Rumen management during aphagia

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ABSTRACT

Ruminants that for any reason are unable to eat enough to survive can be supported *via* rumen fistulation. To successfully accomplish this task, an understanding of rumen physiology is necessary. Some adaptation and modification of the normal physiological processes will be necessary because the extended time normally required to ingest food will, for obvious practical reasons, be reduced to a few minutes repeated once to three times a day. The physiology of significance to aphagic or dysphagic animals is discussed and relevant examples of clinical cases are used to illustrate practical applications.

Key words: aphagia, fistulation, maintenance requirements, rumen temperature, rumen volume, saliva.

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INTRODUCTION

Certain lesions, such as a broken jaw, an obstructed oesophagus, severe tongue trauma or tumours, can result in aphagia or severe dysphagia and adipsia. In ruminants this inability to eat and/or swallow can have serious consequences and along with the primary problem, the rumen dysfunction can quickly become a life-threatening secondary complication.

Treatment of these cases will require careful rumen management, probably for several weeks or longer, to ensure a relatively problem-free convalescent period for the primary lesion. A number of rumen-related factors will have to be considered, monitored and possibly adjusted to ensure that the rumen functions normally. The aim of rumen management should be to mimic as closely as possible normal intake so that the internal rumen environment, and hence fermentation, are as natural as possible for that particular animal.

RUMINAL FISTULATION

Before any additional surgery is performed the owner or caretaker of the affected animal must be aware that managing the rumen is very intensive and requires an inordinate amount of time and patience.

As feed and fluid intake *via* the normal pathway has been blocked, the most practical way to overcome the problem in ruminants is to insert a rumen fistula. The procedure has been adequately described[12,18]. The internal diameter of the fistula should preferably be 8 cm or more to allow for adequate access to and from the rumen interior (Fig. 1). A tight, well-fitting plug should be used to cap the fistula opening to help maintain the normal anaerobic environment within the rumen and, more importantly, to prevent leakage of rumen contents, especially when the animal lies in left ventral recumbency. The fistula wound must be cleansed and disinfected daily until healing has occurred. Pain and infection in this area will suppress rumen function and if left uncontrolled could lead to a peritonitis that will limit the effectiveness of this method for providing nutrition and fluids to the patient.

RUMEN VOLUME

Consuming a forage diet is a full time job for adult ruminants. Cattle may chew up to 50 000 times a day, with high-producing dairy cows resting for no longer than 20 minutes at a time[13]. Ruminants with free access to grazing will eat for approximately 23 % of the day and ruminate for another 32 %[13]. Instead of this continuous addition of small amounts of feed (0.3 grams organic matter/bite at 36 000 bites/day) into the rumen over a relatively long period with a constant reduction of rumen contents due to absorption, digestion and ruminal outflow, feeding an aphagic animal *via* the rumen fistula involves a sudden intake of a large volume of solids and liquids twice or possibly 3 times a day[13]. Rumen volume becomes a limiting factor that can restrict the amount of feed that can be given at each session. Some estimate of rumen volume or capacity is therefore necessary.

Fig. 1: **Bull with a fractured jaw illustrating saliva loss** (visible on the floor – see arrow)**, rumen fistulation, buckets of milled alfalfa hay and a concentrate mix**.

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A large rumen capacity is essential to retain especially fibrous particles in the rumen for adequate microbial fermentation. The rumen volume or capacity is variable and depends on a number of factors including age, breed, pregnancy status, individual variation and especially nutrient requirements[4,5,13]. Values ranging from 90 to 135 ℓ or 15 % to 21 % of body mass (BM) have been reported for adult dairy cows[4,13]. Rumen volume will increase with body size (rumen volume = kg $BM^{0.57}$) but at a decreasing rate[3]. High-roughage diets promote a larger rumen volume because this feed type is not only more bulky but also contains less digestible matter per kilogram fed, and therefore greater volumes are needed to satisfy demands. Roughage also requires a longer period of fermentation for better breakdown and utilisation and therefore needs to be retained in the rumen for a longer time. Animals fed diets consisting of 100 % concentrate, 50 % concentrate and 0 % concentrate (just roughage) had rumen volumes of 13.5 %, 15.5 % and 17.5 % of body mass, respectively[13]. The rumen volumes of these diets fed to a 600 kg cow are estimated at 81, 93 and 105 ℓ, respectively. The dry matter (DM) percentage of rumen contents can range from below 7 % to more than 14 % of rumen wet weight in cattle, with values being greater with increasing DM intake and also with increasing dietary roughage[13]. A 600 kg cow consuming 12 kg of DM (2 % DMI) will have an estimated rumen volume of ±16 % BM (±96 litres) containing ±12.5 % dry matter (±12 kg) in the rumen.

From the above, estimates of rumen volume for a particular animal on a particular diet can be obtained.

INITIAL RUMEN TREATMENT

Owing to failure to recognise the seriousness of the primary lesion and its affect on intake, a number of aphagic cases are likely to have been without food or water for a few days or more before presentation. The rumen is the source of almost 80 % of the animal's energy needs. In ruminants deprived of food for 36 hours, nutrient absorption from the rumen is reduced to ±10 % of the normal fed state[17,19]. If very little or no food is reaching the rumen, fermentation will slow and eventually cease, leaving mostly indigestible material behind. In addition, since gastrointestinal fluid, especially ruminal fluid, attenuates increasing plasma osmolarity resulting from increasing systemic dehydration, in time the rumen contents will become progressively drier and more impacted.[15] Rumen osmolarity will increase to the point at which the movement of fluid out of the rumen is reversed.

In most cases, at the time of placement of the rumen fistula, the bovine, apart from an obvious live mass loss, will exhibit a poorly filled rumen. The rumenostomy will most likely reveal a dorsal rumen void with the ventral rumen sacs containing a reduced amount of dry, impacted, indigestible matter. Rumen fluid can be extracted and examined under a microscope by squeezing a handful of the rumen contents onto a warm glass slide. A few rumen protozoa will probably be seen (1 to 2 + concentration with normal motility) with most staining lightly when iodine is added. In most cases, the New Methylene Blue oxidation-reduction Test on this fluid will delayed and the pH will be higher than [7]. These are all indications of a deteriorating microfloral population[5].

Initial rumen treatment therefore requires dosing substantial amounts of warm fluids, not only to soften the impacted material, but also to increase rumen fill and to stretch the low threshold tension receptors in the rumen wall to encourage rumen motility and to provide a fluid source to help rectify any systemic dehydration. Use of cold water will destroy most of the remaining rumen microflora. Mixing the added fluid with the existing contents will help break up the impacted contents and can be done *via* the fistula using a long plastic tube and/or by external palpation by kneading the left abdominal wall. Ideally, the best method of treatment is transfaunation, which involves the addition of a large volume (±20 ℓ or more) of fresh, warm rumen contents from a suitable donor. This will also help repopulate the dwindling and compromised rumen microflora and provide some much-needed volatile fatty acids. After collection of the fresh rumen fluid, it should be kept warm, not exposed to light (i.e. use a dark container) and should be in an anaerobic environment (i.e. the container should have a tightly fitting lid and be filled to capacity) since these conditions are necessary for rumen microflora survival. Alternatively, the fluid can be a similar volume of warm water with added electrolytes and rumenotorics, with a handful or two of gruel.

Rumen function should be monitored daily and if necessary transfaunation can be repeated regularly.

MAINTENANCE OF BODY TEMPERATURE

A core temperature drop is a normal stimulus to initiate eating in ruminants[1,2]. When cold, these animals will increase reticuloruminal contractions to maximise fermentation rate, and the subsequent increased heat production within the rumen is used to help maintain body temperature[1,4]. Rumen heat production is between 6 and 12 % of ingested feed caloric value[1]. Rumen temperature can range from 38 °C and 42 °C; however, the average intra-ruminal temperature is between 0.5 °C and 1 °C higher than the normal rectal temperature[1,13]. Intra-ruminal temperatures do fluctuate as fermentation waxes and wanes depending on the type and amount of food and the time lapse between feedings. Larger fluctuations tend to occur with the large temperature differences that can occur with water intake[1,3]. Lowered intra-ruminal temperatures will suppress microbial activity and slow fermentation, and subsequently more feed energy will have to be diverted to heat production, which is relatively inefficient and wasteful[10]. Variations in rumen temperature have less of an effect on rectal temperature than on core temperature. Core temperature mimics the rumen temperature changes but is delayed by about 20 minutes[1]. Therefore heat produced within the rumen is important in maintaining the core temperature of the animal.

With rumen stasis and decreased fermentation, the rumen changes from being a heat source to a large heat sink that will potentiate the drop of core temperature, especially in a cold environment. As systemic dehydration worsens with no intake, peripheral perfusion will reduce, which will be reflected by a drop in rectal temperature. Although this temperature is not a true reflection of the core temperature of the animal, it does provide a practical indication that there is a deviation from the norm.

An animal that has been aphagic for a few days will probably have a sub-optimal rumen temperature, so the heat required to produce the desired temperature can be supplied by the addition of warm fluids and/or contents *via* the rumen fistula. This heat adjustment is especially important in the initial treatment, given when the rumen is maximally compromised and at its coldest. To determine the temperature of the contents to be added (T_a), a number of factors must be considered. The existing rumen content volume (V_e) must be known, and can be gauged from the expected rumen volume multiplied by the percentage fill of the rumen. The temperature of the existing ruminal contents (T_e) can be measured. The desired intra-ruminal temperature (T_d) is a given. If the volume of the added contents (V_a) is known, then the temperature of the added contents (T_a) can be calculated using the equation

$$T_a = \frac{T_d (V_e + V_a) - T_e V_e}{V_a}.$$

For example, the temperature of the estimated 20 ℓ of ruminal contents of an affected cow was 36 °C, and with the required intra-ruminal temperature of 40 °C, the temperature of the 25 ℓ of fresh rumen contents to be added should be:

$$T_a = (40 \times (20 + 25) - 36 \times 20)/25$$

$$T_a = 43.2\ °C$$

Initially the temperature of the added fluid content can be fairly warm (calculated required temperature may exceed 55 °C at times), as it needs to raise the temperature of the combined feed and fluid added. Although such high temperatures could negatively influence a normal microbial population, the flora in such a compromised rumen will be almost non-existent anyway. To heat up fresh rumen contents is impractical. Heating them up to such high temperatures would destroy the all-important microflora. However, fresh rumen contents must be kept as warm as possible, and if they do cool, they can be warmed to some extent by the addition of a small volume of hot water. The importance of not dosing with cold fluids cannot be overemphasized.

As the rumen starts to function normally with treatment, this temperature adjustment becomes less important, as normal fermentation will quickly restore the intra-ruminal temperature. However, since the rumen dosing provides a sudden supply of a large bulk of contents, it will have a greater effect on intra-ruminal temperature than normal intake, which comprises small amounts of feed that are heated by mastication and deglutition. It is therefore recommended that the temperature of the added contents is not lower than the desired intra-ruminal temperature, otherwise feed energy, which is needed to maintain the animal's condition, will be wasted on heat production.

Even though extra heat is added *via* the contents dosed through the rumen fistula during the initial rumen treatment, it is recommended that the patient be kept in a warm environment until the rumen is functioning properly.

A 700-kg, growing beef bull was placed in an outside paddock after initial rumen treatment with warm rumen contents. Although his rumen was static, his rectal temperature that evening was normal. The ambient temperature overnight dropped to below 10 °C, and the following morning, the rectal temperature of the bull had dropped to below 36 °C.

Table 1: **Equations predicting water intake.**

Lactating cows

1) Water intake (kg/day) = –26.12 + 1.516 × average ambient temperature (°C) + 1.299 × milk production (kg/day) + 0.058 × body weight (kg) + 0.406 × Na^+ intake (g/day).
2) Water intake (kg/day) = 15.99 +1.58 × DMI (kg/day) + 0.9 × milk production (kg/day) + 0.05 × Na^+ intake (g/day) + 1.2 × weekly minimum temperature (°C).

Growing bulls

3) Water intake (kg/day) = –3.85 + 0.507 × average ambient temperature (°C) + 1.494 × DMI (kg/day) – 0.141 × percentage roughage of diet + 0.248 × DM % of roughage + 0.014 × BM(kg).

THE SALIVARY FACTOR

Saliva volume

The voluminous rumen has a high water content. It is estimated that 70 % or more of the fluid entering the rumen is saliva[13]. Saliva helps maintain a desirable environment for microbial growth and fermentation within the rumen, with the fluid component facilitating mixing and suspension of digesta, ease of microbial movement and improved flow with regard to swallowing and rumination. The amount of saliva produced in normal adult dairy cows is estimated to be between 100 and 190 ℓ/day, the amount depending on the physical texture and moisture of the feed types ingested[5,13]. Cattle between 400 and 450 kg body mass that were fed alfalfa forage produced 150 ℓ of saliva per day[13]. Mastication is the main stimulus for secretion. Starvation, water deprivation and dehydration reduce salivary secretion and, interestingly, water added directly to the rumen also reduces salivary secretion[13].

Regardless of whether or not saliva is being secreted, with aphagia, no saliva enters the rumen, and since it contributes a major share of the fluid volume, the impact of this loss will be dramatic and rapid. The rumen contents will quickly dehydrate and become dry and impacted. Rumen function will slow and eventually cease.

The remaining 30 % of rumen fluid is derived from feed water content and voluntary water intake. A strong stimulus to increase water intake is thirst-derived from an increasing plasma osmolarity due to dehydration. Normally, voluntary water intake is variable and depends on a number of factors including moisture content of ingested feed, dry matter intake (DMI), dietary dry matter (DM) %, milk production, body mass, sodium intake and ambient temperature[6,8,9]. From multiple regression analyses a number of equations predicting water intake have been derived, each emphasising certain factors that appear to be of importance in their particular circumstances and/or environment.

For lactating dairy cows, milk production appears to have a strong influence[6,8], whereas for growing bulls dietary factors appear to be more influential[9] (Table 1).

There appears to be a discrepancy between total fluid intake per day and rumen volume, but continuous through flow and absorption accounts for this difference. However, with a compromised rumen with stasis, the absorption and through flow will be severely curtailed, resulting in fluid retention within the rumen that will limit the amount of fluid that can be administered.

Practically, once the feed required for maintenance has been dosed, the rumen can be topped up with additional warm fluid.

With the resumption of proper rumen function, the 700 kg bull mentioned previously usually required ±12 ℓ of extra warm fluid to top up the rumen after each feeding.

Aphagic animals take in no feed or fluid, therefore the stimulus for salivary secretion will be significantly reduced or absent, and even though this salivary volume is lost to the rumen, it may or may not be lost to the body. If very little saliva is secreted and lost, its systemic effects will be minimal, but if salivation is profuse and not swallowed, then systemic dehydration will occur rapidly.

Saliva composition

As large amounts of saliva are produced in ruminants, the chemical composition of saliva will play an important role. The high levels of sodium (Na^+) (±180 mEq/ℓ *versus* ±140 mEq/ℓ in serum), bicarbonate (HCO_3^-) (±124mEq/ℓ *versus* ±24 mEq/ℓ in serum), phosphate (PO_4^{2-}) (±26 mEq/ℓ *versus* ±4 mEq/ℓ in serum) and potassium (K^+) (±10 mEq/ℓ *versus* ±4.5 mEq/ℓ in serum) have a major influence on the rumen environment and microbial function[13]. One hundred and twenty litres of saliva contain 120 × 124 = 14 880 mEq of HCO_3^-, and since 1 g of $NaHCO_3$ = 12 mEq/ℓ of HCO_3^-, then 120 ℓ of saliva contain the equivalent of 14 880/12 = 1.24 kg of $NaHCO_3$. Regardless of whether or not the animal is salivating, these electrolytes are lost to the rumen environment and will affect rumen function, especially when fermentation is restored. The loss of the bicarbonate and phosphate will have a major impact on rumen pH that will have to be monitored regularly, and if necessary adjusted by the addition of antacids.

The 700 kg bull, which was losing moderate amounts of saliva owing to a fractured mandible, was initially dosed with 20 ℓ warm fresh rumen contents mixed with a couple of handfuls of milled alfalfa hay and left in a small camp over night. The following morning the pH of the ruminal contents was below 6, the contents were watery and smelled slightly acidic. The addition of 50 g $NaHCO_3$ b.i.d. in the feed helped stabilise the rumen pH to between 6 and 7, and, although this amount of antacid seems minuscule in relation to salivary volume, the fact that rumen fermentation was compromised means that smaller amounts of volatile fatty acids were being produced than normal, therefore less buffering was required.

c) Systemic affects of salivary losses

If the affected animal is not producing much saliva, then, although the electrolytes will be lost to the rumen, the body will still retain these electrolytes and hence the systemic affects will be minimal. However, if saliva is secreted and lost from the body, major systemic and metabolic changes can occur.

If a large volume of saliva is lost, then systemic dehydration will be rapid and severe. Daily fluid requirements amount to approximately 40 mℓ/kg body mass/day, *i.e.* 28 ℓ per day for a 700 kg bull. Salivary volume loss can easily match, or even exceed, this amount, hence its dramatic effect on fluid loss.

Similarly, electrolyte losses can be severe. A sodium deficiency will not only reduce fluid volume but will stimulate the aldosterone secretion that helps conserve sodium by exchanging it with potassium in saliva, the kidneys and large intestine. If there is not enough potassium, hydrogen ions are exchanged for sodium in the kidneys[14]. Potassium is dependent on dietary intake, and since the animal is aphagic, the aldosterone effect will potentiate any hypokalaemia that probably exists. Hypophosphataemia can also occur along with moderate hypocalcaemia, but compared to the other electrolytes, these changes will be fairly inconsequential.

The 700 kg Simmentaler bull (Fig. 1) with a mandible fracture had been aphagic for a week, and despite having his jaw taped shut, had been losing a large volume of saliva every day. Abnormal clinical pathological values at the time of presentation are given in Table 2.

From these results it is clear that the bull was systemically dehydrated, had a slightly compensated metabolic acidaemia, mild hyponatraemia, mild hypochloraemia and mild hypocalcaemia. Since base excess (BE) represents the change in strong ion difference, the base excess needs to be quantified in terms of free water change,

Table 2: **Abnormal clinical pathological values at the time of presentation.**

Ht	=	49 %	(24–40)
TSP	=	82 g/ℓ	(65–78)
$pH_{art.}$	=	7.311	(±7.4)
HCO_3^-	=	14.3 mmol/ℓ	(±27)
BE_{vv}	=	–10.4 mmol/ℓ	(±0.0)
pCO_2	=	28.9 mmHg	(±40)
Na^+	=	127 mmol/ℓ	(135–148)
K^+	=	4.31 mmol/ℓ	(3.5–5.3)
Cl^-	=	96 mmol/ℓ	(98–110)
$Ca^{2+}_{(7,4)}$	=	0.99 mmol/ℓ	(1.13–1.34)

Table 3: **Calculation of BE contributions.**

1) Free water changes (using $[Na^+]$ as a measure)		
$= 0.3 \times ([Na^+]_m - 141)$		
$= 0.3 \times (127 - 141)$	=	–4.2
2) Strong ion changes (using $[Cl^-]_{corrected}$)		
$= 104 - ((Cl^-)_m \times 141/127)$		
$= 104 - (96 \times 141/127)$	=	–2.6
3) Protein variation		
$= 3(7.2 - [Prot]_m)$		
$= 3\ (7.2 - 8.2)$	=	–3
Total contributions of 1 to 3	=	–9.8
Measured BE	=	–11
Contribution of unmeasured anions (probably lactate)	=	–1.2

Where $[Na^+]_m$ = measured serum sodium, $[Cl–]_m$ = measured serum chlorine, $[Prot]_m$ = measured serum protein[7,16].

Table 4: **Calculation of the nutritional requirements of a 700 kg growing beef bull** (>12 months)**.**

a) DMI = ±2 % BM
= 14 kg DM/day
(amount normal bull expected to ingest per day).
(700 kg BM/ ±16 % BM = ±112 l rumen volume/±12.5 % DM = ±14 kg DM rumen content).

b) Daily requirements for young growing bull[11].

	NE_m (Mcal/day)	MP (g/day)	Ca (g/day)	P (g/day)	K (g/day)
Maintenance	12.05	517	22	17	88

(provides a rough indication of amount of feed required).

c) Available feed – good quality chopped alfalfa hay[10] (actual measured sample).

DM	NE_m (Mcal/kg)	CP %	Ca %	P %	K %	Na %
90	1.29	17	1.4	0.25	1.9	0.02

- amount of alfalfa needed = 12.05/1.29 = **9.34 kg DM/day**
- practically can feed 1.5 buckets b.i.d. (i.e. 3 buckets per day).
- each bucket holds 2.2 kg as fed alfalfa = 2.22 × 0.9 = 2 kg DM alfalfa.
- 3 buckets/day = **6 kg DM alfalfa/day** (therefore maintenance requirements NOT met).
- an additional energy dense feed is therefore required (i.e. a commercial concentrate).

d) 12 % CP commercial concentrates (as fed values)

DM	NE_m (Mcal/kg)	CP%	Ca%	P%	K(%)	Na% (1% NaCl)
87	1.62 1.86 DM	12	1.2	0.6	0.4	0.4

- reduce volume of hay to 2.5 buckets/day to accommodate concentrates.
- alfalfa hay therefore provides 2.5 × 2.2 × 0.9 = 3.5 kg DM/day (5/0.9 = 5.5 kg as fed)
- 5 kg DM alfalfa hay provides 5 × 1.29 = 6.45 Mcal/day.
- therefore energy shortage 12.05–6.45 = 5.6 Mcal/day.
- amount of concentrates needed = 5.6/1.86 = 3kg DM
  = 3/0.87 = 3.5 kg as fed.
  Total (as fed) = 3.5 + 5.5 = 9 kg.

The bull requires 5.5 kg alfalfa hay plus 3.5kg commercial concentrate (as fed) per day for maintenance (i.e. 2.25 kg alfalfa hay plus 1.75 kg concentrate per feeding).

e) Nutrient balance check[10] (using NRC 2000 computer programme)

	NE_m (Mcal/day)	MP (g/day)	Ca (g/day)	P (g/day)	K (g/day)	Na (g/day)
Required	12.05	517	22	17	88	22
Supplied	12.20	671	41	22	120	12
Discrepancies	+0.15	+154	+19	+5	+32	–10

Where DMI = dry matter intake, Mcal = megacalories, NE_m = net energy for maintenance, MP = metabolisable protein, Ca = calcium, P = phosphorus, K = potassium, Na = sodium, and CP = crude protein.

strong ion change, protein variation and changes in unidentified anion concentrations[7,16]. BE contributions can be estimated (Table 3).

A contraction in fluid volume as occurs with dehydration will lead to contraction alkalosis and should result in hypernatraemia and hyperchloraemia. Although dehydrated, the bull has hyponatraemia that would be even worse if normally hydrated. Hyponatraemia leads to acidaemia as does hyperproteinaemia. The contribution of unmeasured anions to the base deficit is probably a lactate ion increase due to poor perfusion along with a small increase in uraemic ions as kidney function falters.

The above results, although indicating a looming crisis, are not critical and rehydration with intra-venous normal saline will readily rectify the problem. If the rumen is functioning adequately the treatment may even be administered *via* the rumen fistula.

NUTRITIONAL REQUIREMENTS

Rumen volume will dictate the amount of feed and fluid that can be dosed to an animal. Practically, in an aphagic ruminant, the rumen can only be filled twice a day *via* the fistula, which implies that 2 relatively large amounts of feed must satisfy the nutritional requirements of the animal. The normal nutritional requirements for a particular ruminant must be determined, and a ration can be formulated that will maintain the animal's existing body mass when administered twice daily. Use of feeds available on the farm should be considered and, if necessary, a further bag or two of commercial concentrates or even a few bales of alfalfa hay may have to be acquired.

This can be illustrated using the following 2 cases, a 700 kg growing beef bull and a cow with a young calf.

700 kg growing beef bull (>12 months)

The calculated feed (Table 4) meets the minimum requirements for maintenance for the bull except for a slight sodium deficit. The addition of 50 g $NaHCO_3$ twice a day as discussed earlier will more than compensate for this shortage. This feeding regimen will last for a few weeks or more and is only intended to maintain rumen function and body weight over the convalescent period for the initial lesion. Some of the nutrients will be partitioned off for tissue healing, which will be greatest soon after any surgery when the rumen function is at its worst. In this initial period when the rumen is compromised, it is probable that only a portion of the calculated amount of feed required will fit into the rumen, therefore a drop in condition should be expected. As rumen function improves, more of the ration and fluid can be dosed until the calculated amounts are achieved. If possible, an additional 10 % of the calculated feed required can be factored in to cater for the additional healing demand. As the animal improves, feed levels could be increased, which could provide some growth. Over this latter period the animal should regain its appetite and feeding the rumen *via* the fistula can be gradually reduced.

Table 5: **Calculation of the nutritional requirements of a 600 kg Simmental cow with a suckling calf** (3rd lactation)**.**

a) DMI = 2.2 %BM.
(10 kg milk/day 4 % fat) = 13.2 kg DM/day.
(600kg/ ±16 % = ±96 litres rumen volume/±12.5 % DM = ±12 kg DM rumen content).

b) Daily requirements for mature lactating dairy cow[11].

	NE_m (Mcal/day)	MP (g/day)	Ca (g/day)	P (g/day)	K (g/day)
Maintenace (600 kg)	9.7	373	19	10	75
Milk (5 kg/day) (4% fat/3.3% protein)	3.8	246	7	5	8
TOTAL	13.5	619	26	15	83

c) Available feed – good quality chopped alfalfa hay[11].

DM	NE_m (Mcal/kg)	CP %	Ca %	P %	K %	Na %
90	1.29	17	1.4	0.25	1.9	0.02

- amount of alfalfa required = 13.5/1.29 = **10.47 kg DM/day**.
- practically can feed 1 bucket b.i.d. (2 buckets per day).
- each bucket holds 2.2 kg as fed alfalfa = 2,2 × 0.9 = 2 kg DM alfalfa.
- 2 buckets/day = **4 kg DM alfalfa/day** (maintenance requirements NOT met).
- An additional energy dense feed is therefore required (i.e commercial concentrates).

d) 12 % CP commercial concentrates (as fed)

DM	NE_m (Mcal/kg)	CP%	Ca%	P%	K(%)	Na% (1% NaCl)
87	1.62 1.86 DM	12	1.2	0.6	0.4	0.4

- reduce volume of hay to 1.75 buckets/day to accommodate concentrates.
- alfalfa hay therefore provides 1.75 × 2.2 × 0.9 = 3.5 kg DM/day (3.5/0.9 = 4 kg as fed).
- 3.6 kg DM alfalfa hay provides 3.6 × 1.29 = 4,64 Mcal/day.
- therefore energy shortage 13.5–4.64 = 8.86 Mcal/day.
- amount of concentrates needed = 8.86/1.86 = 4.76 kg DM
  = 4,76/0.87 = 5,47 kg as fed.

  Total (as fed) = 4 + 5,5= 9.5 kg.

The cow requires 4 kg alfalfa hay plus 5,5 kg commercial concentrates (as fed) per day for maintenance and milk for her calf (i.e. 2 kg alfalfa hay plus 2.7 kg concentrate per feeding).

e) Nutrient balance check[10] (using NRC 2000 computer programme).

	NE_m (Mcal/day)	MP (g/day)	Ca (g/day)	P (g/day)	K (g/day)	Na (g/day)
Required -m	9.7	373	19	10	75	23
-l	3.8	246	7	5	8	3
-total	13.5	619	26	15	83	26
Supplied	13.7	711	49	27	99	19
Discrepancies	+0.2	+92	+23	+13	+16	–7

- There will be a sodium deficiency with the above diet especially if it is fed for some time. Since the ruminant has not been eating, and in combination with the time needed to get the rumen functioning properly, potassium and sodium deficiency are already a probability. Without a simple, practical means of confirming these suspicions, dosing 50 g KCl and 50 g $NaHCO_3$ with each feed will be beneficial.

Cow with young calf

A dairy cow that is producing milk will have much greater nutritional demands that will definitely not be able to be met *via* twice a day rumen dosing (Table 5). Milk production will suffer and the best that can be expected is to try and maintain the body weight with a small amount of milk to maintain udder function or to feed a suckling calf in the beef or dual purpose breeds.

The above 2 case examples are intended to illustrate a method to determine the

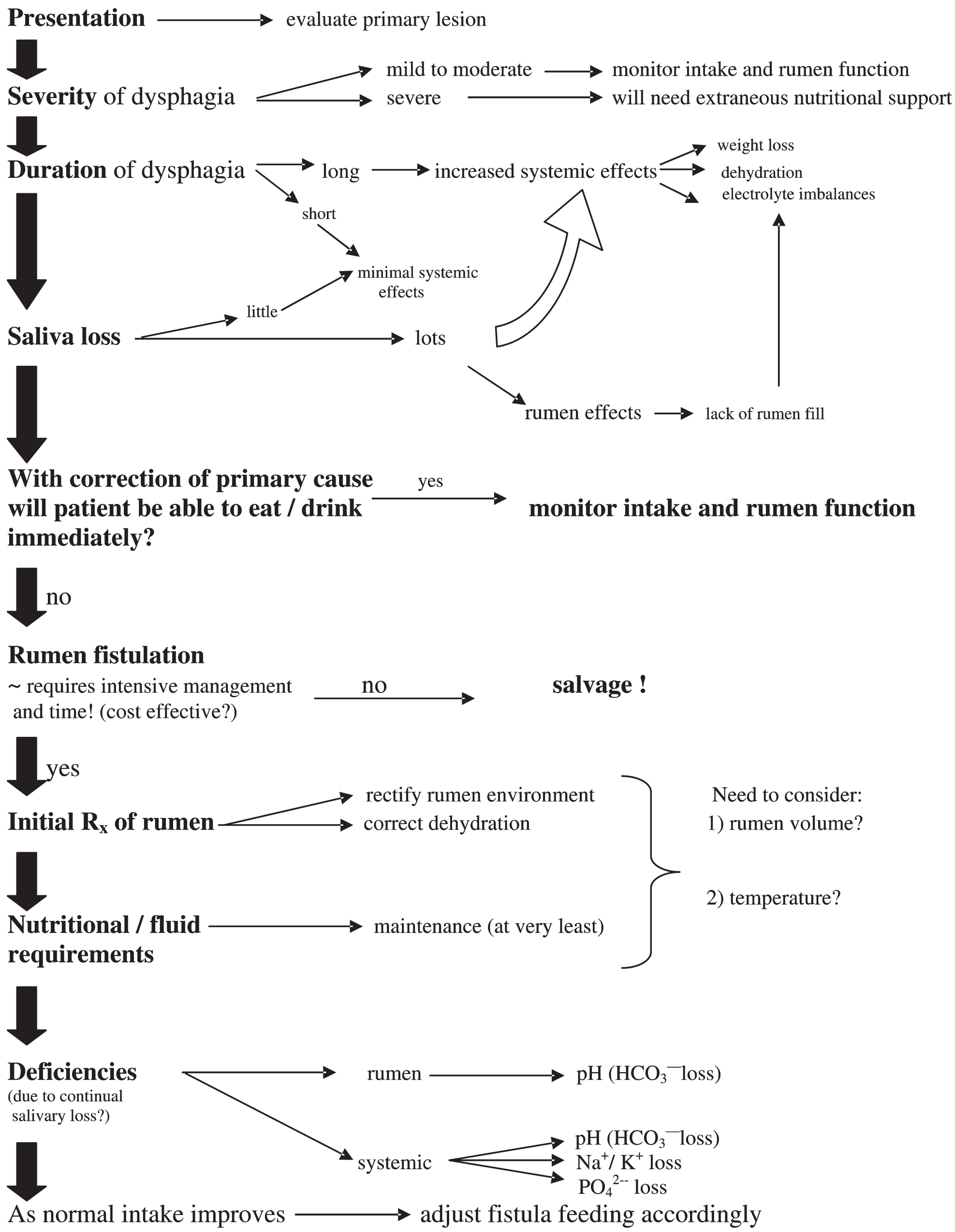

Fig. 2: **Flow diagram to determine the need for nutritional support for an aphagic ruminant *via* a rumen fistula.**

minimum amount of feed that should be fed to the affected animals in order to maintain body weight and condition score. Initially it was not physically possible to feed the amounts calculated owing to feed retention in the compromised rumens, but as rumen function improved, these values were achievable.

RUMINATION

As rumen function improves, rumination will increase and boluses of food will be regurgitated. In cases of mandibular fractures and other similar conditions, the animal will have problems masticating and swallowing its cud. Food can accumulate and drop from the mouth (Fig. 1). The oral cavity should be examined and all retained cud should be rinsed out carefully until the animal can chew and swallow properly.

FAECAL CONSISTENCY AND OUTPUT

Regular monitoring of faecal consistency and volume will give some idea of rumen function. Initially the faeces will probably be hard, dry and scant, but with successful rumen treatment, will become more voluminous and loose and eventually normalise as the gastrointestinal tract begins to function properly.

CONCLUSION

An approach to an aphagic ruminant that may require nutritional support *via* a rumen fistula can be summed up by the flow diagram in Fig. 2.

By taking a closer, detailed look at factors relating to rumen input and its functions, the complexities of this organ can be better appreciated, which will inevitably help to solve problems that directly and indirectly affect the rumen.

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