Nutritional Management of Critically Ill Patients

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Introduction
Sick or injured animals frequently have decreased food intake and experience a negative energy balance. Carbohydrate, fat and protein can all be broken down and utilized as a source of energy. Excessive protein catabolism leads to deleterious consequences; the greater the severity of illness, the greater the degree of catabolic stress a patient experiences. Nutritional support for critically ill patients aims to diminish the catabolic state. However, it is impossible to completely eliminate the catabolic state, which is driven by stress hormones such as glucocorticoids, catecholamines, and cytokines, which are released in response to tissue injury, infectious agents, and inflammation.

Patient Nutritional Assessment
Historical findings of weight loss, decreased food intake, or persistent gastrointestinal (GI) signs, as well as physical examination findings of depleted fat stores, muscle mass wasting, or other indications of nutrient depletion can be used to classify patients as well nourished, borderline, or malnourished. This, in combination with an assessment of the patient’s current disease condition, will help direct the need for assisted feeding. Also, it is often helpful to ask “at what weight was your pet at its heaviest?” to get a sense of how much weight might have been lost and over what time period.

Which Patients Require Nutritional Support?
Clearly patients that are already malnourished at the time of presentation require nutritional support. In addition, patients that are expected to be inappetent for longer than 3 days also deserve attention. Critical illness augments the catabolic state, therefore the patient with significant clinical disease (e.g., trauma, sepsis) should be considered for early nutritional support. As a good rule of thumb, nutritional support should be considered in any animal that has had a decreased appetite or inappetance of ≥ 3 days duration. Remember to consider that this time has frequently elapsed prior to the patient presenting to the hospital. A goal should be to have a nutritional plan in place within 24 hours of hospitalization and once the patient is hemodynamically stable (after signs of shock are corrected). The idea is to start feeding early, rather than follow the “wait and see” approach.

Enteral Nutrition
In all circumstances, follow the adage “If the gut works, use it”! Enteral nutrition (i.e., feeding via the gastrointestinal (GI) tract) is the preferred route for nutritional support and maintenance of GI health. Enterocytes within the GI tract atrophy within 24-48 hours of inappetence. The lack of trophic stimulation from nutrients within the GI tract causes severe villous atrophy and reduced nutrient absorption. Additionally, there is a decrease in immune function (secretory IgA) thereby predisposing to infection. Bacterial translocation may also occur, leading to an increased risk of sepsis. Early enteral nutrition is associated with shorter hospital stays, decreased morbidity, and improved survival in
both human and veterinary patients.

**Strategies to Encourage Eating**

Offer a variety of tasty, odiferous, warmed foods including a variety of veterinary diets as well as tuna, savoury sauces, baby food (chicken, beef flavors), cooked/roasted chicken, or boiled hamburger. Suggested veterinary formulated diets with a high caloric density include Hills® A/D (1.1 kcal/mL, 183 kcal/can), Royal Canin® Recovery (1.0 kcal/mL, 184 kcal/can), or Iams® Nutritional Recovery Formula (2.1 kcal/mL, 340 kcal/can), or a liquid diet such as Clinicare® (1.0 kcal/mL). Also offer dry kibble; some dogs and cats are unfamiliar with canned food and despite an excellent selection of foods, prefer to eat familiar food! Hand feeding can encourage some pets to eat. Attention, stroking, and verbally encouraging the patient can also stimulate a willingness to eat. For nervous patients, the home environment is often the best place to get patients eating again. If the animal must remain hospitalized, encourage the owners to try hand feeding their pet when they come to visit.

**Appetite Stimulants**

Certain drugs may be used to increase the appetite and “remind” dogs and cats of the taste of food in the hopes of encouraging them to eat voluntarily. Appetite stimulants should be considered a short-term “kick-start” for patients that are likely to recover or resume their appetite in a short period. They are not ideal for the long-term inappetent patient and should not be continued if the patient does not respond initially.

**Mirtazapine** is a human anti-depressant medication that increases serotonin levels in the brain. Its beneficial side effects include anti-emetic and appetite stimulant effects. A response should be seen within 1-2 hours of oral dosing. Increasing the dosing interval to q 48 h is recommended in cats with kidney or liver disease, otherwise it is administered to dogs and cats once daily.

**Cyproheptadine** is an anti-histamine that also has appetite stimulant effects in cats. **Benzodiazepines** can also be used to stimulate appetite in cats, remembering that there is a risk of idiopathic hepatic necrosis.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
<th>Side Effects</th>
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<tbody>
<tr>
<td><strong>Diazepam</strong></td>
<td>1 - 2 mg per cat PO (q 24 h)</td>
<td>Sedation, idiosyncratic hepatic necrosis</td>
</tr>
<tr>
<td><strong>Oxazepam</strong></td>
<td>2.5 mg per cat PO (q 12 h)</td>
<td>Sedation</td>
</tr>
<tr>
<td><strong>Cyproheptadine</strong></td>
<td>2 - 4 mg per cat PO (q 12 h)</td>
<td>Occasional excitation, aggression, vomiting</td>
</tr>
<tr>
<td><strong>Mirtazapine</strong></td>
<td>1.875 - 3.75 mg per cat PO (q 24 h) * lower dose with kidney/liver disease</td>
<td>Occasional salivation, vocalization, and hyperactivity (transient effect in the first hour)</td>
</tr>
<tr>
<td></td>
<td>0.6 mg/kg PO (q 24 h) for dogs</td>
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</table>
**Force Feeding**

Some patients will swallow food voluntarily when small quantities are placed gently in the mouth or on the gums using a tongue depressor or syringe; however, oral feedings should be discontinued immediately if the patient does not swallow on its own. “Force-feeding” is not a recommended method of nutritional support due to the risk of causing food aversion or aspiration. This type of feeding should be avoided.

**Feeding Tubes**

For patients unwilling to take food orally, utilizing feeding tubes to provide nutrition is recommended. Several options for feeding tube placement are available. Some feeding tubes are placed within minutes in the clinic and enable stress-free feeding for short periods of time. Other feeding tubes are more invasive, but following placement enable long-term nutritional management that can take place at home. Most owners are accepting of feeding tubes, particularly if they allow for shorter hospital stays and a faster return to the home environment.

**Nasoesophageal (NE) and Nasogastric (NG) Tubes**

These feeding tubes can be placed in 2-3 minutes in an awake patient. They allow for rapid access to the GI tract to provide nutrition during hospitalization. A very small flexible feeding tube is passed from the nostril down to the 9th intercostal space (NE tube) or past the 13th rib (NG tube). Tube size recommendations for dogs are 5F (small dogs) and 8-10 F (large dogs) and for cats 3.5 to 5 F. Infant feeding tubes or red rubber catheters can be used. The small diameter of these tubes limits feeding to liquid diets, typically via constant rate infusions using nutrition bags and fluid pumps. Clinicare® is commonly used to provide nutrition using these tubes. NE tubes are preferred to NG tubes as they minimize opening of the lower esophageal sphincter and subsequent gastric reflux of hydrochloric acid into the esophagus. However, NG tube placement is warranted for patients with nausea and gastric distension or gastric ileus so that gastric aspiration can be performed intermittently to relieve nausea, empty the stomach, and quantify gastric residual volumes. If an NG tube is preferred, weighted tubes are often used to ensure that the tube remains in the stomach. Contraindications for NE or NG tube placement include nasal or head trauma and coagulopathies. Complications associated with these tubes include inadvertent tracheal intubation, rhinitis, and tube displacement during vomiting. If a patient vomits with an NE or NG tube in place, tube placement MUST be re-assessed with a radiograph to confirm proper position prior to re-starting feedings.

**Instructions for NE/NG-tube Placement:**

1. Tip the patient’s nose just above horizontal and instill proparacaine/alcaine ophthalmic drops (3-5 drops) in each nostril.
2. Measure the length of tubing that will need to be inserted depending on function:
   a) NG tube: Measure to 1” beyond the 13th rib.
   b) NE tube: Measure to the 7-9th intercostal space.
3. Mark the proper depth site on the tube with a permanent marker.
4. Lubricate the tube with 2% lidocaine lubricant.
5. Grasp the tube 2 cm from the tip and gently advance the tip into the nostril, directing it
into the ventral nasal meatus, below the middle turbinate. The catheter should point to the first incisor tooth on the opposite side (dogs) or the bottom of the ear on the opposite side (cats).

6. If the catheter is correctly placed in the ventral meatus, it will pass with slight resistance and a "grating" feeling as it passes under the middle turbinate. If the catheter is in the dorsal meatus, it reaches the level of the medial canthus of the eye before running into the ethmoid turbinate. If firm resistance is met, the catheter is undoubtedly in the dorsal meatus. Remove it and try again.

7. After two unsuccessful attempts, re-attempt on the opposite side. There is usually enough asymmetry between sides that you will often get it into the other side on your first attempt.

8. Pass the tubing to the level of the vertical ramus of the mandible, then tip the patient’s nose ventrally to facilitate passage of the tube up and over the epiglottis.

9. As the tube ‘tickles’ the epiglottis be prepared to rapidly pass the catheter in 1-2” during a swallow.

10. Pass the tubing to the pre-marked site. Stop at that depth and apply suction with the syringe. If it is located within the esophagus there should be little or no air/fluid removed before achieving a vacuum. If you continually aspirate air, the tube is likely to be in the trachea.

11. Open the patient’s mouth and make sure there are no signs the tube has coiled back into the pharynx.

12. If your intention is to position the tube within the esophagus, attempt to pass it further into the stomach and aspirate stomach contents as another way to confirm placement within the GI tract and to help rule out the possibility that the tube has folded back on itself. Once you obtain a positive aspirate, either return the fluid or evacuate the stomach (if indicated) and reposition the tube to its marked depth.

13. If the attempt to aspirate stomach contents is negative attempt a test injection of air while auscultating with a stethoscope behind the 13th rib on the left.
   • A difficult injection indicates that the tube has folded back on itself and is kinked.
   • If there is a loud gurgling heard, the tube is likely within the stomach.
   • If the tube terminates in the esophagus, an injection of air will produce an audible burp with distension of the cervical esophagus distal to the partial occlusion produced by your stethoscope.

14. To secure the tube, apply a ‘butterfly’ of white tape immediately where the tube exits from the nostril. Curl the exterior portion of the tubing as tightly back on the patient’s nose as possible without kinking the tube.

15. The tubing will need to be anchored either between the eyes or to a cheek, depending on tube size and facial anatomy. Do NOT let the tube rest in the patient’s field of vision!

16. If feeding is planned, aspirate one last time to confirm that a vacuum is achieved.

17. **Obtain a lateral thoracic radiograph (including the cervical region) to confirm proper tube placement.**

18. Just before feeding, inject 3 – 10 mL of water to confirm an absence of gagging or coughing. For patients that are fed intermittently, do this every time you feed.

19. If the patient shows any of the following, discontinue feeding until tube placement can be confirmed: new onset of cough, gagging, or retching; development of course crackles; resting respiratory rate increase of 6 breaths/min; behavioral change suggesting anxiety.
**Orogastric Tubes**

These tubes require placement at each feeding. A red rubber or polyvinyl chloride tube (8-24 Fr) is passed down the mouth into the stomach. This type of feeding is generally poorly accepted and carries the risk of inadvertent delivery of food into the trachea rather than the esophagus. It is however the feeding strategy of choice for birds and neonatal puppies and kittens.

**Esophagostomy (E) Tube**

This feeding tube is larger in diameter, suitable for longer term nutritional support, and enables bolus feeding of a blenderized diet. The feeding tube is passed from the mid-cervical neck on the left side, into the esophagus and down to the 9th intercostal space (proximal to the lower esophageal sphincter). Patients must be anesthetized for the placement of this tube, which generally takes approximately 10-15 minutes. E-tube recommendations for dogs are typically 16-20 F and for cats are typically 14-16 F red rubber tubes. E-tubes are inexpensive and have the advantage of enabling easy administration of oral medications. Indications for E-tubes include a need to bypass the nares or mouth (e.g., oral/nasal tumours) and the requirement for at-home nutritional support lasting weeks to months. E-tubes can be removed at any time with no concerns. Contraindications for E-tube placement include vomiting and esophageal disorders (i.e., megaesophagus, severe esophagitis). Complications associated with E-tubes include local cellulitis, infection at the insertion site, and tube displacement during vomiting.

**Instructions for E-tube Placement:**

Patients must be anesthetized and endotracheally intubated. Endotracheal tube placement is always recommended during the procedure to decrease the risk of accidental placement of the tube into the trachea. The patient is positioned in right lateral recumbency and the left cervical area is shaved from the angle of the mandible to the thoracic inlet and from midline to the wing of the atlas. A surgical preparation of the site follows. A feeding tube is selected and premeasured from the mid-cervical region to the 9th intercostal space. The jugular groove and jugular vein are clearly identified and avoided. Closed curved Carmalt forceps are inserted into the mouth and down the esophagus to the predetermined skin exit site (mid-cervical region). The curves of the forceps are pointed outward with the tips in an area dorsal to the jugular. A small (< 0.5 cm) skin incision is made parallel to the esophagus by incising with a scalpel blade over the forceps tips. This incision is made deep enough until the forceps tips are visible. A ‘nick’ is made into the cellophane-like mucosa of the esophagus so that the forceps tips can be ‘popped’ through. The tip of the lubricated tube is then firmly grasped with the forceps and is carefully drawn into the esophagus and back out the mouth. The tube is then re-directed back into the oropharynx and down the esophagus (past its entrance through the skin usually with a notable ‘flip’). The tube is passed down the esophagus to its pre-marked depth and is then secured at its exit site using a purse-string and Chinese Finger Trap suture. Following E-tube placement, a lateral radiograph should be performed to confirm correct tube placement in the esophagus past the base of the heart and proximal to the diaphragm.
**Gastrostomy (G) Tube**

This feeding tube completely bypasses the upper GI tract and inserts directly into the stomach. G-tubes can be placed: 1) surgically (during a laparotomy) (recommended in cats), 2) percutaneously (percutaneous endoscopically-placed gastrostomy [PEG] tube), or 3) blindly. Patients must be anesthetized for this procedure that requires approximately 15-30 minutes. For each of the methods, the stomach must be brought in direct apposition with the left body wall. During surgical placement, the stomach is sutured to the left body wall allowing for greater security and decreased risk of gastric leak into the peritoneal cavity. Non-surgically placed G-tubes rely on the tube itself (a bulbous end [i.e., a Pezzer Tube]) to hold the stomach wall to the body wall. Patients should not be fed for the first 12 hours following G-tube placement to allow a fibrin seal to develop around the feeding tube. A secure fibrous track requires 2 weeks to form, necessitating that G-tubes be left in place for a minimum of 14 days prior to their removal. G-tubes are generally considered for patients requiring long-term nutritional support (or water supplementation in the case of chronic kidney disease). They can be left in place for more than a year when necessary. G-tubes are also indicated for patients with esophageal disorders and intermittent vomiting. Complications associated with G-tube placement include exit site cellulitis, premature tube dislodgement, and leakage causing peritonitis (a life-threatening complication).

**Determining the Nutrition Plan**

**Calorie Requirements**

A resting energy requirement (RER) is the number of daily calories needed to maintain homeostasis. Currently, the recommended daily calories for critically ill hospitalized patients are the calculated RER. RER may be calculated using one of two formulas:

\[
RER = 70 \times BW \, (kg)^{0.75}
\]
\[
RER = (30 \times BW \, (kg)) + 70
\]

The second simplified formula is appropriate for patients weighing over 2 kg. Underweight (malnourished) patients should have their RER calculated based on their current BW; however, overweight patients should have their RER calculated based on their IDEAL BW (less than 5% of metabolic rate is due to adipose tissue). Due to their higher metabolic demands, the recommended daily calories for kittens/puppies in hospital are twice the calculated RER.

Current research suggests that over-feeding (greater than RER) critically ill hospitalized patients is more detrimental than underfeeding. Therefore, previously recommended “illness factors” are no longer used to adjust daily calorie requirements above RER. However, once hospitalized patients are recovering and becoming more active, RER will not likely suffice. Thus, patients requiring prolonged in-hospital tube feeding or going home with feeding tubes in place will require adjustments in daily calorie requirements. The daily calorie requirement for healthy patients is termed the maintenance energy requirement (MER) and is approximately 1.4 × RER for cats and 2 × RER for dogs. This is just an estimate and ultimately calorie requirements for long-term
nutritional support should be based on the patient’s physical examination and serial body weight measurements (suggesting weight gain or loss).

Selecting an Appropriate Diet

Diets should be selected based on the patient’s underlying illness and the type of feeding tube (diameter). For example, cats with kidney failure or hepatic encephalopathy (e.g., hepatic lipidosis) require a low-protein diet. Conversely, a dog with a small diameter feeding tube (e.g., nasal feeding tube) is limited to a liquid diet. An ideal diet for tube feeding is calorie dense (to achieve the RER or MER with the least amount of volume) and is easily blenderized for delivery through the tube.

<table>
<thead>
<tr>
<th>Product</th>
<th>Calorie Content (kcal/ml)</th>
<th>Protein Content</th>
<th>Calorie Content (kcal/container)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hills® A/D*</td>
<td>1.00</td>
<td>High</td>
<td>180 kcal/can</td>
</tr>
<tr>
<td>Baby food, chicken</td>
<td>0.88</td>
<td>High</td>
<td>66 kcal/jar</td>
</tr>
<tr>
<td>Eukanuba® Max-Cal</td>
<td>2.11</td>
<td>Moderate</td>
<td>340 kcal/can</td>
</tr>
<tr>
<td>Royal Canin® Recovery*</td>
<td>1.00</td>
<td>High</td>
<td>184 kcal/can</td>
</tr>
<tr>
<td>Clinicare®</td>
<td>1.00</td>
<td>High</td>
<td>237 kcal/can</td>
</tr>
<tr>
<td>Clinicare® RF</td>
<td>1.00</td>
<td>Moderate</td>
<td>237 kcal/can</td>
</tr>
</tbody>
</table>

* blenderize 1 can (156 g) with 30 mL water
** blenderize 1 can (156 g) with 60 mL water

Feeding Schedule

Once the patient’s daily calorie requirements are calculated, the amount of food given is determined by the diet’s calorie content (see above chart). If feeding PO, the amount of canned food fed per day is determined by dividing the daily calorie requirements by the calorie content per can. Otherwise, if feeding via tubes, the daily calorie content is divided by the calorie content per mL of the desired diet. Hills® A/D and Royal Canin® Recovery diets are easy to begin with because once 1 can is blended with 30 mL of water it has a calorie content of 1 kcal/mL.

Feeding should be initiated gradually. Typically, 1/3 to 1/2 of the daily calorie requirement is provided on the first day. The total amount should be divided into multiple feedings, typically 4-6 times per day initially. If the patient tolerates that feeding schedule, the amount fed can be increased to the total daily calorie requirements over 48-72 hours. The gastric volume is approximately 20 mL/kg but may be limited to 5-10 mL/kg during initial food re-introduction. Therefore, initial food volumes administered via tubes should not exceed 10 mL/kg per feeding.

Tube Feeding Instructions

1. Place the patient in a quiet, comfortable environment.
2. Slowly administer warm water (3-5 mL) through the tube to flush it.
3. The diet should be fed at room or body temperature. To warm the food, place the food container in a bowl of warm water and gently shake it every few minutes. If the microwave is used to re-heat food, apply a small amount of food to your skin to
ensuring that it has not overheated. Stir the food carefully to ensure that there are no hot spots.

4. Aspirate the tube prior to each feeding. If greater than half of the previous meal is aspirated, the feeding volume should be halved. If less than half of the previous meal is aspirated, feed the normal volume.

5. Administer the food SLOWLY (over 10-20 minutes).

6. During feeding, the patient should be comfortable – if any discomfort, drooling, licking, gagging, retching, vomiting, or regurgitation occurs, discontinue the feeding and initiate at the next scheduled feeding at a slower rate.

7. If rapid or uncomfortable breathing occur, or if there is a sudden change in breathing during the feeding, discontinue feeding immediately.

8. Food should pass with very little resistance. Food should NEVER drip from the attachment site or from the skin entry site.

9. Always flush the tube after feeding with 5-10 mL of warm water.

**Tube Maintenance**

The tube entry site and overlying bandage or t-shirt should be rechecked once daily. The tube entry site can be gently wiped with warm water and gauze if it is moist or crusted. The site should also be monitored for any foul odors, excessive redness, or discharge. The bandage or t-shirt may be changed on an as needed basis.

**Tube Complications**

Vomiting, nausea, and large gastric residual volumes are fairly common complications of tube feeding in critically ill patients. If these signs are noted, feeding may need to be discontinued for a few hours and re-started more slowly or in smaller volumes. Ensure that the diet is administered at room or body temperature. Also consider adding motility modifying drugs such as metoclopramide, cisapride, or erythromycin.

Diarrhea is also a common complication of nutritional support, especially when liquid diets are used. These diets are low in fiber and often result in soft stool or diarrhea. Consider adding Metamucil® or canned pumpkin to the diet to add bulk, or transition to a different blenderized diet if possible. Be aware that the addition of bulking agents to the diet can lead to tube obstruction.

Tube ejection is an unfortunate complication of enteral nutrition support. This can be avoided by providing medications to decrease nausea and prevent vomiting. An e-collar should also be placed to prevent the patient from pawing at the tube; however, most patients tolerate these tubes very well. Once a tube has been ejected, it must be removed and replaced.

Aspiration pneumonia is an uncommon complication and is typically avoided by ensuring proper tube placement with radiographs. Ensure that the tube is firmly secured in place and monitor the tube for migration or movement by checking that the tube exit site (marked with indelible ink) is not changing each day. If a patient vomits with a feeding tube in place, it should also be re-radiographed to ensure that the tube is still properly positioned.

Tube obstruction (blockage) is a common complication, especially when feeding blenderized tubes via smaller diameter tubes or administering medication via tubes. It is important to flush the tube with water before and after feeding or medication.
administration to clean the tube and verify normal function. Remember that tubes that are 5F and smaller in diameter should ONLY have liquid diets fed through them. If a tube blockage occurs, instill a carbonated beverage (e.g., Coca-Cola®) into the tube to break down the plug. It may need to sit in the tube for 1-4 hours but is sometimes successful in removing the obstruction.

Infection at the tube insertion site is uncommon but does occur. The tube exit site must be monitored for signs of infection including redness, swelling, and discharge. Ensure that the tube is not secured too tightly to the skin, as this will predispose to cellulitis. Also, discard refrigerated food after 3 days and do not hang liquid diets at room temperature for more than 12 hours.

Refeeding syndrome is uncommon but can occur in patients following re-institution of feeding after severe malnutrition or starvation. Refeeding syndrome usually occurs within 3-5 days of resuming feeding. Severe metabolic derangements can occur including hypokalemia, hypophosphatemia, and hypomagnesemia. Fluid shifts can also occur leading to fluid overload. Other noted complications include diarrhea, arrhythmias, and neurologic signs. Refeeding syndrome is avoided by recognizing which patients are at risk and gradually re-introducing food, even starting as low as 10% of RER initially. These patients are often good candidates for referral to a specialty hospital since they require close monitoring of glucose and electrolytes.

**Weaning Patients from Enteral Tube Feedings**

Voluntary feeding should be encouraged in patients being fed via feeding tubes, except when medically contraindicated (e.g., severe oral or esophageal disease, severe vomiting). Most patients begin to eat on their own during the recovery phase of their disease. The diet used for tube feeding can be offered for oral feeding, until the transition can be made to a regular diet suitable for the patient’s disease state. The morning and evening feedings can be delayed to offer the diet and evaluate voluntary consumption. Different diets should also be offered (see previous instructions on Assisted Feeding). Do not attempt to feed patients that are vomiting, nauseated, or appear disinterested as this may create a food aversion. Appetite stimulants are occasionally helpful to restore voluntary food intake in patients with feeding tubes in place. Feeding tubes should be maintained until evidence of recovery from the underlying disease is observed and voluntary food intake is minimally 75-100% of the RER. Body weight and condition can be monitored for a week before tube removal after voluntary food intake has resumed, to ensure continued weight maintenance or gain.

**Parenteral Nutrition**

Parenteral nutrition is nutrition that is delivered intravenously. It is rarely recommended unless severe malnutrition exists and/or attempts at enteral nutrition have been unsuccessful. Complications including electrolyte derangements and infection can occur with parenteral nutrition and a jugular (central) catheter is usually required for administration. Therefore, administration of parenteral nutrition typically necessitates referral to a specialty hospital.