Critical Care Nutrition – Improve Outcomes in Your Patients
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Key Points:

- Providing nutrients to patients during stressed starvation spares endogenous protein losses
- Protein calorie malnutrition is thought to increase morbidity and mortality in veterinary patients
- Once patients are stable, nutritional support should be considered within 3 days of inadequate nutrient intake
- If the gut works use it
- Force feeding, particularly sick, hospitalized animals is the best way to create food aversions.
- Select the food type (liquid, homogenized or blenderized) based on tube size and location

Why you should feed:

Nutritional support of critically ill patients has long been considered a supportive measure of low priority. Recent advances in both human and veterinary medicine have demonstrated that nutritional support is an important therapeutic modality and can aid in the management of many diseases. In diseased states, the inflammatory response triggers alterations in cytokines and hormone concentrations and shifts metabolism toward a catabolic state. With a lack of food intake, the predominant energy source is derived from accelerated proteolysis, which in itself is an energy-consuming process. Thus, critically ill animals may actually preserve fat deposits in the face of lean muscle tissue loss. The goal of nutritional support in these catabolic patients is to feed the catabolism with exogenous sources of protein and fat thereby sparing endogenous protein which is critical to recovery.

Malnutrition in veterinary patients is thought to increase morbidity and mortality, but this has not been statistically quantified. However, nearly every body system is affected by negative energy balance. In the GI tract transit times increase, absorptive capabilities decrease, villous atrophy and there is an increased risk of bacterial translocation. In the kidneys, excretion of urinary calcium and phosphorus increases, ability to excrete acid decreases, gluconeogenesis increases and glomerular filtration rate decreases. Malnutrition has been documented to decrease humoral immunity and barrier function (skin and mucosal surfaces), inflammatory response, leukocyte motility and bactericidal activity. Patients are at risk for pulmonary complications as a result of decreased response to hypoxia, decreased lung elasticity, and secretion production, altered permeability and decreased tidal volume. Cardiovascular complications include increased incidence of arrhythmias and decreased weight of the heart muscle. Protein calorie malnutrition may also alter the normal or
expected metabolism of certain drugs, which may increase or decrease their therapeutic effect even when given at recommended dosages.

**Who you should feed:**

Historically, nutritional support was not considered necessary until animals had inadequate intake for 10 days. This concept is both outdated and unjustified; in fact recent evidence would suggest a more appropriate goal in most cases is to commence nutritional support within 3 days of hospitalization.

Evaluating nutritional status is challenging. Historical weight loss may provide some evidence of inadequate intake and body condition scoring may be helpful to assess fat loss but is not as sensitive for muscle wasting. Laboratory abnormalities may not be present or may be nonspecific. Because of the limitations in assessing nutritional status, early risk factors must be identified that predispose patients to malnutrition, such as a history of inadequate nutritional intake lasting more than 5 days, serious underlying disease (eg, severe trauma, sepsis, peritonitis, acute pancreatitis, major gastrointestinal surgery), and large protein losses (eg, protracted vomiting, diarrhea, protein-losing nephropathies, draining wounds, burns). Patients with these risk factors are candidates for nutritional support.

As with any intervention in critically ill animals, nutritional support has some risk. The risk of complications increases with disease severity. To minimize risks, patients must be cardiovascularly stable before nutritional support is initiated. In shock, perfusion of the gastrointestinal tract is reduced in favor of maintaining adequate perfusion of heart, brain, and lungs. With reduced perfusion, processes such as gastrointestinal motility, digestion, and nutrient assimilation are altered, increasing the chance of complications. In addition, feeding should be delayed until preexisting fluid and electrolyte abnormalities are corrected to avoid exacerbating gastrointestinal hypoxia secondary to increasing cellular metabolism, and to prevent hypophosphatemia and hypokalemia related to refeeding syndrome.

**How you should feed:**

*Feeding tubes save lives and are not used as often as they should be for anorexic patients.*

The gastrointestinal tract needs to be fed. The gut receives an overwhelming percentage of its nutrition from the chyme passing through it. In the small intestine, enterocytes utilize lumenal glutamine preferentially as their source of metabolic fuel. The colonocytes prefer butyrate, a short chain fatty acid formed by fermentation of lumenal carbohydrates. In the absence of these fuel sources, the gut epithelium slows growth and replication resulting in atrophy, necrosis and increased risk of bacterial translocation across the now abnormal gut barrier. A key to prevention of this potentially serious problem is providing nutrition support to the gut. On tenet of nutritional support is; if the gut works use it.

Force feeding sick, hospitalized animals is the best way to create food aversions. It is an inefficient feeding method resulting in more nutrients on the patient rather than in the patient. Typically force feeding will not provide a significant percent of needed
calories and will lead to a false sense of accomplishment and continued inadequate intake. Likewise, appetite stimulants are seldom successful in causing meaningful increases in food intake. Pharmacologic stimulation of appetite is often short-lived and only delays true nutritional support. Appetite stimulants should not be used to manage hospitalized animals when more effective measures of nutritional support, such as placement of feeding tubes, are more appropriate. Appetite stimulants may be considered in recovering animals once they are home in their own environment, because the primary reason for loss of appetite should ideally be reversed by discharge. As with many drugs, appetite stimulants also have negative side effects, such as behavioral changes associated with cyproheptadine and sedation associated with diazepam, and therefore should be used with caution.

Indwelling feeding tube is the method of choice if enteral assisted feeding is necessary for more than two days. After an indwelling tube had been placed, feeding is easier and less stressful. Nasoesophageal, esophagostomy, gastrostomy, and jejunostomy feeding tubes are the most commonly used. In animals undergoing laparotomy, placing gastrotomy or jejunostomy feeding tubes should be considered. The decision to use one tube over another is based on the anticipated duration of nutritional support (eg, days vs. months), the need to circumvent certain segments of the gastrointestinal tract (eg, oropharynx, esophagitis, pancreatitis), clinician experience, and the patient's ability to withstand anesthesia (very critical animals may only tolerate placement of nasoesophageal feeding tubes).

**Feeding Tube Options:**

- **NE tubes** are generally used for 3 – 7 days. Polyurethane tubes and silicon tubes may be placed in the caudal esophagus or stomach. An 8 Fr tube will pass through the nasal cavity of most dogs. A 5 Fr tube is more comfortable in cats. Anesthesia or tranquilization is not necessary (use topical ophthalmic anesthetics to numb the nasal cavity). These tubes can be used in patients considered anesthetic risks.
- **Pharyngostomy and esophagostomy tubes** vary from 8 to 16 Fr and may be place in patients with disease or trauma to the nasal or oral cavity. These tubes can be used for long term in hospital or home feedings. Gastrostomy (mushroom-tipped, 16-22 Fr) can be placed either intraoperatively or percutaneously.
- **Any tube** that has been placed in the esophagus or stomach generally allows for bolus type meal feeding except in patients that vomit after each feeding. These patients will benefit from a slow continuous drip administered by a pump or gravity.
- **Jejunostomy tubes** (J-tubes, 5-8 Fr) are placed within the small intestine either surgically or endoscopically and are appropriate for cases where the stomach and proximal duodenum must be bypassed. Ideally food is administered at a slow, continuous drip delivered by a pump.

**What you should feed:**

Nutritionists debate the exact formula for determining daily energy requirements in critically ill patients. A good starting point is to calculate the resting
energy requirements for the patient’s current weight for animals with a normal or thin body condition score. Ideal weight should be used to determine the RER for obese patients. Use of ideal weight in underweight patients and current weight in overweight patients may increase the risks of complications from overfeeding in these individuals.

**In critically ill patients; feeding is preferable to starving but underfeeding is preferable to overfeeding**

Resting energy requirements can be calculated using the following equation: RER = 70 x (current body weight in kg)^0.75. As noted above use current weight for pets with normal or this body conditions and ideal weight for overweight pets. Calorie intake may need to be adjusted to prevent weight loss or unintended weight gain. Food selection depends on tube size and location within the GI tract, the availability and cost of products and the experience of the clinician. Commercial foods available for enteral use in veterinary patients can be divided into two major types: 1) liquid or modular products and 2) blended pet foods. Nasal and jejunostomy tubes usually have a small diameter (<8 Fr.), which requires use of liquid foods. Orogastic, pharyngostomy esophagostomy and gastrostomy tubes have large diameters (>8 Fr.) and are suitable for blended pet foods.

Liquid foods for humans generally cost more than veterinary liquid products. Most human liquid foods are adequate for adult dogs but are too low in protein for cats, puppies and adult dogs with increased protein losses (e.g., protein-losing enteropathies, drains). Human liquid enteral products may not contain adequate concentrations of protein, taurine, arginine and arachidonic acid for long term feeding of cats, but are satisfactory for fewer than seven days.

Liquid foods are of two basic types: 1) elemental or monomeric and 2) polymeric. Foods said to be "elemental" are not truly elemental, but contain nutrients in small hydrolyzed absorbable forms and are best described as monomeric. The proteins are usually present as free amino acids, small dipeptides or tripeptides or larger hydrolyzed protein fractions. The fat source is often an oil of mixed (medium- and long-chain) fatty acids and the carbohydrate sources are mono-, di- and trisaccharides. There are several liquid foods on the human medical market that are positioned as monomeric or hydrolyzed diets and arc suitable when initially refeeding dogs and cats. These monomeric products are homogenized liquids that can be fed through any feeding tube including a J-tube. Monomeric foods are indicated in disease conditions such as inflammatory bowel disease, lymphangiectasia, refeeding parvoviral enteritis and pancreatitis cases and any other condition in which a patient's digestive capabilities are questionable.

Polymeric products contain mixtures of more complex nutrients. Protein is supplied in the form of large peptides (e.g., casein or whey). Carbohydrates are usually supplied as corn starch or syrup, and fats are provided by mediumchain triglycerides (MCT) or vegetable oil. These foods require normal digestive processes and are appropriate for most veterinary clinical situations, especially when a small tube (<8 Fr.) has been placed and particular nutrient profiles are needed (e.g., low sodium, high protein, soluble fiber).
One of the leading liquid veterinary foods is a polymeric form that meets the current AAFCO nutrient allowances for adult dogs and cats. This product is a homogenized liquid containing 1 kcal/ml (4.2 kJ/ml) and is usually accepted better than human liquid products containing MCT oil. This liquid food is the best option currently available in North America when small-diameter nasogastric and jejunostomy feeding tubes have been placed, or when continuous drip feedings are necessary. Historically, these polymeric foods have caused diarrhea in cats after 24 hours of feeding. However, the manufacturer reformulated the product to reduce the incidence of diarrhea. The number of osmotically active particles was decreased by replacing a small-chain maltodextrin source with a larger-chain maltodextrin, and the casemate source no longer contains lactose, thereby eliminating a lactase degradation process. Several liquid milk replacer products are available; however, these products are not appropriate to feed to adult dogs and cats. They typically contain lactose, have high osmolarity, are lower in caloric density and do not meet AAFCO nutrient allowances for adult animals.

Module products are concentrated powdered or liquid forms of nutrients and are primarily supplemental. These products may be added to a liquid product to increase the concentration of a specific nutrient. There are protein, fat and carbohydrate modules (e.g., casien powder, vegetable oil or corn syrup). For example, a protein modular product may be added to a human liquid product for an animal with high protein requirements. Soluble fiber can be added to these foods using psyllium husk fiber or pectin; however, these fibers may block the small side ports in 8-Fr. and smaller tubes.

Blenderized pet foods refer to commercial products nutritionally complete and balanced according to AAFCO allowances for dogs and cats. These products can easily be blended with a liquid to make a consistency that flows through a feeding tube. Products with a miscible texture have a high water content and very small particle size and may be used without dilution in some tubes. Other products must be blended with water and may have to be strained to remove particulate matter.

Blenderized pet foods are preferable to human liquid products because they are more readily available, better tolerated and less expensive. They contain essential amino acids and micronutrients properly balanced to the caloric density of the food. As a result, fewer medical complications (e.g., diarrhea) are likely to result. Additionally, patients may later consume the pet food orally, eliminating a diet change when the patient's appetite returns and the tube has been removed. However, blended products are more likely to plug the feeding tube if the tube is not properly flushed after feeding. These products are appropriate for patients in catabolic states that are using fat and protein substrates from body stores. When using small-diameter (<8 Fr.) feeding tubes, it will be necessary to dilute the pet food with water, which dilutes the caloric density. Blenderized moist veterinary therapeutic foods may have a place in assisted feeding of patients with specific disease conditions. (Table 1)

Human baby foods are commonly recommended because some veterinary patients voluntarily eat these products. In general, the meat and/or egg baby foods are high in protein (30 to 70% DM) and fat (20 to 60% DM), which compares favorably with
blended pet food products. However, baby foods are more costly, contain only one or two food types (protein, protein/grain) and do not contain a balanced mixture of other essential nutrients (amino acids, vitamins and minerals). For example, these products contain only 10% of the calcium required by dogs and cats, and therefore have a large inverse calcium-phosphorus ratio. Some products contain onion powder, which has resulted in Heinz body formation in cats. These products can be used in 8 french or larger feeding tubes and may be used on a very limited, short-term basis when an appropriate pet food is unavailable. Human and veterinary liquid products have a better nutritional profile than do the human baby food products. (Table 2)

Table 1. Recipe and calorie density for blenderized Hill’s Prescription Diet® foods

<table>
<thead>
<tr>
<th>Food</th>
<th>Recipe and caloric density</th>
<th>Tube size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prescription Diet® k/d™ feline</td>
<td>15.5 oz can + 1.5 cup water = 1 kcal/ml</td>
<td>18 Fr</td>
</tr>
<tr>
<td>Most all foods (k9 or feline) with ≥ 550 kcal / ~ 15 oz can will yield ~ 1 kcal/ml with above recipe</td>
<td></td>
<td>18 Fr</td>
</tr>
<tr>
<td>Prescription Diet® a/d™</td>
<td>2 cans + 50 ml water = 1 kcal/ml</td>
<td>10 Fr hard, 14 Fr easy</td>
</tr>
<tr>
<td>Prescription Diet® l/d™ feline</td>
<td>2 cans + 50 ml water = 1 kcal/ml</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Commercial products used for enteral feeding of veterinary patients.*

<table>
<thead>
<tr>
<th>Commercial Veterinary Products</th>
<th>Form</th>
<th>Energy (kcal/ml or g)</th>
<th>Protein (g/100 kcal)</th>
<th>Fat (kcal%)</th>
<th>CHO (kcal %)</th>
<th>Fatty acid ratio (n-6:n-3)</th>
<th>Arginine (mg/100 kcal)</th>
<th>Tube feeding (Fr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbott CliniCare Canine/ Feline</td>
<td>L</td>
<td>1</td>
<td>8.20</td>
<td>45</td>
<td>25</td>
<td>4.3:1</td>
<td>530</td>
<td>5/8**</td>
</tr>
<tr>
<td>Abbott CliniCare Feline RF</td>
<td>L</td>
<td>1</td>
<td>6.34</td>
<td>56</td>
<td>22</td>
<td>4:1</td>
<td>390</td>
<td>5/8**</td>
</tr>
<tr>
<td>Hill's Prescription Diet a/d</td>
<td>MH</td>
<td>1.2</td>
<td>9.2</td>
<td>55</td>
<td>12</td>
<td>2.5:1</td>
<td>495</td>
<td>18**</td>
</tr>
<tr>
<td>Iams Eukanuba Maximum Calorie</td>
<td>MH</td>
<td>1.95</td>
<td>7.4</td>
<td>68</td>
<td>3</td>
<td>8.3:11</td>
<td>417</td>
<td>18***</td>
</tr>
<tr>
<td>Royal Canin Recovery RS</td>
<td>MH</td>
<td>1.1</td>
<td>9.9</td>
<td>55.7</td>
<td>6.5</td>
<td>1.5:1</td>
<td>500</td>
<td>18***</td>
</tr>
</tbody>
</table>

Key: L = liquid, M = moist, MH = moist homogenized, FA = fatty acid, CHO = soluble carbohydrate, na = information not available or not applicable. *These products meet or exceed AAFCO nutrient profiles for intended species.
**5/8 French is the smallest tube size using a feeding pump/catheter-tip syringe and comfortable pressure.
***18 French is the smallest tube size using a catheter-tip syringe and comfortable pressure.

Feeding schedule is determined by the patient's ability to tolerate food and the logistics of feeding. Feeding an amount equal to the patients RER during the first 24
hours of food re-introduction, if physically tolerated, is recommended. Initially feeding one-third of the RER and then increasing the amount by one-third every 24 hours is a more cautious approach to initial feeding but isn't always necessary. Foods should be warmed to room temperature, but not higher than body temperature before feeding.

Food boluses must be infused slowly (~5 ml per minute) to allow gastric expansion. Daily food dosage should be divided into several meals according to the expected stomach capacity. Capacities for cats and dogs are 5 to 10 ml/kg body weight during initial food reintroduction. Maximum capacities as high as 45 to 90 ml/kg body weight have been measured in cats and dogs when fully re-alimented. Most often, meeting the patient's RER can be done in volumes far less than these maximums. Salivating, gulping, retching and even vomiting may occur when too much food has been infused or when the infusion rate is too fast.

Research in people has demonstrated that the stomach does not "shrink" during a prolonged fast, but rather the stretch receptors are more sensitive and stimulated by a smaller volume when refeeding occurs. Feeding should be stopped at the first sign of retching or salivating, the meal size reduced by 50% for 24 hours and then increased by 25% until the full volume is tolerated. Foods provided via J-tubes must be infused slowly and often in either very small quantities or by a slow gravity drip or enteral pump with an hourly rate equal to RER/24 hours because the jejunum is volume sensitive.

Each meal must be followed by a water flush to clear the feeding tube of food residue. If the patient is volume sensitive, it is important to know the minimum volume required to flush the tube. The patient's daily fluid requirement must also be met and additional tap water may be administered through the feeding tube to meet that requirement. Liquid oral medications may also be administered easily through feeding tubes. Plugged feeding tubes can be cleared by filling the tube with water or a nonalcoholic carbonated beverage and allowing time for the food plug to dissolve. In general, end-port tubes are easier to maintain than side-port tubes because food tends to become trapped in the blind end of side-port tubes. All tubes except orogastric and nasoesophageal tubes require standard bandage care.

In hospitalized patients record food intake / volume of food administered and body weight daily. Body condition is unlikely to change during the hospital stay. Laboratory assessments other than those routinely performed in critically ill patients are generally not necessary. Decreases in serum potassium and phosphate levels, increases in serum glucose, blood urea nitrogen and hyperlipidemia are the most common alterations associated with nutrient administration. Most parameters used to assess the nutritional status of patients (e.g., albumin and total protein concentrations, RBC count and hemoglobin content) will not change in less than two weeks.

**Pancreatitis**

Critical illnesses associated with gut barrier dysfunction included severe acute pancreatitis, inflammatory and non-inflammatory bowel disease, severe burn injury, multisystem trauma and high risk surgery. Gut barrier dysfunction can exacerbate critical illnesses by leading to bacteremia, endotoxemia, systemic inflammatory
response syndrome and multiple organ dysfunction. The nutritional management these disorders has traditionally included an initial period of starvation, ranging from 3 to 7 days. However, the most important stimulus for intestinal mucosal growth, repair, and integrity is the presence of nutrients within the gut lumen. The absence of luminal nutrients leads to marked small intestinal mucosal atrophy and suppressed crypt cell proliferation, marked reductions in gut-associated lymphoid tissue cell mass and function, increased intestinal permeability to bacteria and toxins, and enhanced pro-inflammatory cytokine generation and acute-phase responses. For pancreatitis the recommendation for starvation is based on the belief that “strict pancreatic rest” prevents stimulation of exocrine pancreatic secretion, thus protecting against autodigestion. Recently, this recommendation has come into question. Studies in dogs, rodents and man have demonstrated that exocrine pancreatic excretion is already inhibited by the inflammation associated with pancreatitis and feeding has no impact on exocrine pancreatic secretion.

Recent studies support the general goals of treating pancreatitis should be to feed early and enterally. Prolonged fasting leads to immunosuppression, decreased wound healing and increased bacterial translocation, sepsis and decreased survival. Canine patients should not be held NPO for more than 48 to 72 hours including the time they were anorectic prior to presentation. Fasting has not been shown to be beneficial in cats and may increase the risk of hepatic lipidosis. Enteral feeding improves enterocyte health and immune function. Documented benefits of maintaining a healthy gut barrier function included reduced mucosal permeability, reduced incidence of bacteremia, endotoxemia and septic morbidity, attenuation of the acute phase response and reduced incidence of multiple organ failures, reduced catabolism and preservation of a positive nitrogen balance and perhaps most importantly improved clinical outcomes. Early enteral nutrition is superior to both starvation and total parenteral nutrition in critical illnesses associated with gut barrier dysfunction.

One recent study comparing enteral and parenteral nutrition in dogs with acute pancreatitis documents a significantly greater number of vomiting or regurgitating episodes in dogs receiving parenteral nutrition (PN) versus enteral nutrition. Additionally dogs receiving enteral nutrition did not demonstrate any noticeable postprandial pain. There were more catheter-related complications in the PN group. The authors concluded early EN delivered proximal to the pylorus is well tolerated in dogs with severe pancreatitis and resulted in fewer complications than PN.

Summary

Feeding patients early prevents protein–calorie malnutrition on the cellular level, which in turn improves outcome. In critically ill patients; feeding is preferable to starving but underfeeding is preferable to overfeeding. Feeding tubes save lives and are not used as often as they should be for anorexic patients. Pancreatitis is not a contraindication for enteral feeding. Early enteral nutrition appears to improve the outcome of patients with pancreatitis.