Enteral Nutrition

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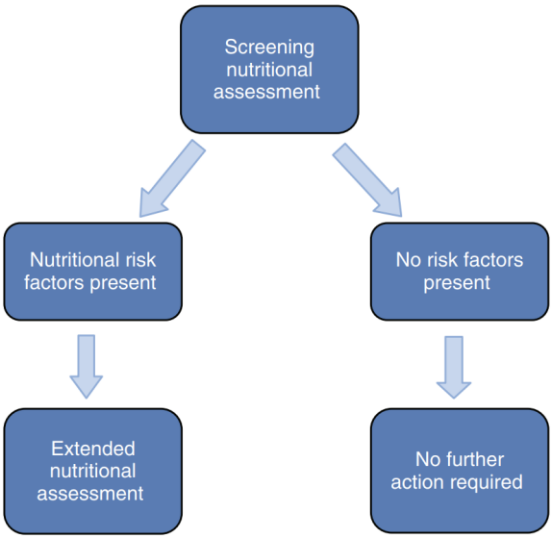
Quick nutritional screening

WSAVA Nutritional Assessment Guidelines (Freeman L, et al. WSAVA Nutritional Assessment Guidelines. J Small Anim Pract. 2011 Jul;52(7):385-96) recommends nutrition as the fifth vital assessment on top of the standard temperature, pulse, respiration and pain to optimize the health and wellbeing of pets.

Nutritional assessment requires repeated assessment over the animal's lifetime and evaluates 3 different factors: (1) animal-specific factors, (2) diet-specific factors and (3) feeding management and environmental factors.

Animal-specific factors include age, physiological status, and activity. Diet-specific factors include the safety and appropriateness of the diet for the patient. Feeding management includes the frequency, timing, location, and method of feeding. Environment factors include space and quality of the pet's surroundings.

The nutritional assessment is described as a 2 part process. It starts with a screening evaluation on every patient and only proceeds onto an extended evaluation if there are one or more nutrition-related risk factors noted in the screen.



A full discussion on nutritional assessment is not in the scope of this lecture in addition to the fact that it is not really the norm in emergency practice given time constraints. However, there is still a need to do a quick screen at a minimum at the time of admission.

The aim of a quick screen should be to

1. Identify environmental factors that may have led to the reason for presentation
    a. Dietary indiscretion

   b. Inappropriate / unconventional diet eg inappropriate diet for lactating dog, vegan diet
   c. Inappropriate housing / cleanliness
2. Identify patient factors that would contribute to development of malnutrition, contribute to development of complications with commencement of nutritional support or affect the delivery of nutritional support
   a. Primary disease process
   b. Other ongoing / previous disease processes
   c. Biochemical / Electrolyte abnormalities
   d. Obvious signs of malnutrition or significant weight loss
   e. Duration of inappetence
   f. Cardiovascular stability

This information will allow treatment of the disease process particularly if related to nutrition, allow appropriate nutrition planning and implement steps to minimise risk for complications associated with feeding.

Nutritional Plan

Information derived from the nutritional screen is used to formulate a nutritional plan.

Create a plan for hospitalized animals

a. Create a monitoring plan and a feeding plan as discussed under animal factors and diet factors (i.e., diet, route, amount, and frequency).
b. Offer usual and favorite ("comfort") foods if at all possible to promote food intake. Avoid introduction of novel foods intended for long term feeding in order to avoid the risk of inducing an aversion to the diet. A food aversion is avoidance of a food that the animal associates with an aversive experience.
c. The optimal route required to achieve nutrient requirements should be reassessed daily, and may include:
   i. Voluntary oral feeding
   ii. Coax feeding – small changes, such as warming the food, taking the animal to a quiet area for feeding, having the owner feed the animal, or stroking the animal while eating can enhance food intake.
   iii. Syringe feeding (be careful in animals with any nausea or who are stressed, as this can induce food aversions)
d. Other nutritional support techniques will be required for animals that have not eaten sufficient amounts by the aforementioned routes for 3-5 days (this includes the time of reduced appetite at home before hospitalization), and are not expected to resume reasonable amounts of food intake prior to further compromise of their nutritional status.[39,40]
   i. Use a feeding tube with animals that are not eating adequate amounts voluntarily. Use parenteral nutrition with animals that have gastrointestinal dysfunction or in animals where enteral feeding has increased risk of aspiration.
   ii. Evaluate closely and watch for complications associated with the route of nutrition used, particularly with recumbent or neurologically impaired patients.

WSAVA Nutritional Assessment Guidelines 2011

WSAVA Nutritional Assessment Guidelines 2011 provides a concise description of the steps to create a feeding plan. In general, the following are required as part of the plan:

1. When to intervene?
2. What to feed?

3. How much to feed?
4. How quickly to achieve feeding goal?
5. How often to feed?
6. How (What method) to feed?
    a. Voluntary oral feeding
    b. Coax feeding
    c. Syringe feeding
    d. Tube feeding
        i. Nasooesophageal
        ii. Nasogastric
        iii. Oesophagostomy
        iv. Gastrostomy / PEG

When to intervene?

Veterinary and human research have shown evidence that early enteral nutrient intake reduces mortality and reduces infectious complications. In gastrointestinal surgery, these benefits extend to a reduction in risk of dehiscence, risk of infection and duration of hospital stay.

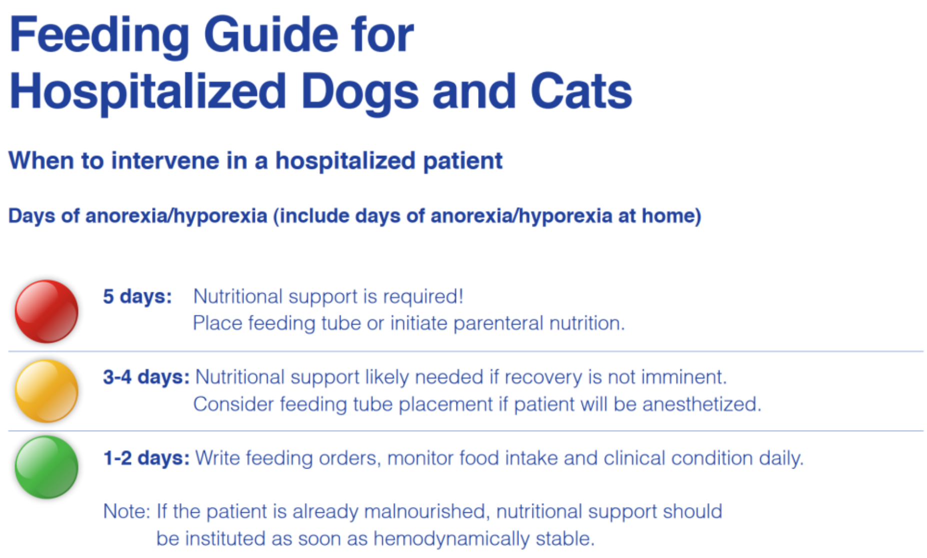
In parvovirus patients, Mohr AJ, et al. Effect of early enteral nutrition on intestinal permeability, intestinal protein loss, and outcome in dogs with severe parvoviral enteritis. J Vet Intern Med. 2003 Nov-Dec;17(6):791-8 showed that starting feeding early results in a rapid improvement in appetite, diarrhoea and resolution of vomiting.

In pancreatitis, Harris JP, et al. Retrospective evaluation of the impact of early enteral nutrition on clinical outcomes in dogs with pancreatitis: 34 cases (2010-2013). J Vet Emerg Crit Care (San Antonio). 2017 Jul;27(4):425-433 showed a decreased time to return to voluntary intake, decreased time to maximum intake, less gastrointestinal intolerance when comparing early to delayed feeding.

Liu DT, et al. Early nutritional support is associated with decreased length of hospitalization in dogs with septic peritonitis: A retrospective study of 45 cases (2000-2009). J Vet Emerg Crit Care (San Antonio). 2012 Aug;22(4):453-9 showed a reduction in length of hospitalisation in septic peritonitis patients.

Current European Society for Clinical Nutrition and Metabolism (ESPEN) 2023 guidelines (Singer P et al. ESPEN practical and partially revised guideline: Clinical nutrition in the intensive care unit. Clin Nutr. 2023 Sep;42(9):1671-1689) in humans suggest that if oral intake is not possible, early enteral nutrition (within 48hrs) in critically ill adult patients should be initiated. They recommend a delay if shock is uncontrolled and haemodynamic and tissue perfusion goals are not reached, where there is life-threatening hypoxemia, hypercapnia or acidosis, active upper gastrointestinal bleeding, overt bowel ischemia, abdominal compartment syndrome or gastric aspirate volumes greater than 500ml/6h (7.1ml/kg assuming at 70kg person).

The WSAVA recommendation is that any patient with 3-4 days of anorexia / hyporexia including days of anorexia / hyporexia at home should be provided with nutritional support especially if recovery is not imminent.



WSAVA Feeding Guide for Hospitalized Dogs and Cats

In clinical practice, food is offered as soon as practically possible as often it forms part of the assessment for suitability of discharge or clinical status. Voluntary oral feeding and coax feeding are usually attempted first failing which, other nutritional support techniques are implemented. In animals where their disease process makes it unlikely that oral intake will be likely to be successful, early feeding tube placement should be considered.

What to feed?

The question of what to feed often depends on the disease process. AAHA Nutrition and weight Management Guidelines provide a list of diseases and conditions along with nutrients of concern to assist in the decision-making process. In the ICU, we are often looking at highly digestible, low to moderate fat for gastrointestinal conditions or high energy density diets for critically ill patients.

Nutrients of Concern for Diseases and Select Specific Conditions

Disease Category	Specific Conditions		Nutrients of Concern	Notes

Adverse food reaction	Cutaneous adverse food reaction		• Limited antigen diet
			  • Novel/hydrolyzed protein
			  • Limited ingredients
				• Ingredients impact success of treatment
				• Noningredients may also impact success (e.g., additives, Maillard production reaction)

	Food intolerance			
	Food-responsive chronic enteropathy			
Inflammatory skin condition	Non-food-related skin condition		• High n-3 fatty acids • Consider n-6:n-3 ratio • High vitamin A • High vitamin E • High zinc • Added antioxidants	• Individual diseases may require different supplements and doses
Osteoarthritis			• High EPA/DHA • Added glucosamine • Added chondroitin • Added antioxidants • Low energy density if overweight/obese	• Additional supplementation may be required to achieve optimal dose • High n-3 fatty acid supplementation may result in gastrointestinal disturbance
Neurologic conditions	Cognitive dysfunction		• Added lipoic acid • Added carnitine • High EPA/DHA • Added antioxidants	• Synergistic effects of nutrients when combined.
	Idiopathic epilepsy		• High medium-chain triglycerides	
	Anxiety		• Added L-tryptophan • Added hydrolyzed casein • Added antioxidants • Modified fiber	
Cardiovascular disease	Degenerative valve disease		• Controlled sodium • High EPA/DHA • Avoid low protein	• Supplement potassium as required • Maintain optimal body and muscle condition.
	Hypertrophic cardiomyopathy			
	Dilated cardiomyopathy		• Controlled sodium • High EPA/DHA • Avoid low protein • Added taurine • Added carnitine	
Urolithiasis	Calcium oxalate		• Low oxalate ingredients • Controlled calcium with appropriate calcium to phosphorus ratio • Avoid vitamin C supplementation • Low relative supersaturation • Added water	• Many of these nutrients of concern can be incorporated into other diets but may be difficult to identify unless specifically labeled for this use • Aim for USG ≤1.020 (dogs) or ≤1.035 (cats) • Struve urolithiasis in dogs is typically infection related and special diet may not be required long term
	Struvite		• Controlled magnesium • Controlled phosphorus • Controlled protein • Target acidic urine pH • Added water	
	Urate		• Low purines • Does not necessarily mean low protein • Target alkaline urine pH • Added water	
	Cystine		• Controlled cystine • Controlled methionine • Target alkaline urine pH • Added water	
Lower urinary tract disease	Matrix-crystalline plugs		• Based on mineral content of the plug • Added water	
	Feline idiopathic cystitis		• Added antioxidants • High EPA/DHA • Added water • Low energy density if overweight/obese	
Pancreatic disease	Endocrine	Diabetes mellitus	• High soluble and insoluble fiber • Low carbohydrate (cats) • High protein (unless contraindicated, e.g., proteinuria) • Low energy density if overweight/obese	• Consistency of meal timing and insulin regimen are most important
	Exocrine	Pancreatitis	• Low fat (dogs) • Limited antigen (cats)	• Dietary fat recommendations may depend on baseline intake and degree of hyperlipidemia
		Exocrine pancreatic insufficiency	• Achieve optimal body condition	• In most cases no specific diet is needed with appropriate enzyme supplementation • Assess serum cobalamin and supplement if indicated • In cases with persistent soft stool, additional fiber supplementation may be warranted

Continued.

Disease Category	Specific Conditions		Nutrients of Concern	Notes
Gastrointestinal	Acute vomiting, diarrhea		• Highly digestible • Low to moderate fat	• Difficult to identify digestibility unless specifically labeled for this use
	Chronic enteropathy		• Limited antigen diet • Novel/hydrolyzed protein • ± modified fiber • ± low fat	• Assess serum cobalamin and folate and supplement if indicated
	Intestinal dysbiosis		• Modified fiber	• Assess serum cobalamin and supplement if indicated
	Protein-losing enteropathy		• Low fat • ± limited antigen	
	Fiber-responsive colitis Large bowel diarrhea		• Moderate to high fiber • Mixed fiber types	• Fiber can be separately supplemented
	Constipation		• Moderate to high fiber • Mixed fiber types • Low energy density if overweight/obese • Increased water	• Investigate underlying causes (e.g., hypercalcemia, hypokalemia, obesity)
	Obstipation		• Highly digestible • Low energy density if overweight/obese	• Difficult to identify digestibility unless specifically labeled for this use • Caution with high-fiber weight loss diets
Other endocrine	Hyperlipidemia		• Low fat	• Consider EPA/DHA supplementation
	Feline idiopathic hypercalcemia		• Controlled calcium • Avoid excess vitamin D • Avoid excess vitamin A • ± increased fiber	
	Hyperthyroid		• Low iodine	• Impossible to achieve necessary level of iodine restriction without specific formulation and production procedures • Specific nutritional modification not required if hyperthyroidism is managed by other means
Liver disease	Encephalopathic		• Low protein • ± B12 supplementation	• Avoid organ meats • Consider vegetarian protein sources
	Nonencephalopathic	Portosystemic shunt Microvascular dysplasia Chronic hepatitis	• Moderate protein	
	Copper-associated hepatopathy		• Low copper • Added zinc	• Only specifically designed low-copper diets are below AAFCO minimums
Kidney	Protein-losing nephropathy		• 25–50% protein reduction from current intake • Meet essential amino acid requirements • High EPA/DHA • Low phosphorus if azotemic	• Protein recommendations will depend upon the degree of proteinuria • Many medications used to address proteinuria and hypertension may exacerbate hyperkalemia, and reducing dietary potassium intake may help
	Acute kidney injury		• Moderate protein	• Consider as a critical care disease category when hypercatabolic
	Chronic kidney disease		• Low phosphorus • ± potassium supplementation • High EPA/DHA • Increased energy density to maintain body and muscle condition (unless obese)	• Many medications used to address proteinuria and hypertension may exacerbate hyperkalemia, and reducing dietary potassium intake may help • Consider vitamin D supplementation
Obesity			• High protein • Moderate to high fiber • Low energy density • Increased nutrient to calorie ratio • Moderate to low fat	• Restriction below RER is not recommended with over-the-counter products

Dental disease			• Mechanical action or masking flavor for
			  • Plaque or tartar reduction and/or prevention
			  • Control of bad breath odor
				• Mechanical brushing and dental prophylaxis are most effective

Critical care			• Highly digestible • Increased energy density • High fat • Added antioxidants • Texture more amenable to tube feeding slurry use	• Difficult to identify digestibility unless specifically labeled for this use

AAFCO, Association of American Feed Control Officials; DHA, docosahexaenoic acid; EPA, eicosapentaenoic acid; RER, resting energy requirement; USG, urine specific gravity.

Avoid raw in hospital

The appropriateness of feeding raw food to pets as the mainstay of their diet is not within the scope of this lecture. The American Animal Hospital Association in their 2021 AAHA Nutrition and weight Management Guidelines state that they do "not advocate or endorse feeding pets any raw or dehydrated nonsterilized foods, including treats that are of animal origin". Whilst in hospital however, I would strongly discourage the feeding of a raw diet.

Feeding a raw diet increases the risk of bacterial and protozoal pathogen transmission to the pets consuming the diet as well as to people and other animals. Owners often have this notion that raw meat-based diets pose no health risk because animals are resistant to such infections or that our domesticated pets are descended from wolves or African Wildcats. While it is true that there may be a reduced risk, pets are by no means immune to systemic infections due to enteric bacteria like Salmonella, Campylobacter or Clostridia. Furthermore, eating a raw diet may pose a risk to others. Several studies have documented the presence of pathogens in raw diets for pets and in the feces of dogs and cats eating the raw diets.

Finley R, et al. The risk of salmonellae shedding by dogs fed Salmonella-contaminated commercial raw food diets. Can Vet J. 2007 Jan;48(1):69-75 showed that dogs fed Salmonella contaminated food shed Salmonella for many days without gastrointestinal signs.

Groat EF, et al. UK dogs eating raw meat diets have higher risk of Salmonella and antimicrobial-resistant Escherichia coli faecal carriage. J Small Anim Pract. 2022 Jun;63(6):435-441 showed that antimicrobial-resistant, multi-drug resistant and third-generation cephalosporin resistant E coli were more likely to be detected in raw few dogs.

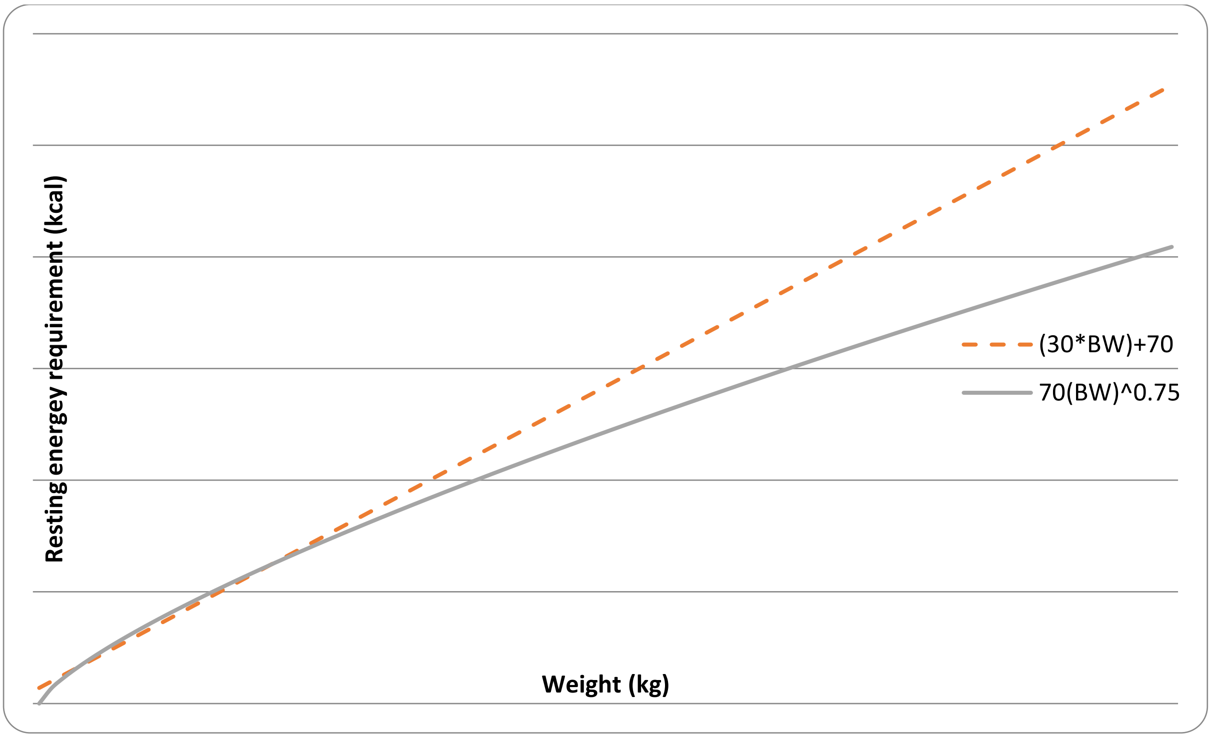
Schmidt VM, et al. Antimicrobial resistance risk factors and characterisation of faecal E. coli isolated from healthy Labrador retrievers in the United Kingdom. Prev Vet Med. 2015 Apr 1;119(1-2):31-40 evaluating faecal samples obtained from Labradors at dog shows noted that the consumption of raw meat was significantly associated with isolation of E coli with amoxiclav and 3rd generation cephalosporin resistance.

Whilst there is no scientific literature to inform us of the risk raw meat fed patients pose to other patients, we need to be cognizant of the fact that there is an increased risk of shedding and potential for contaminating their environment with multi-drug resistant bacteria especially if they are being treated with antimicrobials in hospital.

We are however, not really in a position to discriminate against these patients at the point of admission and without evidence to suggest that they pose a high risk to other patients and isolating them. As such, it would be most sensible to simply ban feeding raw meat diets in hospital and suggest a cooked diet whilst the patient is recovering at home. Consideration can also be given to barrier nursing protocols (e.g., disposable protective clothing, gloves), ensuring staff that come in contact with such patients adhere to good hygiene practice and thoroughly disinfect areas where the patient has resided especially if contaminated with faeces.

How much to feed?

Start by calculating the caloric requirements of the patient. The resting energy requirement (RER) is the number of calories required for maintaining homeostasis while the animal is at rest. The RER is calculated using the following formula RER = 70 x (body weight in kg)0.75 derived by Kleiber and Brody, is a best fitting line of regression of a log plot of the resting energy expenditure of a range of species. A linear equation: (30xBW)+70 can be used to estimate requirements of animals weighing between 3 and 25kg. Outside of this range, the linear equation will overestimate requirements.



An illness factor was traditionally applied to the RER in order to hyperaliment the patient in response to the catabolic state associated with critical illness. Current recommendations are to use more conservative energy estimates to avoid overfeeding, therefore, illness factors are usually not applied when formulating feeding plans of critically ill patients.

The feeding of excessive calories to critical patients may result in metabolic and gastrointestinal complications, electrolyte disturbances, hyperglycemia, increased carbon dioxide production and hepatic dysfunction.

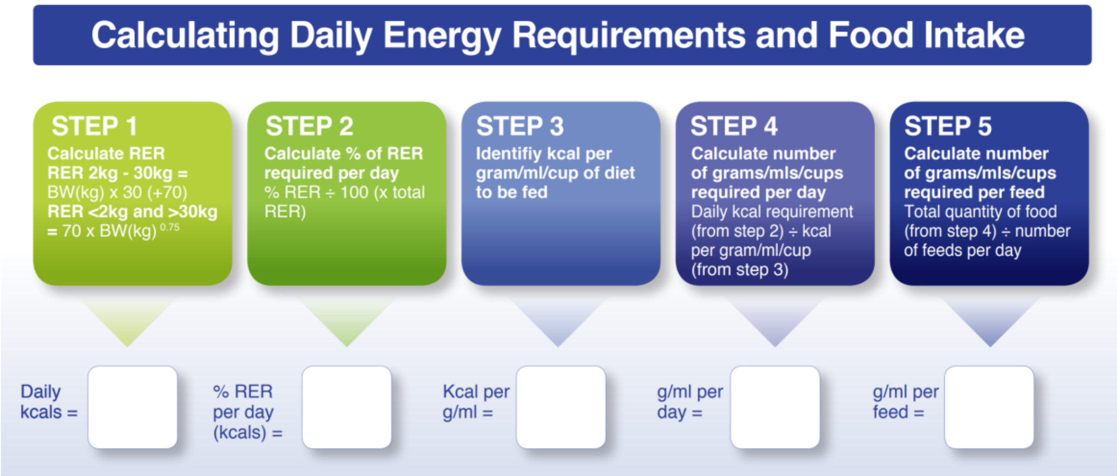
O'Toole E, et al. Comparison of the standard predictive equation for calculation of resting energy expenditure with indirect calorimetry in hospitalized and healthy dogs. J Am Vet Med Assoc. 2004 Jul 1;225(1):58-64 reported that resting energy expenditure in dogs with trauma or major surgery calculated from the predictive equation 70 x $(BW)^{0.75}$ x illness factor showed variation from -82.4% to + 45.8% compared to measured results. The predictive equation only agreed to within ± 20% of the measured results in 51% to 57% of the dogs. Mean values of measured versus predicted energy expenditure for healthy dogs with illness factor of 1 were not significantly different therefore the predictive equation is suitable for estimation of energy expenditure for healthy dogs. However, energy expenditure was overestimated in traumatised and postoperative groups. Despite an increase in resting energy expenditure in dogs with a medical illness or traumatised dogs, the increase was not profound.

Walton RS, et al. Energy expenditure in 104 postoperative and traumatically injured dogs with indirect calorimetry. J Vet Emerg Crit Care 1998;6:71–79 did not find any significant difference in resting energy expenditure between post-operative and traumatically injured dogs and normal controls. These findings coupled with the complications associated with overfeeding have prompted a paradigm shift towards the use of more conservative energy estimates ie the use of the RER.

Interestingly enough, Brunetto MA, et al. Effects of nutritional support on hospital outcome in dogs and cats. J Vet Emerg Crit Care (San Antonio). 2010 Apr 1;20(2):224-31 in a retrospective study on the effect of nutritional support on hospital outcome, did not find any difference in outcome when comparing patients fed at 61-126% RER or greater than 126% RER. This may be due to the size of the study, patients being fed at greater than 100% RER in the 61-126% RER group influencing the results of the group, or more simply, biased data such that patients who had intakes greater than RER were more likely to be voluntarily eating implying less severe disease and therefore more likely to be discharged.

As the predictive equation is based on lean muscle mass, obese patients require adjustments to their calculations. Assuming 25% of excess weight is lean tissue, RER should be calculated using ideal weight plus 25% of excess weight or simply just using ideal weight. In underweight patients, current weight should be used for calculating RER with the aim of maintaining body weight. When feeding over the medium to long term, animals receiving nutritional support should be closely monitored for changes in body weight or body condition which should prompt reassessment and modification of the nutritional plan.

Once the RER has been calculated, the physical amount of food required can then be calculated by dividing the RER by the caloric density of the food. This amount is then divided by the number of feeds per day.



WSAVA Feeding Instructions and Monitoring Chart for Hospitalized Patients

How quickly to achieve goal?

Given the apparent benefit from early enteral nutrition, the logical question to follow would then be how quickly patients should attain RER.

The term microenteral nutrition was proposed in 1992 by Crowe to define the delivery of small amounts of water, electrolytes and readily absorbed nutrients to the gastrointestinal tract. The goals of microenteral nutrition included preservation of gastrointestinal blood flow and protection against atrophy. Recommended solutions included commercial isotonic, balanced, oral rehydrating solutions containing glucose or a formulated solution containing water, glucose (5-25%) and ¼ strength lactated Ringer's solution. Additional constituents to consider included a 3% amino acid solution and 20-40mmol/l potassium chloride. Recommended feeding rates were 0.05-0.2ml/kg/hr as a constant rate infusion or 0.1-0.4ml/kg every 2 hours. The volume was recommended to be increased by 0.2ml/kg every 8-12hours if the patient was able to tolerate the solution. This was changed to a commercial liquid diet after 8-12hours if low gastric residuals and a low frequency of vomiting continued. Used in this manner, microenteral nutrition provided a bridge to enteral nutrition.

Microenteral nutrition itself has fallen out of fashion given the easier option of proceeding directly to a percentage of full requirement on the first day of feeding. In addition, there may be some evidence that trophic feeding where a small volume of balanced enteral nutrition, insufficient for the patient's nutritional needs, may still have positive gastrointestinal or systemic benefit. Owens L, et al. Minimal enteral feeding induces maturation of intestinal motor function but not mucosal growth in neonatal dogs. J Nutr. 2002 Sep;132(9):2717-22 showed that at least 30% of daily nutritional needs was required to stimulate small intestinal mucosal growth.

Whilst the goal is to eventually attain RER, it is not uncommon for patients to be fed a significantly smaller amount at the start and gradually work to RER over 2-4 days. Patients usually start at ¼ RER on day one and the amount is gradually increased until the patient is at full RER. This gradual increase allows the monitoring of patient tolerance including identification of potential developing complications like refeeding syndrome. It also reduces the potential for overfeeding to occur when combined with endogenous energy production.

How often to feed?

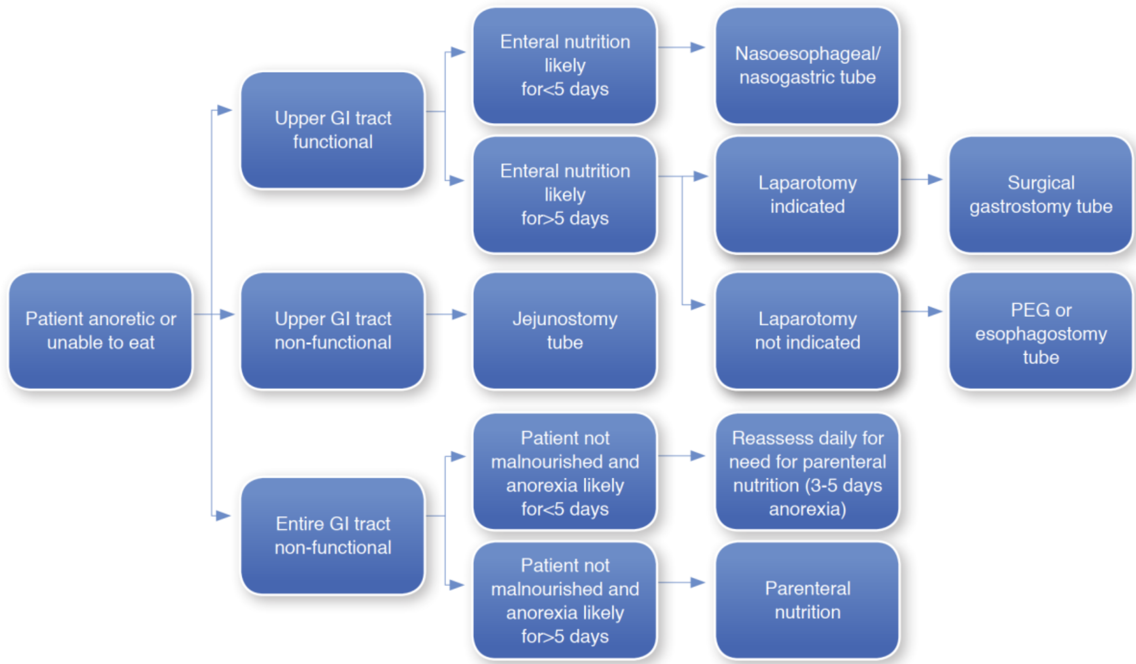
The frequency of feeding is largely determined by patient factors and food volume. If the patient is not able to tolerate the volume of food being fed, the prescribed amount of food is then divided into smaller amounts and fed more frequently. The stomach capacity of cats and dogs is approximately 5-10ml/kg but can increase to 45-90ml/kg. Assuming the use of a 1kcal/ml diet, a 20kg patient will usually require 662ml which approximates 33ml/kg. If fed as a bolus every 6 hours, this reduces each feed to approximately 8ml/kg. It is not uncommon that critically ill patients may not be able to tolerate being fed even smaller amounts with ileus commonly contributing to excessive gastric residual volumes.

What method of feeding?

Voluntary oral feeding and coax feeding are usually attempted first. Strategies to improve success include heating food, removing E collars, having owners visit to trial feed, changing the environment eg putting them in a quiet room away from the treatment areas of the hospital, increasing the distance between litter boxes and the food or changing the food container to a plate or to a different material. Medical management of symptoms like nausea or ileus should also be instituted with the use of antiemetics and pro-kinetics. Appetite stimulants can also be considered but are generally indicated only for short term appetite support while diagnostic results are pending, appetite support in diagnosed chronic illness or when inappetence is due to behavioural food aversion. Use prior to diagnosis is discouraged due to the potential for return of appetite to delay diagnosis of the underlying disease process.

Failing conservative methods or upon identifying the likelihood that the patient's disease process would result in the likelihood of prolonged hyporexia, feeding tubes should be promptly placed. The

WSAVA Feeding Guide for Hospitalised Dogs and Cats provides decision making tree to assist with the most appropriate route.



WSAVA Feeding Guide for Hospitalized Dogs and Cats

In clinical practice, naso-oesophageal, nasogastric and oesophagostomy tubes are the most commonly utilised methods with nasogastric being the most commonly used method at WAVES.

Naso-oesophageal / Nasogastric tube placement

Naso-oesophageal and nasogastric feeding tubes are noninvasive tubes which are easily placed without the requirement for general anaesthesia. Lidocaine is instilled into the nostril followed by insertion of a feeding tube down the nose directed in a ventral and medial direction. Pushing the nostrils upwards during placement assists in guiding the tube into the ventral nasal meatus by allowing a more ventral direction of advancement. Once close to the pharyngeal region, the head should be flexed downwards to reduce the likelihood of passage of the tube into the trachea during advancement. The tube is advanced to the predetermined level followed by removal of the stylet if this had been utilised.

Placement of a nasogastric tube is similar to that of a naso-oesophageal tube apart from the location of the distal end of the tube. The naso-oesophageal insertion distance should be measured from the nostril to the 7th – 8th intercostal space and the nasogastric tube from the nostril to the caudal margin of the last rib. Human studies examining reflux associated with nasogastric tubes have reported variable findings however there is an increase in reflux associated with increased intraabdominal pressure. The benefit of nasogastric intubation is the ability to quantify residual gastric volume thus allowing an assessment of gastric emptying however Holahan M, et al. Intermittent and continuous enteral nutrition in critically ill dogs: a prospective randomized trial. J

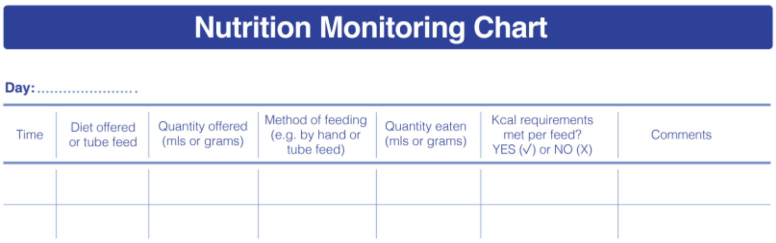
Vet Intern Med. 2010 May-Jun;24(3):520-6 showed that gastric residual volumes were not correlated with the incidence of vomiting or regurgitation in critically ill dogs.

Radiographic examination extending from the pharynx to the stomach is ideal to confirm the location of the tube. Other reported methods include withdrawal of gastric contents to suggest gastric placement, negative pressure when suctioning on the tube, measurement of end tidal carbon dioxide concentrations or instillation of air through the tube and auscultating for borborygmus.

Monitoring

Monitoring of nutritional intake

Monitoring of the patient's nutritional intake should be undertaken to ensure that patients are receiving the desired amount of calories and able to tolerate the volumes of food being fed. Harris JP, et al. Retrospective evaluation of the impact of early enteral nutrition on clinical outcomes in dogs with pancreatitis: 34 cases (2010-2013). J Vet Emerg Crit Care (San Antonio). 2017 Jul;27(4):425-433 reported that only between 33-37% of patients consumed greater than 33-66% of their resting energy requirements. Molina J, et al. Evaluation of the Prevalence and Risk Factors for Undernutrition in Hospitalized Dogs. Front Vet Sci. 2018 Aug 29;5:205 identified that 84.0% of dogs consumed less than 25% of their energy requirements and only 3.4% of the dogs met these requirements.



Nutrition Monitoring Chart

Day:......................

Time	Diet offered or tube feed	Quantity offered (mls or grams)	Method of feeding (e.g. by hand or tube feed)	Quantity eaten (mls or grams)	Kcal requirements met per feed? YES (√) or NO (X)	Comments

WSAVA Feeding Instructions and Monitoring Chart for Hospitalized Patients

Refeeding syndrome

Refeeding syndrome describes the metabolic abnormalities that occur following reinstitution of nutrition in patients who are severely malnourished. These may include hyperglycaemia, hypoglycaemia, hypophosphataemia, hypokalemia, hypomagnesaemia, hyponatraemia and hypocalcaemia.

During starvation, the body utilises fat and protein in place of carbohydrate to produce glucose and energy. Upon refeeding, in particular with carbohydrate, the body reverts to carbohydrate metabolism (anabolic response). Insulin secretion increases in response leading to increased cellular uptake of glucose and an increase in demand for phosphorylated intermediates of glycolysis. Cellular growth and repletion of phosphate stores further contribute to the increase in demand which coupled with decreased total body stores, results in hypophosphatemia.

Hypokalemia and hypomagnesemia also develop as a result of intracellular shifting as part of the anabolic response. Insulin resistance may also be present leading to hyperglycaemia and hyperinsulinemia. The antinatriuretic effect (reduced sodium clearance) from hyperinsulinemia may result in hypernatremia and subsequent fluid retention and expansion of the extracellular fluid volume.

Hypophosphatemia may lead to haemolysis of red blood cells, impaired white cell function, shortened platelet life span, myopathy (impaired diaphragm contractility, respiratory failure) and neurological abnormalities including seizures. Hypokalemia may result in skeletal muscle weakness, respiratory failure from respiratory muscle and diaphragmatic failure, rhabomyolysis, cardiac arrhythmias and sudden death. Hypomagnesemia may also result in signs similar to those of hypophosphatemia and hypokalemia.

Thiamine deficiency can occur as part of refeeding syndrome leading to neurological signs of ataxia, vestibular dysfunction, and visual disturbances. Thiamine is an essential nutrient in dogs and cats because of their inability to synthesise sufficient amounts and because only small amounts are stored in the body. Cats require 2-4 times more thiamine per day than dogs. In humans, thiamine has a half-life of 10 to 14 days as such deficiency can rapidly develop. Thiamine deficiency in humans is reported to be as high as 20% in ICU patients and 10–70% in septic patients.

Thiamine is the precursor for thiamine pyrophosphate (TPP) which is essential for optimal glucose utilization and metabolism. TPP is an essential co-factor for the enzyme pyruvate dehydrogenase which facilitates the conversion of pyruvate to acetyl CoA. In the absence of TPP, pyruvate is instead converted to lactate. Consequently, blood lactate may be elevated in thiamine deficiency.

In thiamine deficiency, the conversion of pyruvate to acetyl coenzyme-A (CoA) is blocked and the accumulating pyruvate is subsequently converted to lactate. This results in an overproduction of lactate and hyperlactatemia may develop.

Refeeding syndrome typically manifests within the first few days of initiation of feeding. Means of prevention may include 1. Identification of at-risk patients, 2. ensuring correction of fluid and electrolyte balances prior to commencing nutritional support, 3. starting at a low percentage of resting energy requirements and gradually increasing over a period of time and 4. empirical supplementation of phosphorus, potassium, magnesium and thiamine in at-risk patients.

Monitoring for tube complications

Common feeding tubes complications include tube occlusion and localized irritation at the tube exit site. A severe cellulitis or abscessation can develop at the exit site although is uncommon. Tube dislodgement can present a minor complication simply necessitating replacement or more serious complications include peritonitis from dislodgement of a gastrotomy tube prior to the minimum of 10 days required for stoma site formation. Nasogastric / oesophageal tubes also have the potential to be regurgitated and aspirated leading to malposition of the tube in the airways.