: Crohn’s disease; inflammatory bowel disease; pancreatitis; CMV; cryptoosporidiosis; short bowel syndrome; bacterial overgrowth; MAI; AIDS enteropathy; or liver disease?
     - Yes (3 points)
     - No (0 points)

5. Treatments and Procedures:
   - Have any of the following treatments or procedures been received over the last 6 months: radiation therapy to the gastrointestinal tract or surrounding areas; intestinal resections; or gastrectomy?
     - Yes (3 points)
     - No (0 points)

6. Serum Albumin:
   - Based on a recent laboratory report (within the last 2 months), what is the individual’s serum albumin level?
     - 2.0 g/dL (4 points)
     - 2.5-3.0 g/dL (2 points)
     - 1.5-2.5 g/dL (3 points)
     - < 1.5 g/dL (0 points)

**TOTAL POINTS:**

<table>
<thead>
<tr>
<th>Total Points</th>
<th>Potential Degree of Malabsorption</th>
<th>Recommended Nutrition Therapy</th>
<th>Suggested Nestlé Enteral Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Low</td>
<td>Utilize whole protein diet.</td>
<td>Nutren®, Nutren® Peptide® or Protamine®</td>
</tr>
<tr>
<td>2-5</td>
<td>Moderate</td>
<td>Initiate MCT-containing whole protein diet, if &lt; 50% of goal rate achieved due to documented GI intolerance*, advance to peptide-based, MCT-containing elemental diet.</td>
<td>Nutren® or Peptamen® Family</td>
</tr>
<tr>
<td>7-14</td>
<td>High</td>
<td>Utilize peptide-based, MCT-containing formula, if &lt; 50% of goal rate achieved due to documented GI intolerance after a reasonable trial, consider use of TPN.</td>
<td>Peptamen® with Profibio®, Peptamen®, Peptamen® 1.5, Peptamen® with Profibio®, Peptamen® AF or Crick®</td>
</tr>
<tr>
<td>15+</td>
<td>Very High</td>
<td>TPN may be indicated as dual feeding with elemental diet, or sole therapy.</td>
<td>If dual feeding, utilize Peptamen® 1.5, Peptamen® AF or Crick®</td>
</tr>
</tbody>
</table>

* Gastrointestinal intolerance: diarrhea > 300 mL/day or more than 4 loose stools per day; abdominal distention; nausea and/or vomiting.

This tool has been validated by Mark Delige, M.D., Charlotte Clinic for Gastrointestinal and Liver Disease, P.A. It has been found to be 79% accurate. Nestlé Nutrition has endeavored to include in these guidelines only such clinical information that it believes to be accurate and reliable. However, Nestlé Nutrition is making no representation or warranty, express or implied, as to the accuracy or completeness of the information, and shall have no liability relating to or resulting from the use of this information.

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status. The use of this scoring system was effective for matching patients and class of tube feeding to avoid tube feeding-related diarrhea.

More recently, the use of probiotics for the treatment of diarrhea in the tube-fed patient has been evaluated. A recent meta-analysis of six trials demonstrated a significant reduction in the risk of developing antibiotic-associated diarrhea in patients treated with probiotics at the initiation of their antibiotic treatment. Recent clinical trial analysis also suggests that probiotics may be useful for the prevention and treatment of Clostridium difficile-associated diarrhea. There are no published trials regarding the addition of probiotics to patients’ medical regimen when they are initiated on tube feeding as a preventative measure for avoiding tube feeding-related diarrhea.

**Bloating and distention**

Abdominal bloating and distention are common physical findings in hospitalized patients. Although frequently used as a rationale to hold or discontinue tube feedings, the pathophysiology and clinical significance of these symptoms remain poorly defined.

Three factors are believed to be important in the pathophysiology of bloating. This includes the subjective sensation of bloating, the objective presence of abdominal distention, and the volume of intra-abdominal contents. Patients with a heightened sensation for intestinal distention, usually by gas, most likely have an abnormality of the sensory loop of the enteric (gut) nervous system. Excess bowel gas production may be a more significant problem for patients who are hospitalized, have an altered bowel flora, and are predisposed to nutrient maldigestion, especially carbohydrates. Hydrogen breath tests have shown that maldigestion of small quantities of carbohydrates can lead to chronic complaints of gas, abdominal pain, and flatulence. Several studies measuring abdominal girth changes, either with a tape measure or computed tomography (CT) scan, have shown that the subjective sensation of abdominal distention is often associated with some objective abdominal distention. Gas transit studies have shown that patients with bloating have some impaired handling of intestinal contents. Elaborate studies of gut gas transit demonstrate that gas retention is usually due to impaired propulsion of gut contents in the most proximal portions of the small bowel. Studies using xenon-labeled gas indicate that the small bowel is responsible for impaired gas transit, not the colon, as is often believed.

The symptoms of abdominal bloating and the finding of abdominal distention are believed to be indicators of a poorly functioning bowel. However, by themselves, these symptoms are not proven indicators for withholding or terminating the use of EN. Often, these symptoms and signs are combined with other radiographic and/or bedside findings in the decision-making process to withhold tube feedings because of poor intestinal motility. Mechanisms of an adynamic ileus are poorly understood. They are a combination of neurogenic, myogenic, and humoral mechanisms. Any of these mechanisms may reduce or abolish motor activity. In general, small bowel motility function returns more rapidly than does colonic motor function following an episode of adynamic ileus.

The presence of bowel sounds is often used as a determinant of the adequacy of intestinal motility. Unfortunately, most clinicians do not spend sufficient time on the auscultation component of the abdominal exam to reliably characterize bowel sounds. In addition, there is tremendous intraobserver variability in the interpretation of the presence and type of bowel sounds, both in normal volunteers and in patients with significant pathologic disease. The use of bowel sounds alone to determine the function of the gut is unreliable.

Radiographic interpretation of the abdomen is frequently used to confirm the diagnosis of ileus or intestinal obstruction. The plain abdominal radiograph demonstrates the amount and distribution of solids, gas, and fluid in the GI tract. In the normal patient, there is almost no gas in the small intestine and only scattered air bubbles and feces in the colon. Often, a radiologist will use the degree of intestinal distention to identify GI pathology and help to identify an ileus or a GI obstruction. However, many hospitalized patients have abnormal abdominal radiographs with increased air, fluid, and feces in the small bowel and colon as a result of inactivity and their overall ‘disease state’. The gold standard for delineating an ileus from a bowel obstruction is a contrast radiographic study, such as a small bowel follow-through, barium enema, or a CT scan of the abdomen. Patients with intestinal obstruction should not receive EN. However, patients with a diagnosis of ileus by abdominal radiograph often will have no difficulty tolerating EN. Thus, the use of an abdominal radiograph alone to determine the adequacy of intestinal function can be misleading. The patient with a triad of an ileus on abdominal radiograph, abdominal distention on physical examination, and lack of bowel sounds is usually the patient who will not tolerate EN.

**Conclusion**

The variety of interpretations of GI intolerance symptoms has led to a non-standardized or haphazard approach to the delivery of EN both in the hospitalized and the home patient. Too often, there are preconceived beliefs amongst physicians about what is and what is not a valid reason for
continuing or withdrawing EN support. A set of specific guidelines is required. Review of the physiology of the GI system and the published clinical data does allow us to create a set of practical guidelines:

A) Vomiting is the regurgitation of substances from the stomach and small bowel to the oral cavity. Measurement of GRV does not reliably predict which patients will or will not tolerate tube feedings. Gastric residuals ≤400 mL should not preclude continuing gastric feedings. Small bowel feedings should be initiated in patients intolerant of gastric feedings.

B) Our ability to consistently document clinically significant diarrhea is poor. Most diarrheas in tube-fed patients are treatable and should not result in withholding of EN. EN should be held for clinically significant diarrhea that worsens with tube feeding and improves upon withholding of tube feeding. Clinically significant diarrhea includes which results in volume depletion, weight loss, decubitus ulcer formation, or worsening abdominal pain. The use of the Malabsorption Index is helpful in identifying candidates for EN and the most appropriate type of formula.

C) The treatment of diarrhea in the tube-fed patient consists of many approaches. This includes evaluation of the patient’s medication list for cathartic-like medications, culturing the stool, checking a *Clostridium difficile* stool toxin, and checking the stool for the presence of fat. The use of anticholinergic medications to slow bowel transit and specific antibiotics to alter bowel flora is appropriate. Changing the composition of the tube-feeding formula to a semi-elemental diet may be helpful in clinical situations where the small bowel absorptive capacity is compromised. The use of probiotics to prevent or treat diarrhea in tube-fed patients appears promising.

D) Abdominal bloating and distension generally should not impede the use of EN. Tube feedings should be held for a diagnosis of intestinal obstruction. If a patient has a triad of visible abdominal distension, lack of bowel sounds, and a significantly distended small bowel and/or colon on abdominal radiograph, EN should be held.

E) The development of an EN feeding protocol supporting early EN and the identification and management of “intolerance symptoms” will allow more effective delivery of EN.

References

8. Heiken JP, Sanyal A. Measurement of GRV does not reliably predict which patients will or will not tolerate tube feedings. Gastric residuals ≤400 mL should not preclude continuing gastric feedings.

8. Heiken JP, Sanyal A. Measurement of GRV does not reliably predict which patients will or will not tolerate tube feedings. Gastric residuals ≤400 mL should not preclude continuing gastric feedings.

Evaluation of nutritional status in cancer patients receiving radiotherapy: A prospective study
Ulud D, Nenad B, Alemano M, Uner A, Ozgur M, Pak Y.
Gazi University Faculty of Medicine, Department of Radiation Oncology, Ankara, Turkey.

OBJECTIVES: The purpose of the present study was to evaluate the nutritional status of cancer patients receiving radiotherapy (RT) and to assess the possible contributions of nutritional support to patients with malnutrition. METHODS: Prospectively, 207 patients referred to our outpatient radiotherapy department were included. The patients were classified according to tumor site (head/neck, breast, lung, stomach, or colorectal). Nutritional status at the onset, at the end of RT, and 3 and 6 months after irradiation was evaluated with the subjective global assessment (SGA). All of the patients were supported with additional portions of meal or standard enteral feeding formula during and after the irradiation period as long as they were in the moderately or severely malnourished groups, respectively. RESULTS: At the onset, malnutrition was present in 31% of all patients, and it increased to 43% at the end of RT. This difference predominated in head/neck cancer patients. Malnutrition ratios in head/neck cancer patients at the onset and after RT were 24% and 88%, respectively. By a 6-month follow-up, the ratio of patients with malnutrition decreased to 8%. Nutritional status of all groups was found to improve during the 6-month follow-up period, except for the breast cancer group, which included no patients with severe malnutrition at any time. CONCLUSION: The results of the present study may be helpful in planning an appropriate nutritional support for cancer patients undergoing radiotherapy according to the irradiation site.

Evaluating predictive factors for determining enteral nutrition in patients receiving radical radiotherapy for head and neck cancer: A retrospective review
Radiother Oncol 2006 Feb;78(2):152-158.
Mangar S, Stovin P, Mais K, Sykes A.
Department of Clinical Oncology, Christie Hospital NHS Trust, Manchester, United Kingdom.

BACKGROUND AND PURPOSE: To identify objective pre-treatment clinical parameters that could be used to predict for patients at high risk of requiring enteral tube feeding prior to head and neck radiotherapy. PATIENTS AND METHODS: A retrospective study was conducted on 160 consecutive patients attending for radiotherapy assessment. Regression analysis was used to determine various pre-treatment nutritional and tumor-specific parameters associated with the use of enteral nutrition either before (prophylactic) or during (reactive) radiotherapy (RT). The significant parameters identified were then selected into categorical variables and compared between those who needed reactive enteral nutrition and the remainder of the group who did not. These results were used to generate predictive factors that could be used to identify those at high risk of malnutrition during RT for whom early or prophylactic enteral nutrition should be considered. RESULTS: Fifty patients required enteral feeding, of which, 60% required this prior to radiotherapy. Multivariate analysis identified the following factors to be significant – body mass index, performance status (PS), advanced stage, pre-treatment weight loss, low serum albumin and protein, age, and smoking. The most significant categorical predictive parameters for reactive enteral feeding were stage 3-4 disease, PS 2-3, and smoking >20/d. The combination of these factors predicted a 75% chance of needing enteral nutrition. CONCLUSION: Nutritional assessment is important prior to radiotherapy and is multifactorial. Using a combination of relatively simple and objective parameters (performance status, smoking and disease stage), it is possible to identify those at high risk of needing enteral nutrition prior to starting RT.

Enteral (oral or tube administration) nutritional support and eicosapentaenoic acid in patients with cancer: A systematic review
Institute of Human Nutrition, University of Southampton, Southampton General Hospital, Southampton, United Kingdom.

The aim of this systematic review was to determine the efficacy and potential benefits of enteral nutritional support (oral nutritional supplements [ONS] or enteral tube feeding [ETF]), and eicosapentaenoic acid (EPA, free acid, ethyl esters or fish oil; provided as capsules or enriched ONS or ETF) in patients with cancer. Clinical studies were identified using electronic databases, and studies were selected according to predetermined criteria. For each treatment modality (chemo/radiotherapy, surgery, and palliative care), the comparisons of interest were nutritional support vs routine care (no nutritional support), EPA supplement (capsule or enriched ONS or ETF) vs routine care (no supplement or standard supplement), and ETF vs parenteral nutrition (PN). The reviewed outcomes were dietary intake, anthropometry, clinical (mortality, length of hospital stay, complications, and quality of life) and hematological/biochemical (white blood count, serum albumin, and transferrin) parameters. A total of 77 studies were included in the review. The use of enteral nutritional support and eicosapentaenoic acid showed no effect on overall survival, and the only positive effect was an improvement in serum albumin levels at days 28 and 56.

The abstracts included in this section were selected from a search on clinical nutrition and related topics of the PubMed database of the United States National Library of Medicine. Published may be accessed via the National Library of Medicine Web site at www.nlm.nih.gov.
cell count, serum transferrin and albumin, CD3-positive lymphocytes, and inflammatory markers. Meta-analyses were performed where possible. In patients undergoing radiotherapy, meta-analysis showed that ONS significantly increased dietary intake (381 kcal/day, 95% CI 193 to 569 in 3 randomized controlled trials [RCTs]) compared to routine care. In patients undergoing surgery, meta-analyses showed that ETF results in a significantly shorter length of hospital stay (1.72 fewer days, 95% CI 0.90 to 2.54 in 8 RCTs), lower incidence of any complications (OR 0.62, 95% CI 0.50 to 0.77 in 4 RCTs) and infectious complications (OR 0.67, 95% CI 0.55 to 0.82 in 11 RCTs), and lower sepsis scores (2.21 points, 95% CI 1.49 to 2.92 in 2 RCTs), but no difference in mortality (OR 0.72, 95% CI 0.40 to 1.29 in 7 RCTs) compared to PN. There was also no difference in mortality between ONS or ETF vs routine care in patients undergoing chemotherapy/radiotherapy (OR 1.00, 95% CI 0.62 to 1.61 in 4 RCTs) or surgery (OR 2.44, 95% CI 0.75 to 7.95 in 4 RCTs). Individual studies of EPA supplementation as capsules showed improvements in survival, complications and inflammatory markers in patients undergoing bone marrow transplant. In palliative care patients receiving EPA-enriched ONS or capsules, there were inconsistent positive effects on survival and quality of life. In those undergoing surgery, EPA-enriched ETF had no effect. Further research is required to elucidate the clinical efficacy of enteral nutrition support, including the potential benefits of EPA supplementation, in patients with cancer.

Nutrition support improves patient outcomes, treatment tolerance and admission characteristics in oesophageal cancer

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AIM: Patients with oesophageal cancer undergoing chemoradiation with curative intent are at high risk of malnutrition and its complications, including increased side effects of treatment. We have developed a nutrition pathway [NP] involving the early then periodic nutrition assessment of all patients presenting to the multidisciplinary oesophageal clinic who were planned to receive definitive chemoradiation.

MATERIALS AND METHODS: Patients were assessed at ‘low’, ‘moderate’ or ‘severe’ nutrition risk, and were provided with appropriate nutrition intervention ranging from preventative advice (low risk) and oral nutrition support (moderate risk) to enteral feeding (severe risk). Outcomes for 24 patients treated before implementation of the NP were compared with those of 24 patients treated using the NP. RESULTS: Patients managed using the NP experienced less weight loss (mean weight change -4.2 kg ± 6.4 cf -8.9 kg ± 5.9, p = 0.03) and greater radiotherapy completion rates (92% cf 50%, p = 0.001); fewer NP-associated complications and its complications, including increased side effects of treatment. We have developed a nutrition pathway [NP] involving the early then periodic nutrition assessment of all patients presenting to the multidisciplinary oesophageal clinic who were planned to receive definitive chemoradiation.

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Distal small bowel motility and lipid absorption in patients following abdominal aortic aneurysm repair surgery

Work J. Gastroenterol 2008 Jan;42(1):582-587.


AIM: To investigate distal small bowel motility and lipid absorption in patients following elective abdominal aortic aneurysm (AAA) repair surgery. METHODS: Nine patients (aged 35-78 years; body mass index [BMI] range: 23-36 kg/m²) were studied. Continuous distal small bowel manometry was performed for up to 72 h during periods of fasting and enteral feeding (Nutrison®). Recordings were analyzed for the frequency, origin, length of migration, and direction of small intestinal burst activity. Lipid absorption was assessed on the first day and the third day post-surgery in a subset of patients using the 13C-triolein breath test, and compared with healthy controls. Subjects received a 20-min intraduodenal infusion of 50 mL of liquid feed mixed with 200 mL of 13C-triolein. End-expiratory breath samples were collected for 6 h and analyzed for 13CO₂ concentration. RESULTS: The frequency of burst activity in the proximal and distal small intestine was higher in patients than in healthy subjects under both fasting and fed conditions (p < 0.005). In patients, there was a higher proportion of abnormally propagated bursts (71% abnormal), which began to normalize by day 3 (25% abnormal) post-surgery. Lipid absorption data were available for seven patients on day 1 and four patients on day 3 post-surgery. In patients, absorption on day 1 post-surgery was half that of healthy control subjects (AUC 13CO₂ 1,323 ± 244 vs 2,646 ± 365; p < 0.05), and was reduced to one fifth of that of healthy controls by day 3 (AUC 13CO₂ 470 ± 832 vs 2,646 ± 365; p < 0.05). CONCLUSION: Both proximal and distal small intestinal motor activity are transiently disrupted in critically ill patients immediately after major surgery, with abnormal motility patterns extending as far as the ileum. These motor disturbances may contribute to impaired absorption of enteral nutrition, especially when intraluminal processing is necessary for efficient digestion.

Causes and consequences of inadequate substrate supply to pediatric ICU patients


PURPOSE OF REVIEW: The prevalence of malnutrition among children admitted to a pediatric intensive care unit is still high. Assessment of nutrient supply is essential in the care of critically ill children because inadequate nutrition can increase morbidity and mortality. This review covers the causes and consequences of inadequate nutrient supply to critically ill children. RECENT FINDINGS: A major factor
contributing to the cause of inadequate nutrient supply is the difficulty in estimating nutritional needs of the individual child. Reasonable values for energy expenditure can be derived from prediction formulae, but measuring energy expenditure by indirect calorimetry is useful in selected cases. Furthermore, under-prescription and inadequate delivery of nutrients caused by fluid volume restriction, procedural interruptions, or cessation because of gastrointestinal intolerance or mechanical problems cause additional nutritional deficits. As routine nutritional assessment is lacking in many pediatric intensive care units, the ability to monitor the adequacy of nutritional support is poor. SUMMARY: In the majority of children admitted to a pediatric intensive care unit, nutritional problems – both underfeeding and overfeeding – occur during admission due to poor estimation of nutritional needs, under-prescribing, and problems in the delivery of the nutrients. Recommendations are made in order to prevent inadequate nutritional supply and its potentially harmful consequences in critically ill children.

Are there any real differences between enteral feed formulations used in the critically ill?

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PURPOSE OF REVIEW: We know that adequate nutritional support is essential in the treatment of critically ill patients, because it can, if applied appropriately, improve the clinical outcome. Increasing evidence seems to suggest that malnutrition itself is a predictor of poor outcome in intensive care, and significant underfeeding during intensive care stay increases the risk of bloodstream infections. The purpose of this review is to highlight recent advances in enteral nutrition in the critically ill adult patient. RECENT FINDINGS: Recent studies suggest that tight glycemic control is associated with improved outcome. Enteral feeding should be encouraged, using simple feeding protocols, and started early if safe to do so. Gastric residual volumes do not correlate with the risk of aspiration, and therefore should be used with caution in feeding protocols. Conflicting evidence exists for supplementation with antioxidant and immunonutrition in the critically ill. Glutamine and fish oil/borage oil should be considered for burns patients and patients with adult respiratory distress syndrome, respectively. SUMMARY: This review offers information regarding the latest developments in nutritional support via the enteral route. Further research is needed to clarify the role of enteral supplements such as antioxidants and ‘immune-modulating substances’.

Nutrition of the critically ill patient and effects of implementing a nutritional support algorithm in ICU

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AIM: To test whether a feeding algorithm could improve the nutritional support of intensive care patients. BACKGROUND: Numerous factors may impede delivery of both enteral and parenteral nutrition to patients in the intensive care unit. Often, there is a discrepancy between what is prescribed and actual delivery of nutrients. The purpose of this study was to test the effect of a nutritional support algorithm in an intensive care unit mainly by using the enteral route and if necessary by combining enteral and parenteral nutrition. METHODS: In this prospective study, nutritional data were collected from routinely fed critically ill patients (controls, n = 21) during the first 3 days following admission to the intensive care unit. A nutritional support algorithm was then implemented and nutritional data were collected from critically ill patients who participated in this intervention (intervention group, n = 21). Data collected included the total amount of calories prescribed vs received, onset of delivery of enteral nutrition, enteral vs parenteral nutrition, and the use and size of enteral feeding tubes. RESULTS: Patients in the intervention group were both prescribed, and actually received, significantly larger amounts of nutrients than patients in the control group. They also received a larger proportion of their nutrients in the form of enteral nutrition. In addition, the nutritional support algorithm led to greater consistency in nursing practices with respect to aspiration of gastric content and rate of increment in enteral feeding. CONCLUSION: The study confirms that a nutritional support algorithm improved the delivery of nutrients to critically ill patients. The algorithm was most effective with respect to the delivery of enteral nutrition. The effect was primarily because of early and more rapid increment in the delivery of enteral nutrition administered by nurses based on improved physicians’ orders. The combination of enteral and parenteral nutrition may contribute to meeting adequate nutritional requirements. RELEVANCE TO CLINICAL PRACTICE: By using a nutritional algorithm focused on enteral nutrition, but including parenteral nutrition as a supplement, it is possible to improve the delivery of enteral nutrition in intensive care unit patients.

Frequency of under- and overfeeding in mechanically ventilated ICU patients: Causes and possible consequences

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INTRODUCTION: In critically ill patients, enteral nutrition (EN) is frequently associated with underfeeding and intolerance, whilst parenteral nutrition (PN) has been associated with a greater risk of infectious complications and overfeeding. MATERIALS AND METHODS: The adequacy of nutritional support provided to critically ill patients was prospectively recorded and compared with estimated requirements. The incidence of, and practices contributing to, under- (<80% of energy requirements) and overfeeding (>110% of energy requirements) were identified. RESULTS: Overall, patients received approximately 81% and 76% of prescribed energy and protein intakes, respectively. Underfeeding occurred on 50.3% of days. Reasons for patients failing to achieve adequate intakes included fasting for airway management procedures (21%) and gastrointestinal intolerance (14%). Overfeeding, although less common (18.6% of days), was more likely to occur in patients with a tracheostomy requiring prolonged
mechanical ventilation (>16 days). The combination of oral and nasogastric feeding or use of nutrient-dense feeds were most frequently associated with overfeeding. DISCUSSION: The overall adequacy of nutritional intakes in the present study was similar to those reported elsewhere. However, the incidence of overfeeding was greater than anticipated and occurred in patients already experiencing delayed weaning from mechanical ventilation.

### FIBER, PREBIOTICS AND PROBIOTICS

#### Small intestinal bacterial overgrowth: Roles of antibiotics, prebiotics, and probiotics

**Gastroenterology 2006 Feb;130(2 Suppl 1):S78-S99.**

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Small intestinal bacterial overgrowth is common in intestinal failure. Its occurrence relates to alterations in intestinal anatomy, motility, and gastric acid secretion. Its presence may contribute to symptoms, mucosal injury, and malnutrition. Relationships between bacterial overgrowth and systemic sepsis are of potential importance in the intestinal failure patient because the direct translocation of bacteria across the intestinal epithelium may contribute to systemic sepsis; a phenomenon that has been well established in experimental animal models. The accurate diagnosis of bacterial overgrowth continues to present a number of challenges in clinical practice and especially so among patients with intestinal failure. The management of patients with bacterial overgrowth remains, for the most part, primarily empiric and comprises antibiotic therapy and correction of any associated nutritional deficiencies. Although evidence from experimental animal studies consistently indicates that probiotics exert barrier-enhancing, antibacterial, immune-modulating, and anti-inflammatory effects, which all could be beneficial in small intestinal bacterial overgrowth and intestinal failure, their role in human beings remains to be evaluated adequately.

#### GENERAL (ENTERAL AND PARENTERAL) NUTRITION

### Cachexia: Pathophysiology and clinical relevance

**Am J Clin Nutr 2006 Apr;83(4):735-743.**

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Cachexia causes weight loss and increased mortality. It affects more than 5 million persons in the United States. Other causes of weight loss include anorexia, sarcopenia, and dehydration. The pathophysiology of cachexia is reviewed in this article. The major cause appears to be cytokine excess. Other potential mediators include testosterone and insulin-like growth factor 1 deficiency, excess myostatin, and excess glucocorticoids. Numerous diseases can result in cachexia, each by a slightly different mechanism. Both nutritional support and orexigenic agents play a role in the management of cachexia.

### Evaluation of a new technique for endoscopic nasojejunal feeding-tube placement

**Gastrointest Endosc 2006 Apr;63(4):590-595.**

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OBJECTIVES: Multiple techniques for endoscopic nasojejunal tube (NJT) placement exist. However, poor experience with these techniques has limited more routine practice of NJT placement for many endoscopists. We evaluated endoscopic NJT placement with a new stiff jejunal (J)-tube method (push technique). METHODS: The GI Tract database at the Medical University of South Carolina was queried for NJT-placement procedures. Records of 42 patients who had undergone NJT placement using the push technique between the years 2001 and 2004 at our institution were reviewed for information regarding procedure success and tube-related outcomes. RESULTS: The push technique of NJT placement was successful in 41 of 42 patients (97.6%), with an average procedure time of 11.6 minutes (range, 5-50 min). Negative outcomes occurred in 61% of properly positioned NJTs and included inadvertent tube removal by the patient or the staff (42.1%), dislodging (10.5%), clogging (5.3%), and kinking (5.3%). The average longevity of the NJT was 7.8 days (range, 1-37 days). Most patients were ultimately converted to a percutaneous enteral access device or to oral feedings. CONCLUSION: Endoscopic placement of NJT by using the push technique is an efficient, reliable method of accessing the small bowel for enteral nutrition.

### Mechanisms of enteral nutrient-enhanced intestinal adaptation

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The role of enteral nutrients in maintaining small intestinal structure and function is well established. Evidence that enteral nutrients induce intestinal adaptation include the structural and functional gradient along the length of the healthy intestine, the atrophy and functional compromise induced by fasting and parenteral nutrition, and the enhanced adaptive capacity of the distal intestine following partial enterectomy. Key mechanisms contributing to enteral nutrient-induced intestinal adaptation include nonspecific luminal stimulation and that provided by specific nutrients, ‘functional workload’ induced by polymeric nutrients, potential stimulation of pancreaticobiliary secretions, secretion of humoral mediators, and induction of intestinal hyperemia. Enteral access in home care

**JPEN J Parenter Enteral Nutr 2006 Jun;30(1 Suppl):S13-S20.**

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Enteral nutrition is the delivery of nutrients through the gastrointestinal tract. For those patients who cannot or will...
not swallow, an enteral access device (EAD) is required. Some of these devices can be passed through the oral or nasal cavity into the stomach or small bowel. Alternatively, the devices can be percutaneously placed by an endoscopist or a radiologist into the stomach or small bowel. Knowledge of the appropriate use of these devices, the appropriate maintenance management of these devices, and the appropriate treatment of EAD-related complications is essential for the clinician to understand in order to provide effective nutrition therapy.

Nutrition support (tube feeding) as a rehabilitation intervention

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Nutrition support (tube feeding) as a rehabilitation intervention. OBJECTIVE: To describe site variation in use of enteral feeding and its association with stroke rehabilitation outcomes, controlling for a variety of confounding variables. DESIGN: Prospective observational cohort study. SETTING: Six inpatient rehabilitation facilities in the United States. PARTICIPANTS: Patients (n = 919) from the Post-Stroke Rehabilitation Outcomes Project database with moderate or severe stroke who were discharged to home, community, or skilled nursing facility.

INTERVENTIONS: Not applicable. MAIN OUTCOME MEASURES: Change in total, motor, and cognitive FIM instrument scores and change in severity of illness. RESULTS: Monitoring of nutritional status and the frequency of tube-feeding interventions for patients with moderate and severe stroke varied significantly among sites. Patients with tube feeding had higher severity of illness and lower functioning on admission compared with patients who did not receive tube feeding. However, when we controlled for severity of illness, admission FIM score, and other important covariates, we found that patients with severe strokes who were tube fed for more than 25% of their stay had greater increases in total, motor, and cognitive FIM scores and greater improvement in severity of illness by discharge. CONCLUSIONS: Nutrition support (tube feeding) is an effective therapy in rehabilitation service for patients with severe strokes and is associated with greater motor and cognitive improvements, even in patients with the most severe strokes.

HEALTHCARE OUTCOMES AND HEALTH ECONOMICS

Parenteral nutrition in adult inpatients with functioning gastrointestinal tracts: Assessment of outcomes


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Malnutrition is a common comorbidity that places inpatients at risk of complications, infections, long length of stay, higher costs, and increased mortality. Thus, nutrition support has become an important therapeutic adjunctive to the care of these patients. For patients unable to feed themselves, nutrition can be delivered via the parenteral or enteral routes. The formulations used to deliver nutrients and the route of nutrient delivery, absorption, and processing differ substantially between parenteral and enteral nutrition. Over the past two decades, many randomized clinical trials have assessed the effects of parenteral versus enteral nutrition on outcomes (ie, complications, infections, length of stay, costs, mortality) in diverse inpatient populations. From a search of medical publications, studies were selected that assessed important clinical outcomes of parenteral versus enteral feeding or intravenous fluids in patients with trauma/burn injuries, surgery, cancer, pancreatic disease, inflammatory bowel disease, critical illness, liver failure, acute renal failure, and organ transplantation. Our goal was to determine the optimum route of feeding in these patient groups. The available evidence lends support to the use of enteral over parenteral feeding in inpatients with functioning gastrointestinal tracts.

Implementation of dietitian recommendations for enteral nutrition results in improved outcomes


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A primary role of the registered dietitian (RD) is to assess nutritional needs of patients in states of physiological stress and illness, and to recommend changes to diet and tube feedings when warranted. However, implementation of changes is dependent upon the physician accepting the recommendations of the RD. This study evaluated outcomes of two groups of enterally fed patients in a long-term acute-care facility in northwest Louisiana: (a) those for whom the physician accepted RD recommendations; and (b) those for whom the physician did not accept RD recommendations.

Data showed that physician-prescribed enteral formulas provided 10.0% less kilocalories and 7.8% less protein than the RD-assessed needs. Tests showed that when RD recommendations were implemented, patients had a significantly shorter length of stay (28.0 ± 4.8 ± 30.5 ± 4.8 days, p < 0.05), as well as significantly improved albumin (0.17 ± 0.44 ± 0.21 g/dL, 1.3 ± 1.7 vs 4.4 ± 2.1 g/L, p < 0.05) and weight gain (0.51 ± 0.1 vs -0.42 ± 0.2, p < 0.05) when compared with those who continued with physician’s orders. These data suggest that if RDs had the authority to write nutrition orders and provide early nutrition intervention, patient care would improve.

Quality improvement of oral medication administration in patients with enteral feeding tubes


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BACKGROUND: The correct administration of oral drugs to patients on enteral tube feeding presents a special challenge. As patients are usually unable to swallow oral
Drugs and many drugs should not be crushed, ways have to be found to administer them through the feeding tube. Measures to improve the quality of oral drug administration in patients with enteral feeding tubes may consist of introducing guidelines, training nurses, or giving patient-tailored advice by the pharmacy. An integrated program comprising all these measures is likely to result in the greatest improvements. METHODS: A study was undertaken in two Dutch hospitals to investigate the effect of such an integrated program. RESULTS: The integrated program in hospital I resulted in a decrease in the number of tube obstructions (odds ratio [OR] 0.22, 95% confidence interval [CI] 0.047 to 1.05). There was a significant decrease in the number of administration errors per nurse in hospital II (OR 0.003, 95% CI 0.0005 to 0.02). CONCLUSIONS: This multidisciplinary program comprising several interventions to promote the correct administration of drugs through an enteral feeding tube results in substantial improvements. As errors concerning administration of drugs to patients with enteral feeding tubes may lead to adverse drug events and loss of effect, these improvements are likely to contribute to a decrease in patient morbidity.

**HEPATIC DISEASE**

**Nutritional support in patients with chronic liver disease**


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Malnutrition is highly prevalent among patients with chronic liver disease and is nearly universal among patients awaiting liver transplantation. Malnutrition in patients with cirrhosis leads to increased morbidity and mortality rates. Furthermore, patients who are severely malnourished before transplant surgery have a higher rate of complications and a decreased overall survival rate after liver transplantation. In light of the high incidence of malnutrition among patients with chronic liver disease and the complications that result from malnutrition in these patients, it is essential to assess the nutritional status of all patients with liver disease and to initiate appropriate treatment strategies.

**Assessing nutritional status in children with chronic liver disease**

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The metabolic changes compounded by anemia associated with chronic liver disease adversely affect growth in children. In many cases, this requires the administration of artificial nutritional support. It is important in this group of patients that those who are becoming nutritionally depleted are identified quickly and, in those receiving artificial nutritional support, the effectiveness is monitored. The current review is an examination of methods available to assess nutritional status. These include anthropometry, methods available in the laboratory, and a selection of less commonly used methods undergoing evaluation at research level. A brief discussion accompanies each technique, outlining the limitations of its use in children with chronic liver disease. The review concludes with an outline of how nutritional status should be assessed in this group of children, and suggests further research.

**IMMUNONUTRITION**

**Fish oil in the critically ill: From experimental to clinical data**


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PURPOSE OF REVIEW: The aim of this paper is to describe recent relevant literature concerning the role of n-3 lipids derived from fish oil in clinical nutrition in an intensive care setting. RECENT FINDINGS: n-3 fatty acids compete with arachidonic acid for metabolism to lipid mediators and exert profound effects on second mediator generation and dependent cellular functions. In experimental models, dietary and parenteral use of fish oil was shown to protect the gut by increasing its perfusion. In contrast, use of immunonutrition including fish oil in critically ill patients or patients with severe sepsis may exert an excess mortality. Using parenteral fish oil in surgical patients, promising data became available. In septic patients, immunologic effects of fish oil-based lipid emulsions have been found, and intravenous supplementation with fish oil may have a beneficial impact on mortality and length of stay. For both patient groups, however, prospective data from randomized trials are lacking. SUMMARY: n-3 lipids exhibit strong immunologic properties. They offer the possibility to counterbalance the negative effects of conventional n-6 fatty acids. Recent studies exhibit positive effects of intravenous use of fish oil on immunologic functions and clinical parameters in surgical and septic patients.

**Temporal nutritional and inflammatory changes in children with severe head injury fed a regular or an immune-enhancing diet: A randomized, controlled trial**


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OBJECTIVE: To analyze the effect of an immune-enhancing (IE) diet on infection and metabolic indices in children with severe head injury fed either an IE or a regular formula. DESIGN: Randomized, blinded, controlled study. SETTING: Pediatric intensive care unit in a university hospital. PATIENTS: A total of 40 mechanically ventilated...
Impact of varying levels of protein intake on protein status indicators after gastric bypass in patients with multiple complications requiring nutritional support

Oliva FP, Schienco E, Pettine SM, Adams E, Harris M. Department of Medical Nutrition Therapy, Poudre Valley Hospital, Fort Collins, Colorado, USA.

BACKGROUND: <6% of patients who undergo Roux-en-Y gastric bypass (RYGBP) for morbid obesity require nutritional support after surgery. Protein and caloric needs have been estimated as 14–21 kcal, 1.2 g protein/kg current body weight in uncomplicated morbidly obese patients. This study assesses the effect of varying protein-calorie intake in complicated patients after RYGBP on two markers of protein status: thymidine-binding prealbumin (TBPA) and serum albumin.

METHODS: This 25-month retrospective study consisted of 22 patients with postoperative complications. Serum albumin, TBPA, medical nutrition care-plans, laboratory data, and history were reviewed. Those post-RYGBP patients who had BMI >35 kg/m² and no multi-system organ failure or fistulas had complications after surgery requiring nutrition support services (NSS). Serum albumin and TBPA were matched to fed levels of protein using random coefficient regression analysis. RESULTS: Mean incremental increases of 2.34 mg/dL (TBPA, p = 0.0113) and 0.11 g/dL (serum albumin, p = 0.0272) were found with each 0.5 g protein intake increase/kg ideal body weight/day (kg IW/BW/d). Patients required NSS for 23 ± 21 (mean ± SD) days, with 15 ± 19 days fed at goal rate. Initial serum albumin was 2.3 ± 0.5, with a final measure of 2.7 ± 0.5 g/dL. Goal protein and calorie intake were 2.1 g and 17 kcal/kg BW/d vs actual intake of 1.6 g and 13 kcal/kg BW/d. CONCLUSION: Morbidly obese patients requiring NSS following RYGBP face iatrogenic protein malnutrition. There was a positive linear relationship between protein status and protein intake that warrants further study of higher protein feeding in complicated post-RYGBP patients.

OBESITY

Impact of varying levels of protein intake on protein status indicators after gastric bypass in patients with multiple complications requiring nutritional support

Oliva FP, Schienco E, Pettine SM, Adams E, Harris M. Department of Medical Nutrition Therapy, Poudre Valley Hospital, Fort Collins, Colorado, USA.

BACKGROUND: <6% of patients who undergo Roux-en-Y gastric bypass (RYGBP) for morbid obesity require nutritional support after surgery. Protein and caloric needs have been estimated as 14–21 kcal, 1.2 g protein/kg current body weight in uncomplicated morbidly obese patients. This study assesses the effect of varying protein-calorie intake in complicated patients after RYGBP on two markers of protein status: thymidine-binding prealbumin (TBPA) and serum albumin.

METHODS: This 25-month retrospective study consisted of 22 patients with postoperative complications. Serum albumin, TBPA, medical nutrition care-plans, laboratory data, and history were reviewed. Those post-RYGBP patients who had BMI >35 kg/m² and no multi-system organ failure or fistulas had complications after surgery requiring nutrition support services (NSS). Serum albumin and TBPA were matched to fed levels of protein using random coefficient regression analysis. RESULTS: Mean incremental increases of 2.34 mg/dL (TBPA, p = 0.0113) and 0.11 g/dL (serum albumin, p = 0.0272) were found with each 0.5 g protein intake increase/kg ideal body weight/day (kg IW/BW/d). Patients required NSS for 23 ± 21 (mean ± SD) days, with 15 ± 19 days fed at goal rate. Initial serum albumin was 2.3 ± 0.5, with a final measure of 2.7 ± 0.5 g/dL. Goal protein and calorie intake were 2.1 g and 17 kcal/kg BW/d vs actual intake of 1.6 g and 13 kcal/kg BW/d. CONCLUSION: Morbidly obese patients requiring NSS following RYGBP face iatrogenic protein malnutrition. There was a positive linear relationship between protein status and protein intake that warrants further study of higher protein feeding in complicated post-RYGBP patients.
additives to enteral or parenteral therapy can further enhance their efficacy, and whether methodologic differences in delivery of enteral nutrition (EN) influence tolerance. METHODS: A computerized search was performed of MEDLINE, Cochrane database, EMBASE, and reference lists of pertinent review articles for prospective randomized trials in adult patients with acute pancreatitis that evaluated interventions with nutrition therapy. Primary outcome data and surrogate endpoint parameters (for nutrition indices, stress markers, and measures of the inflammatory/immune response) were extracted in duplicate independently. Where appropriate, meta-analysis was performed by random-effects model. RESULTS: From 119 articles screened, 27 randomized controlled trials were included and analyzed. In patients admitted for acute pancreatitis, meta-analysis of 7 trials showed that use of EN was associated with a significant reduction in infectious morbidity (risk ratio [RR] = 0.46; 95% confidence interval [CI], 0.29 – 0.74; p = 0.001) and hospital length of stay (LOS; weighted mean difference [WMD] = –3.94; 95% CI, –5.86 – –2.02; p < 0.0001), a trend toward reduced organ failure (RR = 0.59; 95% CI, 0.28 – 1.27; p = 0.18), with no effect on mortality (RR = 0.88; 95% CI, 0.43 – 1.79; p = 0.72) when compared with use of parenteral nutrition (PN). Results from individual studies suggest that EN in comparison to PN reduces oxidative stress, hastens resolution of the disease process, and costs less. Insufficient data exist to determine whether EN improves outcome over standard therapy (no artificial nutrition support) in patients admitted for acute pancreatitis. However, in those patients requiring surgery for complications of acute pancreatitis, meta-analysis of 2 trials indicates that provision of EN postoperatively may reduce mortality (RR = 0.26; 95% CI, 0.06 – 1.09; p = 0.06) compared with standard therapy. PN provided early within 24 hours of admission was shown to worsen outcome, whereas PN provided later, after full-volume resuscitation, appeared to improve outcome compared with standard therapy. In early individual studies, specific supplements added to EN, such as arginine, glutamine, omega-3 polyunsaturated fatty acids, and probiotics, may be associated with a positive impact on patient outcome in acute pancreatitis, compared with EN alone without the supplements, but studies are too few to make strong treatment recommendations. Supplementation of PN with parenteral glutamine was shown to reduce oxidative stress and improve patient outcome (reduced duration of nutrition therapy and decreased hospital LOS) compared with PN alone in patients with acute pancreatitis. A wide range of tolerance to EN exists, irrespective of known influences such as mode (continuous vs bolus) and level of infusion within the GI tract (gastric vs postpyloric). CONCLUSIONS: Patients with acute severe pancreatitis should begin EN early because such therapy modulates the stress response, promotes more rapid resolution of the disease process, and results in better outcome. In this sense, EN is the preferred route and has eclipsed PN as the new ‘gold standard’ of nutrition therapy. When PN is used, it should be initiated after 5 days. The favorable effect of both EN and PN on patient outcome may be further enhanced by supplementation with modulators of inflammation and systemic immunity. Individual variability allows for a wide range of tolerance to EN, even in severe pancreatitis.

Systematic review of peri-operative nutritional supplementation in patients undergoing pancreaticoduodenectomy

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BACKGROUND: Although nutritional supplementation is established in surgical practice, studies on feeding patients undergoing pancreaticoduodenectomy utilize widely disparate protocols, include small numbers of patients, and have disparate endpoints. The aim of this study is to carry out a systematic review of perioperative nutritional supplementation in patients undergoing pancreaticoduodenectomy in order to identify consistent themes. METHODS: Searches of the MEDLINE and EMBASE databases yielded 10 studies examining nutritional support in 571 patients undergoing pancreaticoduodenectomy. Data were retrieved on proportion of perioperative weight loss, biochemical parameters (preoperative albumin and the presence of jaundice), type and duration of nutritional support and clinical outcome (morbidity, mortality, and hospital stay). RESULTS: Perioperative percentage weight loss was similar in all studies evaluated. Routine postoperative total parenteral nutrition (TPN) was associated with a higher incidence of complications. Enteral nutrition reduced infective complications. Cyclical nutrition was associated with a lower incidence of postoperative gastric stasis. CONCLUSION: Clear themes emerge from this systematic review. Patients undergoing pancreaticoduodenectomy are nutritionally depleted at the time of surgery and the perioperative period may present a window for intervention. Routine TPN is not beneficial. Routine postoperative enteral nutritional support delivered on a cyclical basis appears to be the optimal mode of delivery.

Benefits of early postoperative jejunal feeding in patients undergoing duodenohemipancreatectomy

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AIM: To study whether early postoperative enteral nutrition reduces the incidence of complications and/or improves nutritional status following duodenohemipancreatectomy (DHP). METHODS: We studied 39 patients who underwent DHP for a peri-ampullary mass. Twenty-three patients received total parental nutrition and then started to have an oral intake of nutrition between postoperative day (POD) 7 and 14 (late postoperative enteral nutrition [LPEN] group). Sixteen patients started to have enteral feeding through a jejunostomy catheter the day after the operation (early postoperative enteral nutrition [EPEN] group). The incidence of complications and laboratory data at the early postoperative stage were studied in comparison between LPEN and EPEN groups. RESULTS: Serum levels of albumin and total protein in the EPEN group were significantly higher than those in the LPEN group. The loss of body mass index was significantly suppressed in the EPEN group compared with the LPEN group. The lymphocyte count, which decreased immediately after the operation, was restored significantly faster in the EPEN group than in the LPEN group. The EPEN group showed significantly fewer
incidences of postoperative pancreatic fistulas, as well as a significantly shorter length of hospitalization than the LPEN group. There were no significant differences in the incidences of other postoperative complications between the two groups, such as delayed gastric emptying, surgical site infection, cholangitis, and small bowel obstruction. CONCLUSION: EPEN is a safe and beneficial opportunity for patients who have undergone DHP for a peri-ampullary mass.

**Semi-elemental formula or polymeric formula:**

**Is there a better choice for enteral nutrition in acute pancreatitis? Randomized comparative study**

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Common to all pediatric patients receiving enteral nutrition is the stability to consume calories orally. This is often secondary to issues of inadequate weight gain, inadequate growth, prolonged feeding times, weight loss, a decrease in weight/age or weightheight ratios, or a persistent tricusps skinfold thickness <5% for age. Enteral nutrition requires enteral access. In the neonatal period, a nasogastrostomy tube is usually used. In pediatric patients requiring long-term enteral access, surgically, endoscopically, or radiologically placed percutaneous feeding tubes are common. Jejunal feeding tubes are used in pediatric patients requiring long-term enteral access, surgically, endoscopically, or radiologically placed percutaneous feeding tubes are common. Jejunal feeding tubes are used in pediatric patients with gastric feeding intolerance or persistent gastroesophageal reflux. Low-profile enteral access devices are preferred by most pediatric patients because of their cosmetic appearance. For most children, a standard pediatric polypeptide enteral formula is well tolerated. There are specialized pediatric enteral formulas available for patients with decreased intestinal length, altered intestinal absorptive capacity, or altered pancreatic function. Weaning patients from tube feeding to oral nutrition is the ultimate nutrition goal. A multidisciplinary approach to patients with short bowel syndrome will maximize the use of enteral nutrition while preserving parental nutrition for patients with true enteral nutrition therapy failure.

**Nutritional assessment and enteral support of critically ill children**


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Critical care nurses play an important role in feeding of critically ill children. Many procedures and caregiving interventions, such as placement of feeding tubes, registration of gastric retention, observation and care of the mouth, and...
administration of nutrition (enteral or parenteral), are within the nursing domain. This article discusses nutritional assessment techniques and enteral nutrition in critically ill children.

**PROTEINS IN CLINICAL NUTRITION**

Glutamine: Do the data support the cause for glutamine supplementation in humans?

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This review examines the preclinical rationale for using glutamine supplements and reviews the prospective randomized trials using glutamine to improve outcomes in patients. A special role for glutamine in gut physiology and in management of a variety of serious illnesses has been suggested, because it is the most abundant extracellular amino acid, and is used at high rates by the gut, liver, central nervous system, and immune cells. A state of relative Gln deficiency has been postulated in humans based on the decrease in plasma Gln in acute critical illness, but the decrease in plasma Gln is not specific for that amino acid, predicts only poorer outcome, and has not been validated to identify a deficiency state. Current evidence does not necessarily predict a special need or role for Gln in critical illness. Clinical efficacy of supplemental Gln has been difficult to demonstrate, possibly related to the lack of a Gln deficiency state, the wide range of endpoints used that reflect the lack of certainty of the predicted effect of supplementation, the heterogeneous patient populations studied, the lack of stable clinical course during the study, the lack of adequate power, and the relatively short follow-up period. Prospective randomized clinical trials of Gln supplementation were reviewed in patients with short-bowel syndrome, during cancer chemotherapy and in bone marrow transplantation, and in surgical, burn, and intensive care unit patients. No firm recommendation can be made at this time. Future studies should seek to develop a more standard and stable design for intervention in sufficiently powered studies.

Branched-chain amino acid-enriched nutritional support in surgical and cancer patients

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Prolonged surgical stress and advanced malignant disease lead to systemic catabolism characterized by depletion of muscle protein and oxidation of skeletal muscle branched-chain amino acids (BCAAs). BCAA oxidation provides energy for muscle and other organs, and is the precursor for amino acid synthesis to replenish alanine and glutamine depleted in catabolic states. Persistent excessive catabolism leads to skeletal muscle wasting, negative nitrogen balance, and immune system compromise. BCAAs, especially leucine, stimulate protein synthesis, inhibit proteolysis (in cell culture models and in animals), and promote glutamine synthesis. A number of small and diverse clinical trials studied the effects of BCAA-enriched nutritional support in moderately to severely stressed surgical and cancer patients. The findings of these clinical trials have been inconsistent; some show improved nitrogen balance, increased skeletal muscle protein synthesis, and reduced skeletal muscle catabolism, whereas others show no significant improvement. The value of these trials is compromised by small sample sizes, heterogeneous patients, poor study design, varying degrees of metabolic stress, and inappropriate endpoints. More recent trials that evaluate clinical outcomes in hepatocellular carcinoma patients show promising results, in addition to improving metabolic parameters, BCAA-enriched oral supplementation improved morbidity and quality of life in patients undergoing major liver resection and chemo-embolization. In summary, the role of BCAAs in the nutritional support of stressed surgical and cancer patients remains to be clearly defined, despite their potential beneficial biologic properties.

**TRAUMA AND BURNS**

The effectiveness of caloric value of enteral nutrition in patients with major burns


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Enteral nutrition as an important component of modern treatment is mandatory for patients suffering from major burns. Regardless of the initial estimation of caloric requirements, actual daily volume of energy consumption may vary depending on the general condition of the patient and the side effects of enteral nutrition. The aim of our study was to investigate the relationship between caloric value of enteral nutrition and treatment course. METHODS: The prospective study involved 103 adult patients treated in the hospital of Kaunas University of Medicine for 2–3° burns of 10–80% body surface area from 1 January 2001 until 31 December 2003. All patients received enteral nutrition during the acute phase. After the completion of the treatment, caloric value of enteral nutrition was estimated, and patients were divided into two groups: group A received more than 30 kcal/(kg 24 h); and group B received less than 30 kcal/(kg 24 h). We compared patients’ mortality, complication rate, and hospital stay time. RESULTS: The mortality rate of patients who entally received less than 30 kcal/(kg 24 h) was 32.6% compared with 5.3% in patients who received 30 kcal/(kg 24 h) or more (p < 0.01). The caloric value of less than 30 kcal/(kg 24 h) increased the frequency of pneumonia by 2.0 times, and the frequency of sepsis by 1.8 times (p < 0.05). The duration of the treatment of survivors in this group was 12.6 days longer (p < 0.01). CONCLUSIONS: The caloric value of enteral nutrition seems to be associated with patient mortality, complication rate, and treatment duration. The results of the treatment of patients who received more than 30 kcal/(kg 24 h) were much better. Because the determined relationship may not be directly causal, further study is needed to determine whether active intervention to improve nutrition could improve outcomes.

Branched-chain amino acid-enriched nutritional support in surgical and cancer patients

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The effectiveness of caloric value of enteral nutrition in patients with major burns

The obesity epidemic: Threats and opportunities

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In the United States, the prevalence of obesity is worsening rather than improving, especially in African-American women. Thirty percent of US adults are obese. The percentage of overweight young people has more than tripled since 1980. The Centers for Disease Control and Prevention (CDC) priorities to control the obesity epidemic focus on preventing excessive weight gain in children, weight loss and weight maintenance after weight loss in adults, and eliminating the disparities in obesity. Although physical activity has a relatively modest impact on weight loss, it reduces obesity-associated comorbidities and is the single most underutilized strategy to address obesity. Television viewing time and soft drink consumption (Welsh JA, et al. Pediatrics 2005;115:223-229) are both correlated with prevalence of childhood obesity, and strategies center on restricting access.

Treatment and prevention options for obesity must change from the traditional medical model to a chronic care model centered around patient self-management (Bodenheimer T, et al. JAMA 2002;288:1909-1914). In medical settings and plans, priorities are on measuring body mass index (BMI), stratifying care based on return on investment, and reimbursement. The CDC supports partnering with schools, work sites, payers, and the community on programs, such as the Step Community Collaborative, that combine nutrition and physical activity interventions. Industry’s involvement, which was key to eliminating widespread nutritional deficiency diseases, is essential to treating obesity today.

Paradigm shifts in enteral nutrition in critically ill patients: Protein calorie malnutrition

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Protein calorie malnutrition (PCM) commonly occurs in intensive care unit (ICU) patients and is the cause of multiple organ failure. In the 1980s, the goal of nutrition therapy was to feed early and achieve early positive calorie and nitrogen balance to avoid septic autolysis thought to be caused by inadequate nutrition support (NS). Branched-chain amino acids, high-protein stress parenteral solutions, and perioperative parenteral nutrition (PN) were all used to abate stress. However, clinical trials showed that none improved patient outcomes.

In the 1990s, a different strategy was developed using early enteral nutrition (EN) given within 24 to 48 hours of admission at modest dosing of 14-18 kcal/kg/day and limited to 7-10 days. However, early EN will not prevent malnutrition. ICU patients have an obligatory loss of protein stores of 12% to 16%, and early aggressive enteral feeding does not stop the loss (Monk DN, et al. Ann Surg 1996;223:395-405). Early aggressive EN may have harmful effects. In one study, ICU patients who received a moderate dose of enteral feeding had better outcomes than full-dose enteral feedings (Krishnan JA, et al. Chest 2003;124:297-305). The poorer outcomes may have been due to hyperglycemia or pulmonary aspiration. Early aggressive gastric feeding in ICU patients has been associated with more infectious complications and prolonged length of stay (LOS) (Ibrahim EH, et al. JPEN J Parenter Enteral Nutr 2002;26:174-181).

In the 2000s, the goal shifted to maintaining vital gut functions with EN and providing nutraceutical supplementation to modulate inflammation independent of PCM. Insulin, given with glucose, has a dramatic protein-sparing effect and inhibits protein catabolism after injury. Oxandrolone provides an anabolic effect after severe burns and propionalol reverses catabolism.

PCM becomes an important issue in vulnerable patients who have limited reserves (elderly and previously malnourished patients) or in those exposed to major injuries (burns, severe sepsis, trauma, massive soft-tissue injury). In vulnerable patients, Dr Moore recommends: limiting excessive crystalloid fluids and giving intraluminal glutamine during resuscitation; providing early hypocaloric EN for days 2-7 using an immune-enhancing diet (IED); and achieving positive caloric balance with intensive insulin therapy and possibly oxandrolone and propranolol after day 7.

Enteral support of the compromised gut in the critical care setting: Effects on the function of the intestinal epithelium

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A recent study examined the impact of diets containing either intact proteins (POLY), whey-based peptides with a low amount...
Nutrition support in acute pancreatitis: What are the key issues?

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Recent meta-analyses show that, compared with PN, EN decreases infection (McClave SA, et al. JPEN J Parenter Enteral Nutr 2006;30:143-156), reduces the need for surgical intervention, and reduces LOS (Marik PE, et al. BMJ 2004;328:1407) in patients with pancreatitis. Silent stimulation of secretion and exacerbation of symptoms are potential adverse consequences of EN for patients with acute pancreatitis, but have negligible clinical consequences. Exacerbation of the disease process is a rare, but significant, scenario that occurs in 4% of patients (Levy P, et al. Gut 1997;40:262-266).

Options for NS in acute pancreatitis include standard therapy of doing nothing, EN, or PN, and should be selected based on disease severity, timing, and tolerance. Eighty percent of patients need no NS. Those with severe disease need NS, which reduces mortality by 74% in patients given EN compared with no nutrition therapy.

Tolerance is affected by the duration of illness, individual variation with intolerance, institutional variation with intolerance, the level of the infusion, and content of the diet. Pancreatic patients who start enteral feedings within 48 hours tolerate feedings. Having institutional protocols in place to facilitate rapid, early initiation of enteral feedings may reduce institutional variation with intolerance. Infusing the formula more than 40 cm below the ligament of Treitz enhances feeding tolerance.

A recent controversial study comparing nasogastric (NG) and nasojejunal (NJ) feedings in patients with acute pancreatitis suggests that the content of the formula may affect tolerance. In a randomized controlled trial (RCT) of patients with severe pancreatitis, gastric feedings of a formula with protein given as small peptides and 9% fat produced no significant differences in mortality, pain scores, LOS, or C-reactive protein (CRP) levels compared with NJ feedings (Eatock FC, et al. BMJ 2005;331:347-352). PN and pancreatic rest may be indicated in a subgroup of patients with ductal damage. However, early PN does not improve outcome and may be a liability (Sax HC, et al. Am J Surg 1997;173:117-124). In the first 2-4 days of hospitalization, the goal is to attenuate the stress response, and PN, if indicated, should not be started until after the first 5 days.

Relapsing pancreatitis: More gain, less pain

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Chronic pancreatitis is characterized by irreversible loss of pancreatic structure and function, pain, and moderate to severe malnutrition in 30% to 40% of patients. Pain, which may persist for years, and food aversion contribute to...
malnutrition. Short of narcotics, pharmacologic therapy is not effective in treating pancreatic pain. Endoscopic therapy aimed at decompressing the obstructed pancreatic duct has limited benefit, and surgical management of chronic pancreatitis is associated with significant morbidity.

In a recent study, Stanga et al examined the effect of long-term EN using a standard polypeptide formula given by percutaneous endoscopic gastrostomy into the jejunum (PEGJ) or duodenal percutaneous endoscopic jejunostomy (DPEJ) in patients with symptomatic chronic pancreatitis. He found jejunal feedings decreased narcotic use, abdominal pain, and other gastrointestinal symptoms. Albumin and body weight increased and hospitalizations decreased (Stanga Z, et al. J Parenter Enteral Nutr 2003;27:12-20).

Immune-enhancing enteral formulas: Making the decision

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Enteral formula design, or why can't they make the formula I want?

J Saavedra, RD, Glendale, California

Federal food safety regulations, the complexity of formula production, and restrictions that limit product marketing claims make the development of new enteral formulas a complex process. Enteral formulas are classified as food products and, therefore, must conform to food safety regulations and carry no intrinsic risk. Each additive must be included on the generally-recognized-as-safe list. This contrasts to new pharmaceutical drug design in which a balance of intrinsic risk vs benefit is accepted.

Enteral formula production involves a large number (40-50) of ingredients from multiple suppliers who must meet all safety and quality specifications. Each individual ingredient contributes other endogenous ingredients. Nutrient interactions, nutrient stability and degradation, taste and texture qualities, and cost present different challenges to new formula design. Federal regulations limit claims that may be made as to content, structure, function, and health benefits.

Clinical trials to support claims require significant cost and time, and may be limited by the lack of controls. Over the past 50 years, product innovation has shifted from low investment cost and time yielding widespread benefit (ie, iodine fortification) toward high investment cost and time yielding more limited benefit.

Five systematic reviews and meta-analyses of more than 20 trials of immunonutrition have examined the evidence supporting IEDs and concluded that they do not appear to offer benefit to heterogeneous populations of ICU patients. Elective surgical patients demonstrated greater benefit in reductions in infections and hospital LOS versus critically ill patients. Interestingly, when the results of the largest RCT in the ICU population (Kieft H, et al. Intensive Care Med 2003;31:524-532) are included with the existing trials, meta-analysis shows no clinical difference with IEDs for mortality, infectious complications, or LOS in the ICU. IEDs should be considered for elective surgical patients. IEDs should also be considered in acute respiratory distress syndrome (ARDS) patients using a modified enteral formula with n-3 fatty acids from fish and borage oils (Gadek JE, et al. Crit Care Med 1999;27:1409-1420). Subgroup analysis of higher-quality studies suggests IEDs may be associated with increased mortality in some subgroups of critically ill patients. More robust trials in homogenous populations, and on the role of arginine in sepsis and mortality, are indicated.

Translating evidence-based nutrition into effective clinical care: Enteral feeding protocols

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A multidisciplinary, evidence-based enteral feeding protocol expedites efficient EN delivery and streamlines decision-making to manage intolerance (Kozar RA, et al. J Surg Res 2002;104:70-75). Components of a protocol address patient selection, formula selection, access, goal setting, advancement, management of tolerance, and metabolic monitoring. Protocols provide a process to manage intolerance consistently, allow for critical analysis of results, and empower clinicians to act. When practitioners contribute to the development of protocols, they gain increased awareness and enthusiasm for the protocols.

McQuiggan described the enteral feeding protocols at the University of Texas Medical Center. Candidates are identified on day 1 of the ICU stay and are started on early enteral feedings within 48-72 hours. Criteria determine the type of formula (IED, polymeric, elemental or renal failure) that each patient receives, with 60% of patients receiving a polymeric diet. Feeding access options include push NJ, endoscopic NJ, needle catheter jejunalostomy, laparoscopic jejunalostomy, and PEG/PEJ.

The nutrition prescription is calculated based on the BMI, metabolic cart, and established ranges for weight class (underweight, normal, overweight, obesity, and extreme obesity). Feeding advancement begins at 15 mL/h and is advanced incrementally to goal. The protocol includes uniform practices to manage intolerance (vomiting, abdominal distension, diarrhea, high NG output, and medication contraindications). Metabolic monitoring includes an aggressive glycemic control protocol, weekly indirect calorimetry, and weekly CRP, prealbumin, and 12-hour urinary urea nitrogen.

Providing specific clinical feedback on adherence and outcomes increases clinician adherence to the protocol. A protocol is dynamic and requires continual updating, feedback, and monitoring.
Nutritional support in critically ill, trauma patients: Translating evidence-based nutrition into effective clinical care

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Ileus occurs after sepsis and shock-induced gut ischemia/reperfusion, and allows the proximal gut to be a reservoir for pathogens that can cause late nosocomial infections. Thus, the gut can be both a cause and a victim of multisystem organ failure. Gut inflammation contributes to prolonged ileus. Nitric oxide is upregulated in postinjury ileus only after severe insults, and plays a role in gut motility disorders that occur under proinflammatory conditions. The absence of fasting migrating motility complex activity within the gut is associated with poor tolerance of advancement of early EN.

EN is feasible following severe traumatic shock when standard-of-care interventions are modified to reduce ileus and improve tolerance to enteral feeds. Hypertonic saline resuscitation, minimizing narcotics and sedation, and glutamine administration protect against inflammation, injury, and impaired intestinal transit.

Glutamine and arginine differentially modulate gut barrier function. In a recent meta-analysis of 14 RCTs, glutamine supplementation was associated with a reduction in complications and mortality in critically ill patients, presumably by maintaining the physiologic intestinal barrier and by reducing the frequency of infections. Patients receiving high-dose (>0.25 g/kg) parenteral glutamine showed the greatest benefit (Novak F, et al. Crit Care Med 2002;30:2002-2029). Arginine results in worsened mucosal injury, disrupts the actin cytoskeleton, decreases tissue ATP, and enhances permeability compared with glutamine.

Studies have shown that even patients requiring inotropes can be successfully fed enterally. Nonocclusive bowel necrosis, a rare but life-threatening complication, may occur after the second week in severely injured patients after a period of feeding tolerance and requires tight management of feeding intolerance.

Update on glutamine supplementation in nutrition support

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Neither enteral glutamine nor low-dose glutamine has been shown to be effective. Glutamine added to standard feedings or an IED did not improve survival in surgical ICU patients (Schulman AS, et al. Crit Care Med 2005;33:2692-2694). Low-dose enteral glutamine (20 g/L) resulted in no difference in mortality or severe sepsis in critically ill patients (Hall JC, et al. Intensive Care Med 2003;29:1710-1716).

However, emerging data indicate parenteral glutamine may be effective in selected patients. Patients who had cardiac, vascular, or colon surgery had marked improvements in blood glucose, pneumonia, infections, and mortality rates when given alanine/glutamine-supplemented PN compared with pancreatic surgery patients (Zigler TR, et al. JPEN J Parenter Enteral Nutr 2004. [Abstract]). A larger RCT (GLND study) is currently underway to test the results in a larger population.


President’s Lecture: Inflammation as the key interface of the medical and nutrition universes

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Inflammation is a unifying theme between NS and recovery or poor outcomes in critical illness. Its emerging role in chronic conditions is becoming more evident. The cytokine-mediated response to injury and infection is an appropriate adaptive response in the short run. However, cytokines promote muscle catabolism, inhibit muscle synthesis and repair, and trigger apoptosis. Persistent generalized inflammation is detrimental to survival.

Active inflammation can impact the interpretation of nutrition assessment criteria by triggering the acute-phase protein response that favors a catabolic state. Albumin is a poor nutrition indicator in inflammation, but a potent proxy indicator of the inflammatory phase. Routine nutrition assessment should include assessment of CRP, a positive acute-phase reactant to assess inflammation, and evaluate albumin and prealbumin. Inflammation may lead to cachexia, which differs from simple wasting or the unintentional loss of lean body mass (LBM) seen in sarcopenia. Cachexia is the loss of LBM that is accompanied by an underlying inflammatory process and increased cytokine production (Roubenoff R, et al. Am J Clin Nutr 1997;66:192-196).

Conditions with nutritional implications and inflammatory components include gut injury, inflammatory bowel...
disease, wounds and trauma, sepsis and ARDS, and HIV/AIDS. End-stage organ failure syndrome is characterized by cachexia with elevated tumor necrosis factor (TNF), anorexia, and erosion of body cell mass (BCM). In maintenance hemodialysis patients, a malnutrition-inflammation score has shown significant associations with morbidity and mortality, and measures of nutrition, inflammation, and anemia (Kalantar-Zadeh K, et al. Am J Kidney Dis 2001;38:1251-1263). Many chronic diseases are associated with chronic inflammation. In obesity, abdominal adipocytes release proinflammatory cytokines. Obesity is associated with inflammatory comorbid diseases (metabolic syndrome, cardiovascular disease, diabetes, hypertension, and destructive joint disease) and sarcopenic obesity, in which limited mobility causes erosion of the muscle mass. Rheumatoid arthritis patients have increased cytokine production that is inversely correlated with TNF production (Walsmith J, et al. J Rheumatol 2004;31:23-29). Periodontal disease and aging are now recognized as inflammatory conditions.

In modern critical care, patients can be kept alive for extended periods in highly proinflammatory states. Despite receiving nutrition intervention, many such patients deteriorate with erosion of BCM and adverse outcomes. Targeting nutrition therapy may influence the intensity of inflammation in disease.

Realistic goals for nutrition intervention should recognize that nutrition intervention alone is ineffective in preventing lean muscle mass loss in patients with highly proinflammatory states. Integrated approaches should include anti-inflammatory diets with nutrition modulators (such as n-3 fatty acids and antioxidants), appetite stimulants, anti-inflammatory pharmacologic agents, and physical activity. Intensive insulin therapy attenuates the acute-phase response and is associated with reduced ICU stays and improved outcomes (Hansen TK, et al. J Clin Endocrinol Metab 2003;88:1082-1088; Van den Berghe G, et al. N Engl J Med 2001;344:449-461). In the future, we may be able to tailor interventions based upon gene polymorphisms and move nutrition to the forefront of medicine.

Small bowel (SB) feeding reduces gastroesophageal regurgitation (Heyland DK, et al. JPEN J Parenter Enteral Nutr 2002;26:S51-S55). The effect of SB feeding on decreasing aspiration risk is more controversial. One meta-analysis of 10 studies concluded jejunal feedings decreased ventilator-associated pneumonia by 25%. Another meta-analysis of nine studies noted a trend toward reducing pneumonia, but it was not statistically significant (Marik PE, et al. Crit Care Med 2003;31:R46-R51). Expert opinion is that SB feeding decreases aspiration in high-risk patients.


More evidence for the safety and efficacy of gastric enteral feedings in the ICU patient

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Gastric feeding tubes are easy to place and inexpensive, preventing delays in the initiation of feeding often seen in postpyloric feedings. Gastric residual volumes (GRV) do not correlate with aspirations pneumonia or reflect gastric emptying or intestinal motility. GRV cannot be used as a marker for risk of aspiration (McCclave SA, et al. Crit Care Med 2005;33:324-330). Most aspiration pneumonia occurs from oropharyngeal secretions; the contribution of enteral formula to aspiration pneumonia remains unclear.

Results comparing gastric feeding with SB feeding vary. One meta-analysis of nine studies comparing SB and gastric feeds showed gastric feeding was associated with more pneumonia; however, the patient population was heterogeneous, making it difficult to draw conclusions (Marik PE, et al. Crit Care Med 2003;31:R46-R51). In another study, no difference was found in aspiration rates between SB feeds and gastric feedings (Meert KL, et al. Chest 2004;126:872-878). Mentec found ICU patients receiving NG tube feeding frequently aspirated; however, aspiration was more frequent in seated patients or those receiving catecholamines (Mentec H, et al. Crit Care Med 2001;29:1955-1961). Expert opinion from the aspiration summit recommends that feedings not be held for volumes less than 500 mL. GRV between 200-500 mL require prompt bedside evaluation, and GRV should be used along with clinical judgment. Most patients can be fed via the gastric route with the head of the bed elevated (McCclave SA, et al. JPEN J Parenter Enteral Nutr 2002;26:S80-S85).

Does small bowel feeding benefit patient outcomes compared with gastric feeds?

JC Fang, MD
Salt Lake City, Utah

Nutrition support in the elderly critically ill

G Jensen, MD, PhD
Nashville, Tennessee

Changes in body composition and physiology alter nutrient requirements and complicate nutrition assessment in the elderly. Decreased bone density, sarcopenia, and increased body fat increase protein and decrease calorie needs. Polypharmacy contributes to taste and smell changes. Poor dentition correlates with mortality. Achlohydria causes B12 deficiency, found in 20% to 30% of community-dwelling older persons.

Aging is now considered an inflammatory condition. High levels of IL-6 carry poor prognosis in older persons, while higher levels of physical activity are associated with lower levels of CRP and IL-6 (Reuben DB, et al. J Am Geriatr Soc 2003;51:1125-1130). Using four blood measures of inflammation – albumin, cholesterol, IL-6, and CRP – a summary score can identify healthy older persons who have a much higher risk of mortality (Reuben DB, et al. J Am Geriatr Soc 2002;50:638-644).

Nutritional assessment should be based on physiologic age and condition, not chronicologic age, and may include weight loss/gain, supplement use, eating difficulties, depression, functional capacity, perioral and swallowing evaluation, loss of muscle or fat, and presence of edema. Laboratory evaluation may include albumin/prealbumin, CRP, and homocysteine or B-vitamin levels.

The elderly can deteriorate rapidly when admitted to the ICU, and NS should be considered within 2-3 days of acute critical illness. EN is preferred and gastric feedings are usually well tolerated. Most elderly critically ill persons tolerate conventional nutrition formulations. Hyperglycemia is common, and intensive insulin management and reduced dextrose loads may be indicated if PN is needed.

Update on geriatric nutritional assessment: What’s old, what’s new and what’s next?

RA DiMaria, PhD, J Dwyer, RD, SM, SD
Charleston, West Virginia; Boston, Massachusetts

Functional dependency and decreased general health status or quality of life correlate with poor nutritional status in frail older adults (Keller HH. J Am Geriatr Soc 2003;6:245-252). Therefore, geriatric nutrition assessment should not be viewed in isolation, and should consider functional and general health assessment. Functional screening tools assess a person’s ability to perform the daily tasks of living and are sensitive to changes in declining health status (Katz S, et al. Gerontologist 1979;10:20-30). The most widely used tool to measure general health status or quality of life in clinical practice is the SF-36.

Nutrition screening tools, such as the Nutrition Screening Initiative DETERMINE checklist or the Registered Nurses Nutrition Risk Classification (RNNRC), quickly identify persons at risk within a targeted population, but are better educational tools than diagnostic tools. Nutrition assessment tools, such as the MNA®, Subjective Global Assessment (SGA), and Anthropometry, Biochemistry, Clinical Indicators, and Dietary (ABCD) method, diagnose nutrition problems and should incorporate special considerations in the elderly.

Body composition changes in older adults (decreased LBM, body water, and bone mineral mass, and increased fat tissue) make weight and weight changes more useful than BMI in monitoring the elderly. Azoetric gastritis and malabsorption due to B12 deficiency, occur in 15% to 20% of frail elderly. Reports of limited physical activity or difficulty rising from chairs are quick assessments. Simple nutrition screening by front-line caregivers must become routine in assisted-living facilities and outpatient settings dealing with frail elders. Using a validated tool like the DETERMINE checklist or 2-step MNA® is recommended.

Scientific Abstracts

Whey-based formulas improve feeding intolerance in pediatric burn patients

Dylewski ML, Prelack K, Sheridan RL
Boston, Massachusetts

A retrospective chart review was conducted between January 2003 and April 2004 to investigate the effects of the type of tube-feeding formula on feeding tolerance in pediatric burns patients. Seventeen pediatric patients required enteral tube feeding upon admission. Mean total burn surface areas = 45%. Mean age = 5 years. Nine patients received whey-based peptide formula. Eight patients received casein-based intact protein formula. Vasopressor, paralytic, and gut prophylaxis therapies were similar between groups. Compared with children who received the casein-based intact protein formula, the group of children receiving the whey-based peptide formula reached their goal rate faster, experienced significantly less diarrhea, and required fewier interruptions of tube feedings due to high residuals. This retrospective review indicates that a whey-based peptide formula may be better tolerated than a casein-based intact protein formula for pediatric burns patients. Prospective, randomized trials are needed to confirm this observation. Due to the ongoing success with this whey-based formula, the current standard of care at this institution is to initiate enteral NS with a whey-based peptide formula for all acute burns patients older than 1 year.

The views expressed in this newsletter are of the presenters and participants, not Nestlé.

The next Clinical Nutrition Week will be held on 28-31 January 2007 in Phoenix, Arizona. Further information may be found at www.nutritionweek.org.
### Conference Calendar

#### 4th Congress of the European Union Geriatric Medicine Society (EUGMS)
23-26 August 2006
Geneva, Switzerland
**Organizer:** MCI Suisse SA
Tel: +41 (0) 22 339 9686
Fax: +41 (0) 22 339 9691
E-mail: eugms2006@mci-group.com
Web site: www.eugms2006.org

#### Malaysia-Singapore Congress of Medicine
24-27 August 2006
Petaling Jaya, Malaysia
**Organizer:** Secretariat, 40th Malaysia-Singapore Congress of Medicine
Tel: +603 2093 0100
Fax: +603 2093 0900
E-mail: acadmed@po.jaring.my
Web site: www.acadmed.org.my

16-19 September 2006
Honolulu, Hawaii, USA
**Organizer:** American Dietetic Association
Tel: +1 800 877 1600 ext 4862
E-mail: fnce2006@eatright.org
Web site: www.eatright.org/FNCE2006

#### 38th Congress of the International Society of Paediatric Oncology (SIOP)
17-21 September 2006
Geneva, Switzerland
**Organizer:** MCI Suisse SA
Tel: +41 (0) 22 339 9648
Fax: +41 (0) 22 339 9651
E-mail: siop2006@mci-group.com
Web site: www.siop2006.com

#### 19th European Society of Intensive Care Medicine (ESICM) Annual Congress
24-27 September 2006
Barcelona, Spain
**Organizer:** ESICM Congress Manager
Tel: +32 2 559 0355
Fax: +32 2 527 0062
E-mail: public@esicm.org
Web site: www.esicm.org

#### 31st European Society for Medical Oncology (ESMO) Congress
29 September-3 October 2006
Istanbul, Turkey
**Organizer:** Congress Department, ESMO Head Office
Tel: +41 (0) 91 973 1919
Fax: +41 (0) 91 973 1918
E-mail: congress@esmo.org
Web site: www.esmo.org

#### 19th North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition (NASPGHAN) Annual Meeting
19-22 October 2006
Orlando, Florida, USA
**Organizer:** NASPGHAN
Tel: +1 215 233 0808
Fax: +1 215 233 3918
E-mail: naspghan@naspghan.org
Web site: www.naspghan.org

#### 28th European Society for Clinical Nutrition and Metabolism (ESPEN) Congress
19-22 October 2006
Istanbul, Turkey
**Organizer:** MCI Suisse SA
Tel: +41 22 339 9580
Fax: +41 22 339 9651
E-mail: espem2006@mci-group.com
Web site: www.espem.org

#### The World Congress on Controversies in Obesity, Diabetes and Hypertension (CODHy)
26-29 October 2006
Berlin, Germany
**Organizer:** Contact International
Tel: +972 3566 6166
Fax: +972 3566 6177
E-mail: info@contactmed.com
Web site: www.codhy.com

#### Annual Meeting of the British Association for Parenteral and Enteral Nutrition (BAPEN) 2006
1-2 November 2006
Brighton, United Kingdom
**Organizer:** Sovereign Conference
Tel: +44 (0) 1257 518 777
Fax: +44 (0) 1257 518 718
E-mail: enquiries@sovereignconference.co.uk
Web site: www.bapen.org.uk/conferences.htm

#### 19th World Diabetes Congress
3-7 December 2006
Cape Town, South Africa
**Organizer:** Congress Secretariat, International Diabetes Federation
Tel: +32 2543 1631
Fax: +32 2538 5114
E-mail: wdc@idf.org
Web site: www.idf2006.org
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