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Review: Nutritional care of Acute and Chronic Diarrhoea as well of Parvovirus infected dogs

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1. Introduction

Nutritional care is very important for the management of gastrointestinal diseases in both cats and dogs where diarrhoea is present, as there is a change in frequency, consistency or volume of bowel movements and stools. History taking of the patient, together with a thorough physical examination and in certain cases, diagnostic tests, is very important to assess if the cause of diarrhoea is coming from the small or the large intestine and if it is acute or chronic.

Dietary therapy could be used alone in certain cases without the need of adding drug therapy. Malnutrition can result as a consequence of an inadequate or unbalanced diet or, if necessary precautions or considerations are not taken during a treatment. Considerations that should be done include: the toxins produced, the allergens, the toxic dietary excess or the nutritional deficiencies in cases such as acute and chronic diarrhoea (Chandler 2002). All of these have an effect on the physiology and the motility of the intestines, the cell renewal rate, the bacterial flora, the enzyme and ammonia production, and the volatile fatty acid content (Chandler 2002).

According to Freeman and Parker (2012), if not enough calories so as to meet with the energy requirements are taken, amino acids are mobilised from the lean body mass so as to compensate. Protein is an inefficient caloric source as it provides 4kcal/g, whilst fat on the other hand provides 9kcal/g. This means that the patient would lose its' body mass, whilst making metabolic changes and losing critical functional tissue. Fat would then start to being used instead. However by this time, malnutrition could have already manifested.

Studies have shed the light on the fact that malnutrition can result in a lower immunocompetence, decreased tissue repair of the intestines and its' mucosa, and also, an alteration on the drug metabolism (Yam&Cave 2003).

In case of a parvovirus infection in puppies, nutritional care is the key point in helping the patients to survive this deadly disease. Therefore, a good feeding plan by changing the type of food to take into consideration the nutrient profile is a very important management aspect in the treatment of such cases. Drug therapy would have less positive results if discarding the nutritional support out of the treatment equation.

2. Aim

My main aim of this thesis, is to break down the food's composition in detail, with regards to first acute diarrhoea, then secondly to chronic diarrhoea and last of all, parvovirus infection. As these cases offer different problematic factors which should be tackled individually, their nutritional care is somewhat different from one another. In each case, the provided nutritional care is more specific.

I will also tackle the methods of feeding with the main nutritional factors to all three cases. The goal of nutritional support is to provide energy and nutrients in proportions that can have maximum beneficial results.

A few reading materials were found which helped me understand better what the body needs when encountering these diseases. I will review them, together with asking the opinions of veterinary professionals on their experience when dealing with acute and chronic diarrhoea as well as parvovirus disease in puppies.

With these findings, I hope that unnecessary antibiotics are opted out of first line medication routine when veterinarians are dealing with such cases. A more nutritional support systemic is beneficial. In addition, long-term dietary management has the ability to repair the damaged intestinal lining, restoring normal populations of intestinal microflora, promoting normal gastrointestinal motility and function, supporting immune function, and reducing gastrointestinal inflammation (Case et al 2011:455).

One of the major complaints coming from dog and cat owners when they seek veterinarian advice is that their pet has been experiencing diarrhoea. Therefore, if the use of antibiotics is decreased when they meet with cases like these, it will be beneficial for not only the animal itself, but to the owners and to the veterinarian as well. One should keep in mind that both owners, and most of all, veterinarians and also other health care professionals, deal with different diseases in their lives. Using unlimited antibiotics can change our own antibiotic-resistance, which will be harmful not only to us if a serious disease is encountered, but also to our future generation. Also some medications would not act in their full effect if malnutrition is present due to lack of nutritional support.

Keeping this in mind, there is no treatment in case of parvovirus disease and the only way to help the dog fight this virus, is by supporting it through nutritional care and symptomatic treatment. My aim is also to provide the best information to veterinarians to help fight this deadly disease.

3. Literature review

3.1. Summary on the physiology of the gastrointestinal tract as described by German and Zentek (2006)

The major site of digestion and absorption of nutrients in the gastrointestinal tract of both cats and dogs is the small intestine. The villi and the microvilli aid in providing a larger surface area, meaning that there will be a higher rate of absorption. The brush border which is found on the enterocytes in the luminal surface, provide the most important enzymes which are specific for digestion. There are carrier proteins which aid in the transport of monosaccharides, amino acids and electrolytes.

Proteins: Proteins are digested first in the stomach with the aid of the enzyme pepsin. Protein digestion is stopped as the food pass through the duodenum. However, it starts again in the small intestine once the pancreatic enzymes and the microvillar membrane (MVM) enzymes are secreted. The end result is peptides and amino acids, which are absorbed by specific carriers in the MVM.

Fats/Lipids: Fats are emulsified in the small intestine, and thanks to the interaction produced when encountering the bile acids, micelles are formed. They are then digested by the pancreatic enzymes lipase, phospholipase and cholesterol esterase. The end result is triglycerides which are subsequently digested into monoglycerides and free fatty acids. Bile results are absorbed back in the ileum and transported to the liver.

Carbohydrates: Carbohydrates start being digested in the mouth and continue in the intestines. Starch is broken down to maltose by pancreatic amylase. It later continues being digested, together with lactose and sucrose by MVM enzymes to monosaccharides which are then absorbed by specific transporters or by facilitated transport system.

Minerals: Minerals are absorbed mainly in the small intestine. However, the large intestine may still help in the absorption process. Macrominerals together with trace elements have a very important role in transportation. Calcium absorption is regulated by a homeostatic mechanism which includes vitamin D, parathyroid hormone and calcitonin. However, dogs have a passive process which can affect a small portion of the active calcium absorption. Phosphorous has also a very similar absorption mechanism. There is no homeostatic regulation for magnesium. The small intestine is the site where absorption of sodium, potassium and chloride ions are absorbed. Zinc, iron and manganese are absorbed by

regulatory mechanisms, whilst manganese and copper by the active transport system. Passive diffusion can also be observed in other important elements.

Vitamins are divided into lipid-soluble vitamins and water-soluble vitamins. Vitamins A, D, E and K are lipid-soluble vitamins and are therefore dissolved in mixed micelles. They are passively absorbed through the MVM. Vitamin B, together with other water-soluble vitamins are absorbed through passive diffusion, facilitated transport or active transport.

3.2. Acute diarrhoea

Acute diarrhoea is one of the most common diseases in both cats and dogs, where its cause could be due to several infectious, toxic or dietary interactions. It is frequently a self-limiting problem and does not need a combination of nutritional and medical support like in chronic diarrhoea, except in viral or bacterial infections, or gastrointestinal obstructions. A general physical examination, together with a thorough history assessment, should be carefully evaluated. One of the most common causes of acute diarrhoea is due to a problem in the diet. This could be due to a change from a moist high-fat or meat-based food, or raw food or a number of factors including infectious, toxic or parasitic causes.

It is very important for the veterinarian to make a physical examination of the dog or cat, and also, to take the history as the answer to the cause may lie in that. For example, the pet may have played with a stick, or eaten a dead bird which may cause a *Salmonella spp* infection.

One should also check if the owner is giving regular anthelmintic treatment as it may result in diarrhoea.

3.2.1. Water

All sources together with all veterinarians whom I spoke with, agree that water is one of the most important nutrients in patients with acute diarrhoea. It is one of the four macronutrients including also protein, carbohydrates and fat. Water makes up 60% of the animal's body. It reduces the chance of dehydration due to fluid loss without consecutive replacement. If dehydration is observed where it is more moderate to severe, parenteral fluid therapy is suggested, rather than the oral route. The reason for this is that it should be corrected as soon as possible. On the other hand, oral fluid therapy is suggested to patients which have minor fluid losses.

Oral fluids, together with electrolytes are substantially enough in moderate cases of acute enteritis. Parenteral fluid therapy is given intravenously. However, intra-osseous route of

administration can also be done if it is difficult to insert a catheter in the vein and subcutaneously is not adequate enough.

Oral fluid therapy consists of water mixed together with glucose, amino acids (glycine, glutamine, or peptides) and electrolytes. The physiologic basis for these solutions is the coupled transport of sodium and glucose, and other actively transported small organic molecules (Hand et al 2000:754). The maximum uptake of water and electrolytes occurs when the ratio of carbohydrate to sodium is close to 1:1, shown in table 1, which is adapted from Hand and others (2000).

Canned foods have more than 70% water, semimoist food contain between 20 to 40% water, whilst dry food contains less than 10% water. In healthy animals, water is regulated by the kidneys. The fluid requirement in small dogs is 60mL/kg/day whilst in bigger dogs, it is 40mL/kg/day and the maintenance needs have been based on the caloric needs.

All veterinarians whom I spoke with recommend semimoist food as a nutritional support. This is because it contains carbohydrates, amino acids, and electrolytes needed like for example sodium and potassium. In some instances it was reported that semi-moist food could result in causing more diarrhoea until further improvement.

Table 1: A number of commercial oral rehydration solutions for the use in dogs and cats (Hand et al 2000:755):

Products (manufacturers)	Na	K	Cl	Mg	Ca	P	Citrate	ME (kcal/l)	Comments
Electramine (Vitae Inc.)	69.8	15.4	69.7	-	-	-	-	-	Contains glycine
Pedigree/Whiskas Electrolyte Instant Fluid (Waitham)	40	20	40	-	0	0	9	197	Contains glycine, maltodextrins
Pedialyte Solution (Ross Laboratories)	45	20	35	-	-	-	30	3	-
Resol Solution (Wyeth-Ayerst)	50	20	50	4	4	5	34	2.5	-
Biolyte (Pharmacia/Upjohn)	134	22.8	75.8	6.6	-	-	-	-	-

3.2.2. Minerals

The loss of gastric and intestinal secretions can result in systemic electrolyte imbalance (Hand et al 2000:754). Vomiting and diarrhoea in both cats and dogs may result in low, normal or high serum sodium, potassium and chloride concentrations (Hand et al 2000:754). The state of the animal depends on the severity of the disease. Serum electrolyte concentrations are helpful in tailoring the fluid therapy and nutritional management of these patients (Hand et al 2000:754). Mild hypokalaemia, hypochloraemia and either hypernatraemia or hyponatraemia are the electrolyte abnormalities most commonly associated with acute vomiting and diarrhoea (Hand et al 2000:754). The decrease of the potassium level in the body is a result of severe and chronic gastrointestinal diseases where there is a loss in potassium which is not compensated by the intake of food. For this reason, electrolyte disorders should be corrected by parenteral fluid and electrolyte therapy (Hand et al 2000:755). According to Hand and others (2000), the recommended levels of sodium, chloride and potassium nutrients, are 0.35 to 0.50% DM, 0.50 to 1.3% DM, and 0.80% to 1.1% DM respectively as shown in Table 2.

Burns and Wortinger (2015), also suggests to administer 0.3 to 0.5% DM sodium, 0.5 to 1.3% DM chloride and 0.8 to 1.1% of DM potassium.

All veterinarians whom I spoke with could not stress enough about the fact that a responsible clinician should always think beforehand about the consequences of diarrhoea. One should immediately give oral rehydration with the needed nutrients and mineral and if the patient is in a severe condition, intravenous infusion should be administered.

Table 2: Important nutritional factors for dogs and cats with acute enteritis expressed on a DM basis (Hand et al 2000:754):

Factors	Recommended levels
Chloride	0.50 to 1.3%
Crude Fibre	0.5 to 15%
Digestibility	≥87% for protein and ≥90% for fat and soluble carbohydrate
Energy Density	3.f to 4.0 kcal/g
Fat	12 to 15% for dogs 15 to 22% for cats
Potassium	0.80 to 1.1%

Protein	Suitable for life stage
Sodium	0.35 to 0.50%

3.2.3. Fat

According to Hand and others (2000), food given to patients with acute enteritis, and also other related gastrointestinal diseases, should contain moderate amount of fat. This is because fat is a concentrated source of calories, and if it is given in a high level, smaller portions of food can be ingested to meet with the patient's DER (Distributed Energy Source) (Hand et al 2000:755). This is also agreed by Case and others (2011).

The recommended dietary fat levels according to Hand and others (2000), are 12 to 15% on a dry matter basis (DMB) for dogs and 15 to 22% DMB for cats. Case and others (2011) also agrees with Hand and others (2000) as it is recommended to give approximately 11% to 15% or less total fat. However this is for both dogs and cats. Carciofi and Brunetto (2009) state, that the best amount of fat for dogs is 15% DM, whilst in cats it is 25% DM fat. In severe cases, it can go as low as 6% in dogs.

Simpson and Wills (1994) suggest giving high amounts of fat as the triglyceride provides the main energy source for catabolic patients.

According to Fascetti, Delaney and Elliott (2006), highly digestible commercial foods which are not fat-restricted can provide up to 30% of calories from the fat. Cottage cheese or skinless chicken, mixed with rice are often recommended as they are palatable to the cat and dog, but great alternative to a high-fat commercial food.

Most veterinarians suggest administering highly digestible fat. All agree that this is because it can allow us to give smaller amounts of food with the result of containing the amount of diarrhoea. It was also stressed that the type of fat is very important due to the fact that it could result in more diarrhoea, rather than stopping it. As Fascetti, Delaney and Elliott (2006) have mentioned, highly digestible commercial foods which are not fat restricted, can provide up to 30% calories. Dogs and cats need that amount of calories to avoid malnutrition, meaning that moderate amount of fat can avoid hypokalaemia and hyponatraemia.

3.2.4 Energy

Most veterinary clinical nutritionists, believe that the energy requirement of patients, should be close to their resting energy requirement (RER) which is calculated using a specific equation: RER = 70 x (body weight in kg)^0.75 = kilocalories/day (Remillard et al

2001). Fascetti, Delaney and Elliott (2006) state that this equation serves as a starting point to the dietary need of the patient to stabilize the weight and maintenance.

The macronutrients that provide energy are fat, carbohydrate and protein.

According to Hand and others (2000), energy density of the food should be moderate (3.5 to 4.0 kcal/g [14.6 to 16.7kJ/g] DM) so that to ensure the intake of enough energy with small amount of ingested food. Foods that have a higher energy density can help to restore or maintain body weight and condition in patients with acute enteritis. However, higher dietary fat levels are needed (Hand et al 2000:755).

The volume and type of liquid used to lower the viscosity of a canned food must be carefully selected and it is important to find a balance between slurry energy density and viscosity (Fascetti&Delaney&Elliott 2006:4630). On the other hand, a high level of dietary fat which are not highly digestible, should be avoided due to the fact that it delays gastric emptying (Hand et al 2000:755).

Oil is beneficial as it provides the greatest amount of energy. However, it also provides the greatest dilution effect on the nutrients resulting in a decrease in essential nutrients. On the other hand, corn or maple syrup can also be used in dogs in order to increase the energy density of the slurry, while still decreasing the diet's viscosity (Fascetti&Delaney&Elliott 2006:463). It is important to know that if one increases the canned diet to a moisture level of 80%, it can create a slurry blenderised that is both relatively energy dense (diet dependent) and also easily administered (Fascetti&Delaney&Elliott 2006:463).

3.2.5. Fibre

Dietary fibre primarily affects the large intestine in both dogs and cats. However, it can also affect the gastric, small intestinal and pancreatic structure and function (Hand et al 2000:755). There are a number of beneficial reasons, which are: modifying gastric emptying, normalizing intestinal motility and intestinal transport rate, buffering toxins in the gastrointestinal lumen, binding or holding excess water, supporting growth of normal gastrointestinal microflora, buffering gastric acid and altering viscosity of the gastrointestinal luminal contents (Hand et al 2000:755). It is very important as it has a role in the change of bacterial populations found in the gastrointestinal tract.

According to Hand and others (2000), dietary fibre can also add to the non-digestible bulk and it lowers the dry matter digestibility of the food. There are a number of dietary fibre types for patients with acute enteritis. Hand and others (2000) recommends very low fibre

foods (<1% DM crude fibre) to increase the dry matter digestibility and provide 'low residue' in the gastrointestinal tract. This is also agreed by Case and others (2011). According with Carciofi and Brunetto (2009) crude fibre should not exceed more than 3% DM.

In fact, the type of dietary fibre which is included in the dogs and cats diet is important. This is because there are various bacteria in the intestines which ferment fibre producing different amounts and types of by-products. Cellulose, gum karaya and xanthan gum are nearly non-fermentable in the intestines of dogs and cats, whilst pectin and guargum are fermented easily. Beet pulp and rice bran are moderately fermented (Case et al 2011). The end products of fibre fermentation are primarily acetic, butyric and propionic acids. This is also agreed by Simpson and Wills (1994). These are great energy sources for the colonocytes as they derive more than 70% of their energy requirement from them (Case et al 2011).

According to Carciofi and Brunetto (2009), foods that contain gel-forming soluble fibres should be avoided in patients which are vomiting and/or diarrhoea. This is because these type of fibres have the ability to increase the viscosity of ingesta and slowing gastric emptying. These fibres include pectins and gums (example gum arabic, guar gum, carrageenan, psyllium gum, xanthan gum, carob gum, gum ghatti and gum tragacanth).

Tables 3 and 4 show Commercial and Prescription dog diets, whilst Tables 5 and 6 show Commercial and Prescription cat diets. All have will be divided into dry and semi-moist diets. They all show the difference of crude fibre content in % dry matter (DM) between them, and also protein and fat content as well.

Table 3: Commercial dog food diets expressed in % DM:

	Protein	**Fat**	**Crude fibre**	**Fibre source(s)**
Dry canine products				
Royal Canin Urban Life Adult	19.0	13.0	4.1	Beet pulp, Pea fibre, Psyllium seed husk
Eukanuba Lifestage Formulas Adult Maintenance	25.0	16.0	5.0	Beet pulp
Semi-moist canine products				
Royal Canin Urban Life adult	6.5	4.5	1.6	Cellulose, Beet pulp
Eukanuba canned nutrition Hearty stew with beef and vegetables in gravy	9.5	6.5	1.2	Beet pulp

Table 4: Prescription dog food diets expressed in % DM:

	Protein	**Fat**	**Crude Fibre**	**Fibre source(s)**
Dry canine products				
Hill's Prescription Diet Canine i/d	27.0	14.8	1.4	Soya fibre
Eukanuba Intesinal diet	25.8	14.8	2.4	Maize grit, Beet pulp
Royal Canin Gastrointestinal high energy diet	20.0	8.5	3.6	Cellulose, Beet pulp
Semi-moist canine products				
Hill's Prescription Diet i/d	25.8	14.8	2.4	Soya fibre
Eukanuba	8.0	4.5	0.5	Maize grits, Beet

Intestinal Diet				pulp
Royal Canin Gastrointestinal	6.0	2.5	2.5	Cellulose, Beet pulp

Table 5: Commercial cat food diets expressed in % DM:

	Protein	**Fat**	**Crude Fibre**	**Fibre source(s)**
Dry feline products				
Royal Canin Indoor adult dry food	27.0	11.0	15.0	Beet pulp, Psyllium seed pulp
Eukanuba Dry Adult cat for sterilized cat	33.0	12.7	1.7	Maize grits, Beet pulp
Moist feline products				
Royal Canin Adult cat Instinctive food	11.0	1.4	2.0	Cellulose
Whiskas Chicken dinner in gravy	8.0	3.0	1.0	-

Table 6: Prescription cat food expressed in % DM:

	Protein	**Fat**	**Crude Fibre**	**Fibre soure(s)**
Dry feline products				
Hill's Prescription Diet Feline i/d	37.0	20.8	0.8	Soy fibre
Eukanuba Gastrointestinal cat	33.0	13.0	1.90	Maize, Maize grits, Beet pulp
Royal Canin feline Gastrointestinal diet	8.0	5.0	1.5	Cellulose
Semi-moist feline products				
Hill's Prescription Diet Feline i/d	40.6	24.7	1.08	Soy fibre
Eukanuba Gastrointestinal cat	10.0	4.0	0.5	Maize grits, Beet pulp
Royal Canin feline Gastrointestinal	29.0	13.0	4.7	Psyllium seed husk, Maize grits,

diet				Beet pulp

3.2.6. Digestibility

The average digestibility coefficients for popular commercial dog and cat foods are 78 to 81%, 77 to 85% and 69 to 79% for crude protein, crude fat and nitrogen-free extract (NFE, carbohydrate), respectively according to Hand and others (2000).

According to Burns and Wortinger (2015), the protein requirement should not be more than 30% for dogs and 40% of cats with regards to proteins.

According to Simpson and Wills (1994), experimental studies that are done on 15-25kg dogs, have shown that the energy requirement is 80kcal/kg/day. The minimum maintenance protein requirement for normal dogs is 6-7% kcal as determined by nitrogen balance experiments (Simpson&Wills 1994:45). 20 to 48% kcal are needed in case of hospitalised patients according to Simpson and Wills (1994).

Commercial veterinary therapeutic foods which target patients with gastrointestinal diseases usually contain meat and carbohydrate sources which are highly refined to increase their digestibility (Hand et al 2000:755). This could be seen in table 4. The meat source which is used in these therapeutic foods, are usually muscle and organ sources rather than bone meals, egg, cottage cheese, chicken and ground beef which are typically used in commercial diets (Hand et al 2000:755).

Carbohydrates make up the largest non-water fraction (60-80% DM) of commercial and homemade foods which are directed to patients with gastrointestinal diseases according to Hand and others (2000). Dogs digest most properly cooked starches, which also include corn, rice, barley and wheat (Hand et al 2000:755). Other starches like potato and tapioca, are less digestible, particularly if they are not cooked well (Hand et al 2000:755).

According to Case and others (2011), gluten-free carbohydrates in diets formulated for intestinal disease is very beneficial. Potato and tapioca starches are less digestible than rice. However, corn is contraindicated by Case and others (2011) in dogs which are hypersensitive to this particular ingredient. Wheat, oats and barley contain grain.

On the other hand, according to Hand and others (2000), cats which are carnivorous in nature efficiently digest carbohydrates. However, some veterinarians think that cats with small intestinal disorders are less tolerant to dietary carbohydrate than dogs and more

tolerant to increased fat which have similar causes of malassimilation (Hand et al 2000:755).

According to Lewis and others (1994), there are differences in the digestibility of carbohydrates, like all other nutrients. This is because there it is greatly magnified if there is any impairment in the ability to utilize these nutrients. In one particular study, it was shown that there was nearly a six-times greater difference in digestibily (15% greater versus 89% greater) between a highly-digestible diet (Prescription Diet i/d Hill's) and a regular commercial dog food (Purina Dog Chow, Ralston Purina) when fed to a healthy dog, compared to a dog with pancreatic exocrine insufficiency (Lewis et al 1994:7-41). Therefore, this would show that rice has a greater digestibility than corn or wheat and this would be magnified in a patient with impairment in carbohydrate digestion or absorption (Lewis et al 1994:7-41). This shows that commercial diets have the ability to increase diarrhoea and so should be avoided in case of enteritis (Lewis et al 1994:7-41).

Recent studies have shown that there is also a link between the particle size and the carbohydrate digestibility in moist foods (Hand et al 2000:755). These studies show that carbohydrate ingredients like rice and corn should be chopped or grinded before they are added into moist foods (Hand et al 2000:755). However, this is not the case when using extruded dry products due to the extrusion process which allows for a more complete cook than the canning process (Hand et al 2000:755). Other studies have also shown almost complete ileal carbohydrate digestibility in healthy dogs which consume extruded grains et al 2000:756).

Dietary fat is more digestible than soluble carbohydrates and protein. In fact, the digestibility of fat in average commercial dog food is approximately 90% (Hand et al 2000:756). On the other hand, in cats, it is 74 to 91% (Hand et al 2000:756).

3.2.7. Glutamine

Glutamine amino acid is an essential nutrient for pets which have severe gastrointestinal disorders. A healthy animal does not require it. It is the preferred energy substrate for enterocytes as glutamine is necessary for maintaining the gut mucosal integrity (Hand et al 2000:756).

According to Chandler (2002), supplementation in catabolic patients, result in an improved structural integrity, function and repair of the intestinal mucosa, decreases bacterial translocation and improves nitrogen balance. Commercial food should contain meat which

provides the required glutamine. According to Hand and others (2000), glutamine intake can be increased by orally administering a 2% solution of glutamine in water; 0.5g of glutamine per kg body weight should be provided daily. Solutions could be administered by syringe or by indwelling feeding tubes. These could also be used in treating dogs which are infected with parvovirus (Hand et al 2000:756).

According to Simpson and Wills (1994), glutamine is present as a percentage of 4 to 10% of the amino acids which are found normally in petfoods and protein based enteral formulae.

If administered enterally, amino acids can have a protein-sparing effect. Studies have shown the potential benefit of enterally administered glutamine, based on the whole-body leucine kinetics (Humbert et al 2002). A constant rate of infusion of an enteral product given below the patient's RER, with the concurrent parenteral administration of the remaining caloric requirement, may be of importance in reducing the occurrence of villous atrophy and bacterial translocation (Qin et al 2002).

3.2.8. Assess the food and feeding method

One should consider the feeding frequency, the amount of food and how the food should be given, if there is other food around and the person who is feeding the animal. One should also check the body score condition of the cat or dog (3/5) and the amount of food that was given prior the diarrhoea, to check the energy supply and if everything was as it should be.

First and foremost, when handling a case of acute enteritis, one should tackle dehydration and electrolyte imbalance, together with glucose and acid-base imbalances. This is important to provide the required nutrients and therefore normalizing the intestinal motility and function which has just been disturbed. Medications can include antibiotics, non-steroidal anti-inflammatory agents (example flunixinmeglumine), anti-endotoxin sera and anthelmintics (Hand et al 2000:756).

According to Hand and others (2000), when having a case of acute enteritis, the first move is to feed a highly digestible, low-residue food with moderate levels of fat (12 to 15% DMB for dogs, 15 to 22% DMB for cats) and lactose-free diet, like for example Diet i/d, Hill's (Hand et al 2000:756). ≤5% of mixed fibre can be included. A highly digestible diet with a major source of carbohydrate, results in a greater amount of the diet to being digested and absorbed in the upper small intestine. This means, that it would be beneficial to the animal which cannot process and absorb the nutrients due to a disease (Lewis et al

1994:7-41). It is very important to keep in mind that puppies and kittens have their own special nutritional requirements, which should be catered in these diets. Feeding puppies which are recovering from parvoviral enteritis a monomeric liquid food containing maltodextrins and glutamine, reduces nausea and vomiting, and subsequently eases the transition to feeding other commercial veterinary therapeutic foods (Hand et al 2000:756).

According to German and Zentek (2006), there are two types of dietary management. It is suggested to stop all oral intake of food and water so that the patient is fasted for 24 to 48 hours. It is important so that the gut of patients having acute enteritis can rest. If the patient is vomiting and is showing signs of dehydration, it is preferred to give oral fluids. However, if the fluids lost are in high amounts and the patient is vomiting excessively, parenteral fluids should be administered. If no vomiting is observed, oral glucose-electrolyte rehydration solutions can be given. Also in this case, if dehydration is observed, parenteral fluids should be given. It should also be administered if the patient is unresponsive, or is not interested in drinking. Eventually, water can be offered and later also low-fat meals in small amounts and frequently. It is suggested by German and Zentek (2006) to begin with one-third the amount needed to meet the normal caloric needs and gradually increase to the amount needed to maintain body weight over the next several days. If neither diarrhoea, nor vomiting is observed, then the amount of food can be increased. Food should be immediately stopped if diarrhoeal episodes come back. The best suggested home-made meal is one part boiled rice, and one part boiled lean meat like for example chicken or turkey. Milk products should be completely avoided according to German and Zentek (2006) due to their lactose concentration which can make the diarrhoea worse. Yoghurt contains lactose in similar amounts to milk which is 11g per 250ml, while cottage cheese contains much less lactose which is 6g per 250ml and therefore, it is a better choice for dogs with intestinal disorders (Chandler 2002). The second approach according to German and Zentek (2006), is that the owner keeps feeding the pet normally. This approach would reduce the morbidity in a parvovirus infected puppy. However, it is not very practical to treat the pet this way if they are vomiting or having diarrhoea in high amounts. It would cause a problem where there would be an easier passage of the dietary antigens, with the result of developing hypersensitivity to the proteins used in enteral diets. It is therefore suggested to use a protein source which is not normally used in the daily diet (German&Zentek 2006:112).

The suggested diet for dogs which have gastrointestinal disorders is as follows. It provides approximately 400kcal and is adapted from Guilford (1996):

- 225 g cooked white rice
- 125 g cottage cheese, tofu, cooked chicken meat without skin, or cooked lamb (higher in fat)
- 1 to 2 tablespoon(s) of fibre or bran for patients with colonic disease (omit if diet is being used for elimination diet)
- 0.75 teaspoon of potassium salt or 'light' salt, as used in cardiac patients
- Multivitamin supplementation; may need additional injection of vitamin B_{12}

The suggested diet for cats which have gastrointestinal disorders is as follows. It provides approximately 400kcal and is adapted from Guilford (1996):

- 100 g rice cereal powder cooked in chicken broth or soup
- 100 g cooked chicken meat without skin, or cooked lamb (higher in fat)
- 1 teaspoon of vegetable oil
- If needed, 1 teaspoon of cooked liver, fish or tuna oil to increase palatability and calories (if not being used as an elimination diet)
- 0.5 teaspoon of potassium salt or 'light' salt, as used for cardiac patients
- Multivitamin and mineral supplement; may need additional injections of B_{12}andB_1

Lewis and others (1994) agree with the above. It is suggested that most carbohydrate source is from rice or Prescription Diet d/d, Hill's.

Battersby and Harvey (2006) also agree that the patient should be faster ar at least 24 hours with a gradual introduction of food frequently and in small amounts of a bland diet consisting of chicken and rice. Antibiotics should only be used if a bacterial infection is suspected.

Shojai (2001) suggests a percentage of 50% of rice and a percentage of 50% of boiled skinless boneless chicken breast. There should be low amount of fat, no salt and a tablespoon of chicken broth for flavouring. Plain yoghurt or cottage cheese can be used, but one should be aware of lactose intolerance. In very rare cases, there were adult dogs and cats which were not able to maintain the needed amount of blood sugar concentration when they were fasted. If lethargy and weakness are observed, one should rub a sugar solution like karo syrup or honey on the gums immediately (Shajai 2001).

Lobetti (2010) suggests a bland diet which is also given in small amounts and frequently for 3 to 5 days. For home-made cooked diets, Lobetti (2010) also adds white fish instead of chicken and as others suggested, low-fat cottage cheese with boiled rice. Cats can benefit

from a diet with a high fat content as they have a lower tolerance to dietary fat (Lobetti 2010). Lobetti (2010) also agreed on feeding novel proteins during this recovery period.

In case of a puppy fighting parvoviral enteritis, nutritional care is more complicated as the patient develops gastro-paresis. The puppy may in fact need prokinetic drugs in order to help with the feeding process. Intravenous metroclopramide (at a rate of 1.0 mg/kg body weight/day) is recommended (Hand et al 2000:757).

The prognosis in case of acute enteritis is good. An important aspect that should be noted on a daily basis is the body weight as it not only gives a sign on the loss or gain of the body tissue, but also of the hydration status. Most importantly, parasitic causes should be tackled before anything else, to eliminate any doubt.

According to Lobetti (2010), bismuth subsalicylate, kaolin-pectin, montmorillonite which is a refined form of kaolin, activated charcoal and magnesium, and aluminium and barium products should be administered in case of acute diarrhoea. This is done to bind bacteria and their toxins and also to protect the intestinal mucosa. They also have the ability to bind water and may be anti-secretory. If there is no improvement in the health status, they should not be given more than 3 days.

Carciofi and Brunetto (2009) state that in an ideal elimination diet. The veterinarian should avoid giving too much protein, where the ideal balance would be 16 to 26% in dogs and 30 to 40% in cats, use highly digestible protein (≥87%) and have a small number of novel protein.

3.3. Chronic enteritis

Chronic enteritis is characterised by inflammatory infiltrates within the lamina propria of the gastrointestinal tract (Hand et al 2000:758) and results in an increase in the frequency, fluidity or volume of the faeces. Nutritional support should work together with medical treatment in chronic enteritis. Here, there is a persistence of diarrhoea for 3 to 4 weeks or a relapsing of diarrhoea every so often. There could be a number of reasons which could cause it, which are parasites including protozoa, inflammatory bowel disease, pancreatic disorders (exocrine pancreatic insufficiency, chronic pancreatitis or pancreatic neoplasia), metabolic disorders hyperthyroidism, liver failure, cholestasis, uraemia or renal failure), alimentary lymphoma or food allergies which could result in 30 of cases. Inflammatory bowel disease is considered to be the most common cause of chronic diarrhoea in dogs and cats (Hand et al 2000:757). The condition varies from mild to life-threatening protein losing enteropathies (Hand et al 2000:758). It does not seem to be related to age or gender,

although it has been noted that there is a genetic predisposition in certain dog breeds, like for example German shepherds and Chinese Shar-Pei.

Diarrhoea together with vomiting and weight loss, are the most common clinical signs in dogs and cats when it comes to inflammatory bowel disease. When the stomach and the proximal duodenum are affected, vomiting tends to happen. On the other hand, when the small intestine is involved, loose stools are observed. When there are lesions in the colons, tenesmus, mucous and small scanty stools is seen (Hand et al 2000:755).

It is very important to note the frequency and the consistency of the vomit and stools as food could be observed or only fluid or froth. Vomiting is a very typical sign in cats which can be associated with hairballs, meaning there is irritation in the stomach. Black vomit indicates gastric ulceration. In the case of diarrhoea, the observation of the colour is also very important as it might indicate bleeding in the intestines coming from the small or the large intestines. This could be seen in table 7.

History taking and physical examination are very important as they might indicate peripheral lymphadenopathy in cats with eosinophilic gastroenteritis, thickened loops from intestinal intussusceptions, foreign bodies, histoplasmosis and neoplastic lesions, and also gastroduodenal ulceration (Hand et al 2000:758). Haemorrhages or phyoproteinemia may be observed in very severe cases (Hand et al 2000:759).

It is very important to diagnose if the diarrhoea is due to small intestinal, large intestinal or diffuse disease, so that a rational therapy could be administered.

Table 7: Differentiation of small intestinal diarrhoea from large intestinal diarrhoea (Hand et al 2000:755):

	Clinical signs	**Small intestinal diarrhoea**	**Large intestinal diarrhoea**
Faeces	Volume	Markedly increased	Normal or decreased
	Mucous	Rarely present	Common
	Melena	May be present	Absent
	Hematochezia	Absent except in acute hemorrhagic diarrhoea	Fairly common
	Steatorrhea	Present with malabsorption	Absent
	Undigested food	May be present	Absent
	Colour	Colour variations occur, example, creamy brown, green, orange, clay	Colour variations rare; may be hemorrhagic
Defecation	Urgency	Absent except in acute or very severe disease	Usually but not invariably present
	Tenesmus	Absent	Frequent but not invariably present
	Frequency	2 to 3 times normal for a patient	Usually greater with distal colonic or rectal disease
	Dyschezia	Absent	Present with distal colonic or rectal disease

Anchillary signs	Weight loss	May occur in malabsorption	Rare except in severe colitis and diffuse tumors
	Vomiting	May be present in inflammatory diseases	Uncommon- Probably occurs in ~30% of dogs with colitis
	Flatulence and borborygmi	May occur	Absent
	Halitosis in the absence of the oral cavity disease	May be present with malabsorption	Absent unless perianal licking

3.3.1. Water

Just like in acute enteritis, all veterinarians agree that water administration is of utmost importance in case of chronic enteritis. Dehydration is a frequent occurrence as a result of chronic enteritis due to fluid losses from vomiting and/or diarrhoea. It is therefore important to sustain fluid intake orally. In severe cases, parenteral fluid administration is given.

3.2.2. Minerals

Frequently, kypokalaemia can develop in cases of chronic enteritis. Due to this, Hand and others (2000), state that foods containing 0.85% to 1.1% DM potassium are preferred for dogs and cats as seen in table 8. It is very important to note that at first. Potassium levels should be restored with intravenous potassium supplementation (Hand et al 2000:758). This is also supported by Battersby and Harvey (200*) where microenteral nutrition of water, electrolytes and readily absorbed nutrients (glucose, amino acids and small peptides), are important in supporting the animal. If naso-oesophageal tube is used, the initial volume should be 0.05 to 0.2 ml/kg/hour, which is gradually increased to 1 to 2 ml/kg/hour in 24 to 28 hours.

According to German and Zentek (2006), some sources of minerals can have traces of protein. Unfortunately if the patient is having food allergies and needs a novel protein, it could provoke adverse reactions. This could also happen in vitamin supplementation due to some vitamins being encapsulated by gelatin which is derived from beef or pork. This can also happen due to home-made diets or commercial diets. It is therefore important to prepare home-made diets and or choose commercial/prescription diets which are based on the minimum of the previous dietary ingredients, keeping in mind not to develop any nutritional deficiencies by having a balanced diet.

Table 8: Important nutritional factors for dogs and cats with chronic enteritis expressed on a dry matter basis (Hand et al 2000:755):

Factors	Recommended levels
Crude fibre	0.5 to 15%
Digestibility	≥87% for protein and ≥90% for fat and soluble carbohydrate
Energy density	3.5 to 4.0 kcal/g 14.6 to 16. kJ/g
Fat	12 to 15% for dogs 15 to 22% for cats
Potassium	0.85 to 1.1%
Protein	Limit dietary protein to one or two sources Use protein sources to which animal has not been exposed previously 16 to 20% for dogs 30 to 45% for cats

3.3.3. Energy and Fat

Fat is a major caloric source. According to Hand and others (2000), energy-dense foods are preferred for managing patients with chronic enteritis. This is because it gives the veterinarians the chance to give smaller amounts of food to minimise the gastrointestinal tract to stretch and secrete less, due to the fact that the food contains enough calories. The only downside is that these types of food can contain higher amounts of fat, which may result in osmotic diarrhoea and protein loss. It is therefore recommended to provide food with moderate energy density (3.5 to 4kcal/g [14.6 to 16.7 kJ/g] DM) and fat levels (12 to 15% DMB for dogs and 15 to 22% DMN for cats) (Hand et al 2000:760).

This is also advised by Hall (2002). According to Hall (2002), studies suggest that adding medium chain triglyceride oils as a supplementation, does not have any benefits, and therefore should be avoided.

According to German and Zentek (2006), energy intake could be adjusted according to the patient's need. If malnutrition is observed, increasing the density of certain nutrients can be helpful. This includes fat. However, fat can also result in the worsening of enteritis. Therefore, it is important to evaluate the patient's situation. According to German and

Zentek (2006), in many chronic intestinal diseases, a high level of fat which is 20% of crude fat in dry food which also supplies more than 40% of calories, is tolerated quite well by dogs.

All vets whom I spoke with agreed with using a low fat diet in both dogs and cats due to malabsorption. Low fat diet can decrease the secretory diarrhoea. It is important to use mainly medium chain triglycerides since they are hydrolysed better than the long chain triglycerides in fat.

In the case of Lymphangiectasia, limiting fat intake of less that 10% DM for dogs and less than 15% for cats can result in decrease of lymph flow which minimises lymphatic distension and decreases protein loss. Unfortunately, this means less calorie intake. Medium chain triglycerides are therefore needed.

3.3.4. Protein

Diarrhoea can result in loss of proteins in dogs and cats. According to Hand and others (2000), high biologic value having highly-digestible (≥87%) protein sources should be used to compensate for the loss. Some veterinarians recommend the use of hypoallergenic food or elimination foods. According to Hand and others (2000), ideal elimination foods should avoid protein excess, have high protein digestibility (≥87%) and contain a limited number of novel protein sources to which the animal has never been exposed.

All vets whom I spoke with recommend a good quality of highly digestible proteins. Otherwise it can result in secondary consequences. Novel protein should be used in trial therapy when the patient is thought of having food sensitivities. This should be fed for a period of 3 weeks. Novel proteins could come from lamb, rabbit, venison, salmon or duck. Unfortunately, it is impossible to exclude all the proteins which were used before.

Hydrolysed protein sources which are treated enzymatically to alter their structure, have become available according to German and Zentek (2006). Since they have a small size, they are less likely to interact with the immune system. It is very beneficial in patients with food allergies. Dossin and others (200) say that hydrolysed diets can offer an alternative to patients in which novel protein diets are not working as they are highly digestible and can be used in different gastrointestinal disorders.

Hall (2012) states, that there are several studies which are showing positive results with using hydrolysed protein diets.

In lymphangiectasia, more than 25% DM protein in dog and in cats more than 35% DM protein is recommended, together with low fat diet or novel proteins.

3.3.5. Fibre

Soluble or mixed fibre is beneficial in chronic enteritis. According to Hand and others (2000), short-chain fatty acid and butyrate enemas induce clinical improvement in people with ulcerative colitis. According to Hand (2000), a number of substrates like for example beet pulp, soy fibre, insulin and fructo-oligosaccharides, produce volatile fatty acids when fermented in case of chronic enteritis in the distal small intestine and colon. 1 to 5% DM of crude fibre is recommended in commercial diets (Hand et al 2000:761).

According to Cook and Purcell (2010), high-fibre diets are very good for cats. This is because insoluble fibres add to the amount of faecal bulk, increase intestinal motility and also bind non-absorbed fluid in the intestinal lumen. Contrary to insoluble fibres, soluble fibres decrease the faecal bulk, whilst binding the non-absorbed fluid into gels and also increasing the number of beneficial bacteria. The soluble fibres are then fermented by the bacteria which end up in short-chain fatty acids which as mentioned already, are the preferred energy source of colonocytes.

Leib (2008) also agrees with the above as highly digestible fibre is very recommended. Leib (2008) says that soluble fibre like for example 2 tablespoons per day of psyllium hydrophilic mucilloid (Metamucil), mixed together with a highly digestible diet (i/d Hill's) in dogs, has given positive results in approximately 80% of patients with chronic enteritis. Leib (2008) did a study to determine how a dog would react to fibre supplementation. In some dogs, it was reduced or completely removed, and in others, it was changed to a grocery brand of food after the dog is healthy again.

According to German and Zentek (2006), it is recommended to start by administering low fibre diet of less than 3% crude fibre. It can be increased if it is necessary by adding small amounts of cellulose, carrots, beet pulp or psyllim.

3.3.6. Digestibility

Feeding highly digestible (dry matter digestibility ≥90%) foods is also very beneficial in cases of chronic enteritis in cats and dogs according to Hand and others (2000). This is because they are more readily absorbed in the proximal gut. Ideal food would be free of lactose. This is to avoid lactose intolerance (Hand et al 2000:761).

Monomeric feedings provide energy and nitrogen in a readily available, non-antigenic form (Hand et al 2000:761). Hand and others (2000), state that monomeric liquid foods can also supply glutamine. Bowel rest may worsen the gastrointestinal mucosal lesions, as the mucosal epithelial cells will be deprived of nutrients such as glutamine and short-chain fatty acids.

Cook and Purcell (2010) also agreed with giving a highly-digestible protein source, which has a single protein source. Therefore, there should be neither additives nor flavourings. Cook and Purcell (2010) also mention that the protein digestibility should be more than 87% whilst also saying that the carbohydrate digestibility should be bigger than 90%.

Zoran (2011) too agrees that the digestibility of protein should be bigger than 87%, whilst that of carbohydrates is bigger than 90%.

All this is also confirmed by German and Zentek (2006). It was also discussed that high digestibility can provide a better absorption whilst reducing the potential load of antigenic material.

In cases where dietary sensitivity or allergy is suspected, antigen-limited hypoallergenic diet is recommended by German and Zentek (2006) and also other veterinarians. The diet can consist of either a highly digestible meat like chicken and fish, or other highly digestible meat which is not normally used in commercial diets like for example rabbit or lamb, making it a novel protein. Otherwise, a hydrolysed protein diet can be used.

In cases where there is an intestinal bacterial overgrowth, highly digestible carbohydrate sources should be used like for example cooked starch. Rice is preferred as the source of highly digestible carbohydrate due to its starch content as it has low fibre content.

3.3.7. Vitamins

It is very important in critical patients with chronic enteritis to take water-soluble and fat-soluble vitamins. This is because the water-soluble vitamins might have been lost with the diarrhoea like for example B complex and C vitamins. On the other hand, fat soluble vitamins like vitamin A, D, E and K may be lost in animals with fat malabsorption.

Cats have a very high requirement which make them predisposed of getting vitamin B deficiencies. According to Chandler (2002), a weekly dose of cobalamin of 250 to 500µg/cat subcutaneously for four weeks has been shown to replete the blood levels. On the other hand, the dose for dogs is 20µg/kg subcutaneously monthly, although studies on repletion have not been published (Chandler 2002). Halls (2002) also suggests that parenteral supplementation is required to restore tissue stores and serum concentrations.

According to Cook and Purcell (2010), a lot of cats suffer from hypocobalaminaemia if they are suffering from a chronic gastrointestinal disease. If this problem is treated, according to Cook and Purcell (2010), there would be a less incidence of diarrhoea in cats. All cats with serum cobalamin concentrations less than 300ng/L should receive parenteral cobalamin supplementation (Cook&Purcell 2010). Cyanocobalamin is the generic preparation used for subcutaneous or intramuscular injection (Cook&Purcell 2010). It usually contains 1,000µg/ml of cobalamin in solution, making it more convenient and less irritating than B-complex preparations (Cook&Purcell 2010). Cobolamin supplementation is then given for a long term until the cat gets better.

According to Maunder (2010), parenteral supplementation of cobolamin, should be given until the serum levels are restored and the way of supplying it is 0.25mg to 1.0mg subcutaneously every seven days for four weeks, then every 28 days for three months.

Vitamin E can be restored by supplementing it orally.

There could be loss of thiamine which occurs at a high frequency and it can affect the appetite. Lost vitamins can be supplied by parenteral administration. However, when the disease is mild and the treatment responds well, dietary intake is often enough.

3.3.8. Zinc

A common deficiency with regards to chronic diarrhoea is that of zinc. The small intestine is the primary site of zinc homeostasis (Hand et al 2000:761). If poor coat quality or dermatitis is observed in both cats and dogs, dietary zinc intake should be checked as this could be the cause.

3.3.9. N-3 Fatty Acids

N-3 fatty acids are derived from fish oil. This is very beneficial in controlling the mucosal inflammation with regards to chronic enteritis. A suggested amount of N-3 fatty acids in animal trials is approximately 175 mg/kg body weight/day (Hand et al 2000:761).

3.3.10. Assess the food and feeding method

One should check if enough nutritional requirements are met with regards to the patient. Important nutritional factors are water, minerals (very importantly potassium), energy density, fat, protein, fibre and digestibility. If there are any deficiencies, the given food should be assessed and changed to an appropriate diet with all the required nutritional factors being met.

The feeding method, together with the feeding frequency, amount fed, how the food is offered, access to other food, and the person feeding the animal should be checked. The body condition scare (3/5) should also be observed.

It is very important to note that one of the causes of chronic enteritis is due to the diet itself. Malabsorption and malsecretion can also result with regards to this disease. One should aim in controlling the clinical signs, as well as providing the much needed nutrient requirements due to the losses met through the gastrointestinal tract. Antibiotics (example tylosin, tetracycline, and metronidazole), anthelmintics (example fenbendazole) and immune-suppressive agents (example corticosteroids, azathioprine, and cyclophosphamide) are frequently used in the case of chronic diarrhoea (Hand et al 2000:762).

Foods that reduce the intestinal irritation/inflammation and normalises the intestinal motility, are preferred. There are three types of foods that are helpful in managing the diarrhoea which is related with chronic enteritis. These are highly digestible, low-residue foods formulated for gastrointestinal disease, fibre-enhanced foods, and elimination foods (Hand et al 2000:762).

Veterinarians mostly suggest to feed a highly digestible, low-residue gastrointestinal food, with medium levels of fat (example 12 to 15% DMB for dogs, 15 to 22% DMB for cats) (Hand et al 2000:762). Another way is to increase the dietary fibre content, so as to normalise the intestinal motility, water balance and microflora (Hand et al 2000:762). Moderate levels of dietary fibre (10 to 15% DMB) add non-digestible bulk, which buffers toxins, holds excess water and most importantly, provides intraluminal stimuli to re-establish the coordinated actions of hormones, neurons, smooth muscles, enzyme delivery, digestion and absorption (Hand et al 2000:762). Fibre normalises transit time through the small intestine, which means fibre slows a hyper-motile state, but also improves a hypo-motile state to re-establish normal peristaltic action (Hand et al 2000:762).

Elimination food with a small number of highly digestible, novel protein sources could be also used. This is because the diarrhoea could be secondary due to mucosal inflammation. In this way, protein indigestion is low, reducing the production of toxins by putrefying bacteria flora (German and Zentek al 2006:127). These could be commercial veterinary therapeutic foods, or homemade foods that contain protein sources like for example lamb, rabbit, venison, duck or fish, which have a high digestible or novel carbohydrate source (Hand et al 2000:762). All the other food should be eliminated. All the clinical signs should disappear in a three week period if a strict diet is maintained. Once all the signs are

gone, individual specific ingredients that were previously fed can be added so that the allergen can be identified (Hand et al 2000:763). It is very important to restrict fat diets since there could be adverse reactions. According to Hall (2002), stopping the intake of food in case of chronic enteritis, will do more harm as it would potentially result in malnutrition.

In some cases, according to German and Zentek (2006), patients may benefit from a low-fat diet due to the fact that fatty acids have the ability to be hydroxylated in the gastrointestinal tract by certain bacteria which in turn can results in secretory diarrhoea. This means that now the diet consists of a high percentage in either proteins or carbohydrates. However there were studies which noted that high-fat dry food (20%) can improve faecal consistency, decrease vomiting frequency and improve the body condition according to Lecoindre and Biourge (2005). Vegetable oils, poultry fat and fish oil are acceptable fat sources with the latter offering a high percentage of long chain omega-3 fatty acids (EPA-DHA) resulting in anti-inflammatory activities (German&Zentek 2006:127).

Probiotics and prebiotics can be very beneficial. Probiotics are living organisms that can be taken orally. They can be beneficial to the intestine. According to German and Zentek (2006) two strains can be identified by the European authorities as feed additives in complete dog food: *Lactobacillus acidophilus* and *Enterococcus faecium*. On the other hand, prebiotics are substrates made of non-digestible carbohydrates or also lactulose, which are beneficial to the bacteria which cause changes in the luminal microflora. This is done to favour conditions to the preferred flora. Example of several carbohydrates is insulin or certain oligosaccharides like for example fructo-oligosacharides, galacto-oligosaccharides or mannan-oligosaccharides (German&Zentek 2006:127). According to Cook and Purcell (2010), physllum fibre supplements can be used in cats to increase the faecal consistency and the recommended dose is 1 teaspoon mixed together with food once or twice daily. Water should be in constant availability as it might cause obstruction.

When it comes to Lymphangiectasia, low fat, moderate fibre and high carbohydrate and protein should be fat. Fat should be less than 10% DM in dog which less than 45% DM in cats. They should be fed multiple times per day.

3.4. Parvovirus infection

There is no treatment aimed directly at curing a puppy infected with this disease. Over days, the virus will eventually run its course, and supportive care treatment will help the body to fight it off. Nutrition is very important as gut bacterial translocation can lead to sepsis and therefore, increase in mortality. Studies in general hospital populations of critically ill small animals have also shown that nutritional supplementation, even in moderation and providing close to resting energy requirements (RER), was positively associated with discharge from hospital (Brunetto et al., 2010, Liu et al., 2012).

3.4.1. Electrolytes

Restoration of the fluid loss which resulted from the diarrhoea and vomit is very important to protect the gastrointestinal tract and the kidneys from further injury. This includes fluid therapy with Ringer/lactate or normosol-R intravenous, analgesia, transfusion therapy, colloid fluid therapy, anti-emetics, nasogastric suctioning and early nutritional care, according to Judge (2015). Electrolyte disturbances can be different according to the severity of the affected puppies. These could be hypochloraemic alkalosis and mildly affected puppies being more likely to have hyperchloraemic acidosis (Burchell et al. 2014). After correction, there should be stabilisation. In most cases, according to Judge (2015), Lactated Ringers Solution, with 5% glucose, and 20-30 mEq/L potassium chloride is used. In patients which are not severe, 0.45% sodium chloride solution, 2.5% glucose, and 20-30 mEq/L potassium chloride is enough to meet with the fluid requirements.

Tams (2011), also agrees with this method of fluid therapy. Tams (2011) also points out that if the patient is in critical condition, a "shock dose" of fluids should be given in the first hour and is roughly up to 40 ml/lb (in the first one to two hours).

According to Judge (2015), the initial fluid rates should be enough to correct the deficiencies by intravascular fluid within the hour. If there is barely any haemodynamic improvement within 30 minutes, a bolus of synthetic colloid like for example hydroxy-ethyl starch (Voluven) or Pentaspan is administered at a dose of 3-5 ml/kg intravenously (Judge 2015).

According to Brashear (2004), in severely affected dogs, multiple boluses (10-20ml/kg) may be needed until the heart rate decreases and the blood pressure increases. According to

Tabor (2011), colloid administration should be definitively administered if the albumin level decreases to <2g/dl where the normal is between 2.6 to 4.0g/dl, or the total protein level decreases to <4g/dl where the normal is between 5.8 to 7.2g/dl.

Mensack (2010) also agrees in treating the patient with intravenous fluids, electrolyte and glucose replacement and crystalloid and colloid fluids. He states that a large volume of crystalloid fluids which are made up by water with sodium and glucose together with electrolytes and other bases, are a very important aspect of the treatment in the first hour after infusion.

Them the veterinarians whom I spoke with agreed with this.

3.4.2. Potassium

Brashear (2015) advices that potassium should also be supplemented so that to replace any renal and gastrointestinal losses. Potassium chloride should not be infused higher than 0.5mEq/kg/hr (Brashear 2004). Hypokalaemia can result in muscle weakness, paralysis of the ileus, cardiac arrhythmias and polyuria (Tabor 2011).

Tams (2011), describes how in parvovirus a patient can result in hypokalaemia and therefore it should be supplemented early before hypokalaemia shows up. Tams (2011) advices to give patients 20 to 30 mEq per litre of fluids. Some dogs require supplementation at 40 mEq per litre.

According to Mensack (2010), potassium can be added to the crystalloid fluid therapy at concentrations up to 80mEq/L. He also states that the administration rate of potassium containing fluids should not be more than 0.5mEq/kg/hr as cardiac arrhythmias can be seen.

3.4.3. Glucose

Blood glucose levels should be monitored daily so that hypoglycaemia is avoided. Dextrose fluids can be used. Glucose is very important as it is needed for the proper functioning of white blood cells.

According to Tams (2011), a bolus of glucose (1 to 2 gms/10 lb, or approximately 1 ml 50% dextrose per 4 lb), should be slowly given intravenously at the start of therapy and then added to the fluids as a 5% solution as dehydration nears resolution. A bolus of 25% dextrose is preferred over a 50% concentration because the latter is quite hypertonic and may induce vomiting.

Mensack (2010), states that dextrose concentrations of 2.5-5.0% can be used. However, concentrations can go up to 10% if necessary. If high concentrations of dextrose are needed, these should be administered via a central catheter to prevent vasculitis secondary to their increased osmolarity (Mensack 2010).

3.4.4. Crystalloid and Colloid therapy

According to Judge (2015), in patients which lost a large amount of gastrointestinal fluid, blood or protein, a combination of isotonic crystalloid and colloid therapy, using hydroxy-ethyl starch, Pentaspan, or blood or fresh frozen plasma transfusion is needed, so that to maintain blood volume, hydration status, and colloid oncotic pressure which are necessary for tissue oxygen delivery to body tissues. Some studies show that using fresh frozen plasma and colloid therapy is controversial.

Mensack (2010) says that fresh frozen plasma from regularly immunised dogs, is a very good way in providing antibodies against the circulating parvovirus, therefore helping to neutralise the virus.

3.4.5. Glutamine

Glutamine supplementation could also be done as its' deprivation would result in apoptosis due to the fact that it is the preferred source of energy to enterocytes. According to Mensack (2010), glutamine can be found as a stable powder and is supplemented at a dose of at least 1 gram/kg body weight per day.

3.4.5. Methods of feeding

Most veterinarians agree to avoid giving food for the first six to twelve hours from the start of treatment. This is due to the fact that it decreases the number of osmotic particles which are found in the intestinal lumen. This helps for a rapid re-growth of the intestinal villi with the end result being recovering of the intestinal function. Micro-enteral nutrition should then start.

However, in recent studies, it was seen that in puppies which were fed through nasoesophageal feeding tubes from the first 12 hours after admission, they showed earlier substantial improvement of clinical signs and also had significant weight gain compared to puppies that were not fed until vomiting had stopped. The improvement of the intestinal barrier function were also observed, suggesting that early enteral nutrition may limit bacterial or endotoxin translocation from the intestines decreasing the potential resultant

coliform septicaemia and SIRS according to Mohr and others (2003). It was observed that haemorrhagic gastroenteritis may result in the first hours due to the enteral feeding, but this was not detrimental to the health of the dog. There were some experiments in which patients where fed within 2 hours of hospital admission and the therapy had positive results.

Glucose, hydrolysed proteins and isotonic electrolyte solutions, such as Lectade or Vytrate, have been shown to maintain intestinal mucosal health, reduce atrophy of the intestinal lumen cells, and improve recovery rates from diarrhoea (Judge 2015). The suggested rate of administration according to Judge 2015, is 1-2ml/kg/hr. After 12 hours of this nutrition, more complex nutritional formulations should be administered, mainly by nasogastric or oesophagostomy tube (Judge 2015). A low-fat with high biological protein value with mostly carbohydrate diet should be administered (Judge 2015). Rice with chicken is the best food. Veterinary prescription foods like for example Hill's i/d are preferred to be prescribed.

In recovering animals, one can also use lactobacilli preparations. This is done so that to help in the restoration of the normal intestinal flora.

3.4.5.1. Feeding steps adapted from Judge 2015:

3.4.5.1.1. Micro-enteral feeding:

• Begin within 2-12 hours of admission to the hospital.

• Solution - lectade, gastrolyte, OR 0.45% NaCl + 2.5% dextrose solution.

• Additives: - Potassium chloride- 20mEq/L - Amino acids - 3% amino-acid solution. Addition of amino acids promotes a protein-sparing effect in critically ill patients. Amino acids should not be supplemented in micro-enteral formulations for use in patients with pancreatitis - Glycine hastens the resolution of diarrhoea, improves intestinal morphologic characteristics in patients with diarrhoea, and enhances the uptake of glucose. - Glutamine is the preferred energy source of rapidly dividing cells (GUT cells, lymphocytes, and "broblasts). Glutamine plays a role in the maintenance of the integrity of the GI mucosal barrier and preventing bacterial translocation.

• Rate of administration: - CRI rate of 0.5 - 2.0 ml/kg/hr OR - Bolus infusion of 1.0-4.0 ml/kg every 4 hours - Increase volume administered by 0.2-0.5 ml/kg/hr every 8-12 hours if patient is tolerating the solution.

• Begin feeding a commercial liquid diet if micro-enteral nutrition solution is being tolerated after 6-18 hours.

• If vomiting is present, so as to control flux oesophagitis, cimetidine 10 mg/kg tid or ranitidine 2 mg/kg bid and buprenorphine 0.01mg/kg tid if severe abdominal pain is present.

3.4.5.1.2. Post-micro-enteral feeding:

• Fluid Requirements - normal patient's fluid requirements are between 60 and 80 ml/kg/day.

• Energy Requirements - there are numerous methods and recommendations for estimating patient caloric needs during illness - none of which has been validated. Current practice is to feed critically ill patients resting energy requirements (RER) only, and to only multiply RER in cases of severe malnutrition, and only then once the patient is tolerating feeding.

RER = Bodyweight (kg) x 30 + 70 (dog > 2kg)

RER = Bodyweight (kg) x 70 (dog<2kg)

RER = Bodyweight (kg) x 40 (cat)

RER = Bodyweight (kg) 0.75

3.4.5.1.3. Feeding the patient

Enteral feeding should be initiated within 12 to 24hrs of hospitalisation if one follows what a lot of veterinarians suggest. Nowadays, veterinarians suggest that enteral feeding should be in 2 hours of admission, and this is in fact showing to be the most effective treatment. If oral feeding is not possible, a gastric feeding tube (nasogastric, oesophagostomy, or gastrotomy tube) should be done. Feeding should be done by bolus feeding, or on the other hand, by constant rate infusion. The residual gastric volume should be monitored, and the feeding regime adjusted. In every single case, the target energy and protein requirements for the specific patient should be met by the third day of feeding. If the protein content cannot be reached by this time, another diet which contains higher protein content should be fed.

3.4.5.1.4. Feeding devices

Puppies can be fed through force feeding or syringe feeding or alternatively, one of various feeding devices such as nasoenteric-, oesophagostomy-, gastrostomy- or jejunal feeding tubes can be placed (Prittie, 2004). Most puppies with parvovirus enteritis will require less than 10 days of nutritional support, making naso-enteric tubes the best choice in these patients (Marks, 2001).

Since puppies affected with parvovirus disease are not good candidates for anaesthesia procedures, oesophagostomy, gastrostomy and jejunal tubes are not recommended.

Table 9: Pros and cons of different types of enteral or parenteral feeding (Fascetti&Delaney&Elliott 2006):

Type of food	**Pros**	**Cons**	**Indication**
Hand feeding	- Simple - Not stressful for the dog	- Time consuming - Applicable only in some cases	- Very short-term feeding
Apetite stimulants	- Few available	- Hepatotoxicity possible	- Short-term feeding (2-3 days)
Nasoesophageal feeding	- Easy to place tube - Non-invasive - Minimal tranquillization - Few complication	- Tube not always tolerated - Elizabethan collar mandatory - Liquid diet	- Short-term feeding (1-2 weeks)
Esophageal feeding	- Easy and fast tube placement - Elizabethan collar not mandatory - No nasal –irritation - Does not prevent the dog from eating	- Special equipment required - General anaesthetic mandatory	- Several weeks of supported feeding
Gastrostomy feeding	- Easy to maintain tube in position - Few complications	- Risk of infection of insertion site	- Several months of supported feeding
Jejunostomy feeding	- Bypass the pancreas	- General anaesthetic mandatory - Delicate tube placement - Intensive care required - Elemental nutritional solutions	- Pathology of stomach, duodenum or pancreas
Parenteral feeding	- Permits nutritional support during digestive surgery or serious digestive complaint	- Cost - Constant surveillance - Major risks: metabolic complaints, thrombophlebitis, septicaemia, atrophy of the intestinal villi, Adynamic ileus	- Any situation in which the digestive tract needs rest

3.4.5.2. Feeding steps adapted from Lobetti (2010)

• Lobetti (2010) also suggests on feeding the patient, in about 4-12 hours after admission. It is noted that it should be done after rehydration.

• Lobetti (2010), also advices that in the first 24 hours, the patient should be fed the minimum of 1/3 of its' nutritional requirement. If the patient is vomiting, food should be stopped for 1-2 hours or a reduction of the quantity should be made. If it is not possible to feed the patient orally, Lobetti (2010) also suggests the naso-oesophageal tube feeding.

• It is also suggested to administer plasma transfusion at 10-20 ml/kg if albumin is less than 20 g/l, a blood transfusion if the patient does not improve and has a haematrocrit lower than 15–20%, deworming, administering sucralfate 1ml/3kg three times daily, or if the patient is in severe condition, 4 times daily.

4. Conclusion

Oral or intravenous rehydration fluids with water mixed with electrolytes are of utmost importance and should be given immediately in cases of acute and chronic diarrhoea and also parvovirus infection.

In both Acute and Chronic enteritis, as well as Parvovirus infection, highly digestible diets are of the utmost importance.

The required amount of protein in a healthy adult dog is 22% whilst in a healthy adult cat is 28%. The average digestibility of proteins should be ranging from 85% to 90% in both dogs and in cats in acute enteritis. On the other hand, it should be bigger than 87% in chronic enteritis. This is because if the proteins are highly refined, there would be an increase in their digestibility into amino acids which can then be absorbed and utilised. If less refined proteins with a low digestibility are given, they have the ability to increase the diarrhoea when the patient is affected with a gastrointestinal disease. Highly-digestible proteins which are also of high quality have a positive effect on the gastrointestinal tract. However, if the patient is suspected to be sensitive to the type of diet, a novel protein source should be introduced. These include proteins which the patient has never eater, like for example lamb, venison, rabbit and duck. Hydrolysed proteins can be also used as they are showing positive results if no other diets can stop the diarrhoea.

Fat is important to have a high caloric value. Fat can therefore be given in a moderate amount. This gives us the possibility to decrease the amount given to the recovering patient which needs energy. The required amount of fat in a healthy adult dog is 5.5%, whilst in a healthy adult cat it is 9%. The recommended dietary fat levels are 15% in dogs and 22% in cats with acute or chronic enteritis. The type of fat used should be a medium chained triglyceride. This is the main source of calories for catabolic patients.

The recommended amount of fibre in a healthy adult dog and cat is less than 4% and between 2.5 to 4.5% respectively. It is recommended that fibre content in gastrointestinal disease diets is less than 5%. Soluble fibres like beet pulp and rice bran are more beneficial than non-soluble fibres, as they decrease the faecal bulk whilst binding the non-absorbed fluid into gels and also increasing the number of beneficial bacteria.

I compared a number of the most sought out Prescription diets and Commercial diets of dogs and cats which is seen in Tables 3, 4, 5 and 6.

The Prescription diets dry food in dogs, have more protein than the Commercial ones. However on the other hand, Prescription diets have less proteins than Cmmercial diets. The

same thing is shown when it comes to the fat content, although Hill's Prescription diet i/d still contains a higher fat content. Prescription diets have less crude fibre content than the Commercial diets. It is seen that Commercial diets do not meet with the requirements for protein and fat as they are less than 22 and 15% respectively. However, it is seen that Commercial diets have higher fibre content than the Prescription diet in dry food.

I would personally recommend Hill's Prescription Diet i/d dry food. This is because it has 27.0% protein content, 14.8% fat content and 1.4% crude fibre content. In gastrointestinal disease, the diet should contain less fibre and in fact it meets is. When it comes to fat content, it is exactly like in Eukanuba Intestinal diet, whilst in protein content it is higher.

The same is in semi-moist food where I would suggest Hill's Prescription diet i/d as it still has a high protein content of 25.8% and fat content of 14.8%. The crude fibre is 2.4% which is higher than the Eukanuba's and Royal Canin Gastrointestinal diet.

The Prescription diets of cats have a higher protein and fat percentage in both dry and semi-moist food. However, they both have a low amount of crude fibre except Royal Canin Indoor adult dry food which is a commercial diet. I would also personally choose Hill's Prescription diet i/d for both dry and semi-moist food. This is because it has a high protein content, as well as fat content, whilst having low crude fibre content. Most veterinarians choose also Hill's Prescription diets.

In case of acute enteritis, the patient should be fasted for at least 24 hours and should be fasted so that the intestines are put to rest. If the no vomiting is observed, oral glucose-electrolyte rehydration solutions are enough. If the patient is vomiting a lot or is dehydrated, parenteral fluids would be given. If there is no vomiting and diarrhoea after 24 hours, the patient can be given small amounts of food and frequently. I recommend a home-made diet which consists of 50% boiled rice and 50% of boiled lean chicken meat. Yoghurt or cottage cheese can be also be added. Hill's Prescription diet i/d can also be given instead.

In case of chronic enteritis, highly digestible diets are important. Using highly digestible proteins, together with using elimination diet, novel source of protein, or hydrolysed proteins are of utmost importance. Stopping food intake will do more harm and should therefore be given in small amounts and frequently. Vitamin supplementation is also very important particularly Vitamin B (cobalamin). It should be supplemented for for 4 weeks in both dogs and cats subcutaneously.

I recommend that in case of Parvovirus infected dogs, stopping food will do more harm than good. Veterinarians should feed from the first 12 hours of admission by

nasoesophageal feeding tubes if they are vomiting. Fluid therapy should be started immediately and a ‘’shock dose’’ of fluids should be administered in the first hour. Potassium should be supplemented as soon as possible as well and should be about 0.5Eq/kg/hour to avoid hypokalaemia. Glutamine supplementation and a bolus of glucose should also be administered intravenously at the start of therapy. Isotonic crystalloid and colloid therapy using hydroxyl-ethyl starch, Pentaspan or blood or fresh frozen plasma transfusion should also be given. A low fat diet would also be beneficial and a home-made diet of rice and potatoes or a Prescription diet such as Hill’s Prescription diet i/d can also be given.

5. Summary

When it comes to acute and chronic enteritis, a highly digestible diet is suggested. If the patient has a hypersensitivity to the food, a hypoallergenic or novel protein source should be suggested or even hydrolysed protein. Low fat food but using highly digestible fat with high caloric value should be used. Medium chain triglycerides should be the main source of fat in catabolic patients. Low amount of crude fibre should be used. Soluble fibres like beet pulp and rice bran should be used instead of non-soluble fibres as they help in binding the non-absorbed fluid into gels.

If one administers a highly digestible diet with rice as the major carbohydrate component, and keeps in mind low-fibre, and lactose-free diet, after 24 hours of fasting, the results would be even greater and more beneficial in acute enteritis. On the other hand, in chronic enteritis, stopping food intake would be harmful and therefore the patient should be fed in smaller amounts but frequently. Highly digestible proteins in elimination diet, novel source of protein, or hydrolysed proteins should be used instead.

Oral or intravenous rehydration is of utmost importance. One should assess the severity of the case and select the route and diet for administering the nutritional support. Hill's Prescription Diet i/d food would meet with the required amount needed in dogs and cats that have gastroenteritis.

In parvovirus infected puppies, early per os feeding is more beneficial than fasting. Nasoesophageal feeding tube should be used if there is excessive vomiting. It is very important to work on the electrolyte imbalance and give a ''shock dose'' of intravenous fluids to counteract the result of profuse haemorrhagic diarrhoea and vomiting. Glutamine and potassium supplementation using low fat diet should be done. . Isotonic crystalloid and colloid therapy using hydroxyl-ethyl starch, Pentaspan or blood or fresh frozen plasma transfusion should also be given.

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