Fluid and Electrolyte Therapy

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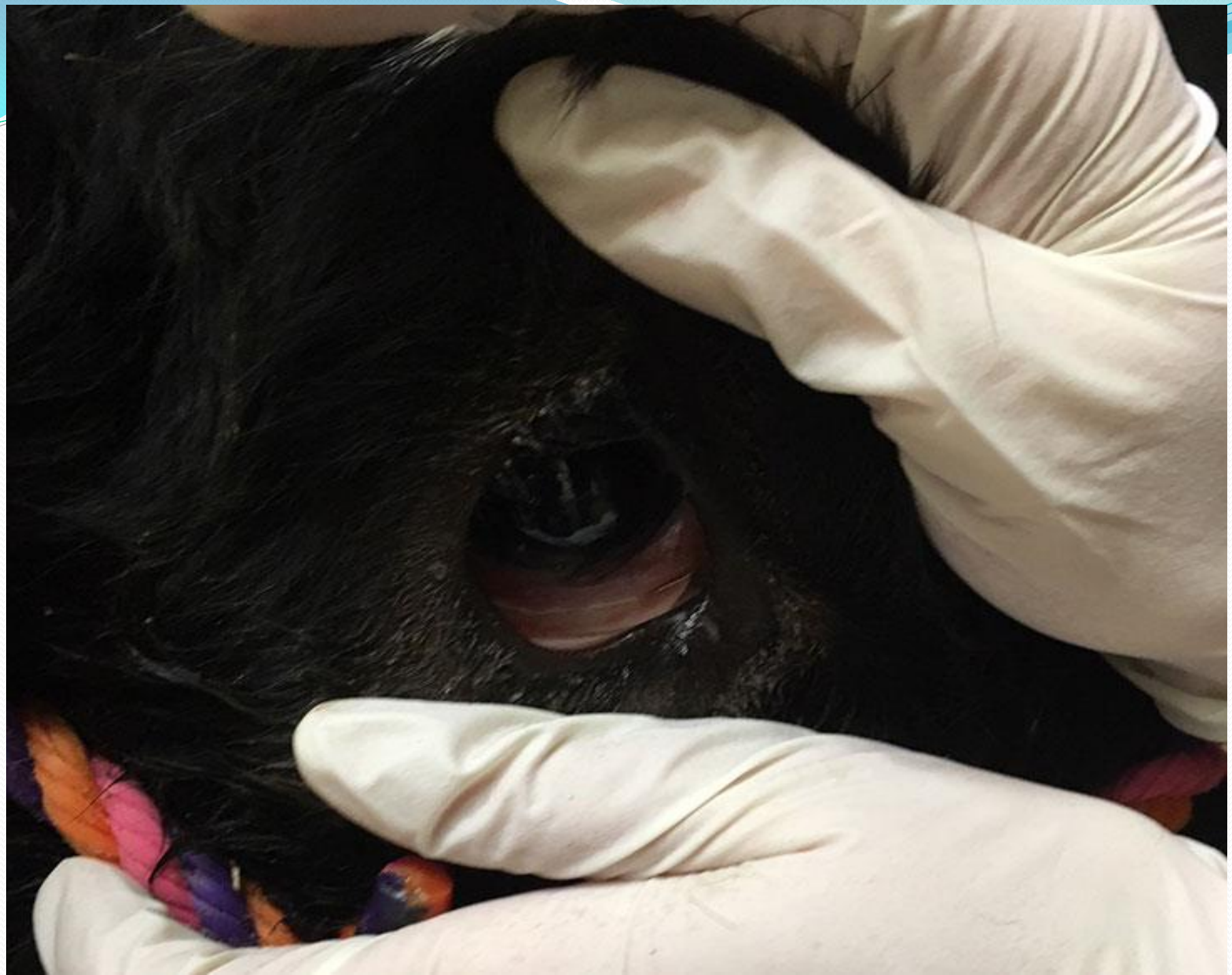
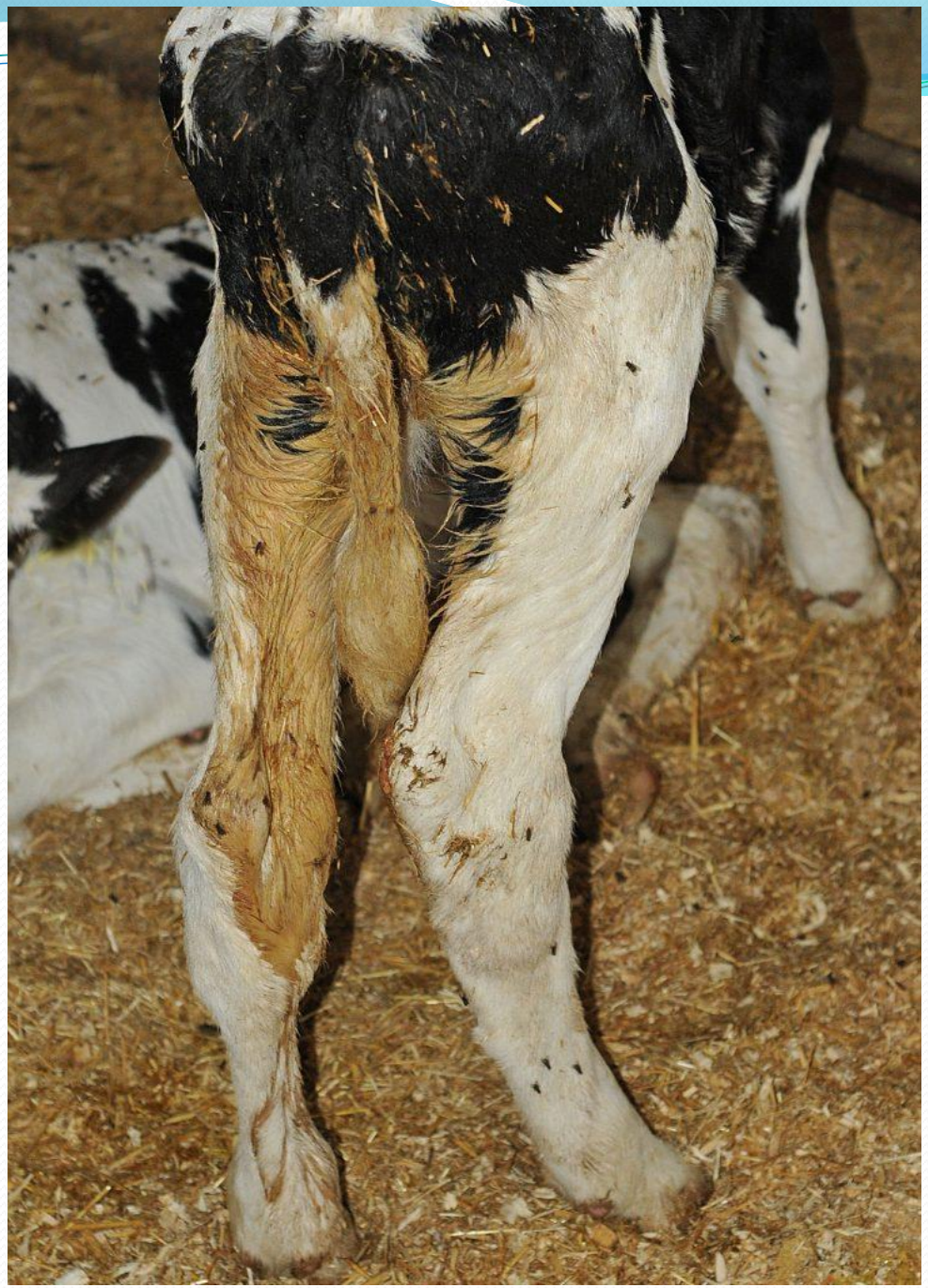
Acid-base, electrolyte and fluid balance

- Sick neonatal and adult ruminants frequently need fluid therapy to **correct imbalances** of acid-base, electrolyte, or water and to optimize tissue blood flow, provide nutrients (eg, parenteral nutrition), or treat shock.
- Acid-base and electrolyte abnormalities usually can be **predicted** on the basis of the suspected disease process; however, laboratory measurement is required to accurately quantify the magnitude of the derangement.
- **Clinical signs** can give clues to the presence of derangements in the absence of laboratory test results.

- **Muscular weakness** can result from changes in pH, K^+, and Na^+ or decreased Ca^{2+}.
- **Depression and inappetence** may be associated with changes in pH, K^+, and Na^+ or decreased Ca^{2+} and glucose,
- **Excitement or mania** may be due to decreased Ca^{2+} and Mg^{2+}.
- **Altered hydration status** (usually **dehydration**) can be estimated and quantified using **eye position** within orbit, extent of skin elasticity, and degree of **mucous membrane** moistness.
- The **effective circulating blood volume** and cardiac output can be estimated and quantified by the clinical assessment of activity level, **heart rate**, **mucous membrane color**, **capillary refill time**, and **temperature of the extremities** (eg, ears and feet)




HOARD'S DAIRYMAN



- Fluid therapy is very much used when treating calves with **diarrhea**.
- It is necessary to discuss fluid therapy of **mature cattle** separately from fluid therapy of calves because the metabolic abnormalities commonly seen in mature cattle are **quite different** from those of calves and other species.
- The fluid therapy is often a **key factor** in the **recovery** process.
- The **type** of fluid, the **volume** and the **route** the fluids are to be given will help to **correct circulatory collapse**, **electrolyte imbalances** and **base deficits**.

- **Certain emergency** conditions of adult cattle cause different degrees of fluid and electrolyte deficits and changes in the animal's acid-base status.
- Often, **it is not practical** to perform laboratory analysis when working as a **field vet**.
- It would mean taking a blood sample, driving back to the surgery to **analyze** it and then back to farm to administer the right fluids.
- What we do know is that in adult cattle, conditions such as **grain overload** and **choke** (oesophageal obstruction) cause an **acidotic state.**
- We also know that gastrointestinal catastrophes such as **abomasal volvulus** and **cecal or abomasal torsion** result in a **metabolic alkalosis**.
- **Circulatory collapse** is often a result of **endotoxaemia** caused by peracute Gram-negative bacterial infections, such as *Escherichia coli* mastitis, severe endometritis and septic peritonitis.
- In these **above**-mentioned scenarios, **correction of dehydration** will often **restore renal function sufficiently** that electrolyte and acid-base imbalances will then self-correct.

- When addressing hydration status, **body weight** and **rumen fill** can be misleading, as can **skin tent time** and **eyeball recession** –
- for example, animals in poor body condition will have skin that tents and retracted eyeballs, regardless of their hydration status.

- Clinical signs vary between the various degrees of dehydration in the adult ruminant

DEGREE OF DEHYDRATION	CLINICAL SIGNS
SEVERE	Recession of the eyeball > 5mm Persistence of a skin tent on neck ⩾ 7 seconds Oral mucous membranes dry and cold
MODERATE	Recession of the eyeball > 5mm Skin turgor reduced Persistence of a skin tent on neck 6 to 7 seconds Oral mucous membranes dry and cold
MILD	Depression Mucous membranes tacky Persistence of a skin tent on neck ⩾ 5 seconds No visible recession of the eyeball

Determining a patient's degree of dehydration (Clinically)

The clinical signs of dehydration and their corresponding body dehydration percentages are presented below:

1. **No detectable clinical signs**

2. **5%-6% dehydrated:** Minimal loss of skin elasticity, semidry mucous membranes, ***normal eye.***

3. **6%-8% dehydrated:** Definite delay in return of skin to normal position (skin turgor), slight increase in capillary refill time, and eyes may be slightly sunken into orbits, dry mucous membranes, weak rapid pulses.

4. **10%-12% dehydrated:** Extremely dry mucous membranes, complete loss of skin turgor, eyes sunken into orbits, dull eyes, possible signs of shock (tachycardia, cool extremities, and rapid and weak pulses, hypotension), and possible alteration in consciousness, and extremely dry mucous membranes.

5. **12%-15% dehydrated:** Definite signs of shock; death is imminent if not corrected

Certain circumstances make it difficult to determine how dehydrated a patient is. For example:

- Emaciated animals that have metabolized the fat from around their eyes and in their skin will have sunken eyes and decreased skin turgor caused by the loss of fat and elastin in the subcutaneous area.
- Also, dogs that profusely pant will have dry mucous membranes, making it more difficult to assess hydration status.
- A patient that has fluid leaking into spaces within the body cavity (third spacing) will have a rapid change in fluid from the intravascular compartments before the interstitial loss is seen.

Calculating the fluid replacement volume and fluid rate

- Body weight in kg × percent dehydration (as a decimal) = the fluid deficit in **L**

or

- Body weight in lb × percent dehydration (as a decimal) x 500 = fluid deficit in **ml**

❖ Example: Cow body weight = 500kg, degree of dehydration = 7% (0.07)

Fluid replacement = 500 × 0.07 = 35 L

❖ Example: Cow body weight = 500lb, degree of dehydration = 7% (0.07)

Fluid replacement = 500 × 0.07 × 500 = 17,500 ml

Calculating the fluid replacement volume and fluid rate

The maintenance fluid plan should address three ongoing requirements: ***replacement*** of lost interstitial volume (rehydration), ***maintenance fluids*** (for normal homeostasis), and ***replacement of ongoing losses***.

- The volume of rehydration fluids required is determined by reassessing hydration parameters after resuscitation, using the following formula:
  % dehydration × body wt (kg) × total body water (0.6).

- This volume is commonly administered throughout **4–12** hours with standard isotonic, balanced electrolyte replacement fluids.

- Maintenance fluid requirements are added to the rehydration rate.

- Maintenance fluids are calculated with one of the following formulas:
  30 x body weight (kg) + 70 = mL of maintenance fluids per 24 hours

- ***Ongoing or increased fluid losses*** vary substantially and must be estimated and replaced.

- Ongoing losses can be estimated by measuring urine and fecal output, nasogastric tube suction, bandage weight, or vomitus volume.

- Patients should be weighed regularly to determine changes in body weight. Insensible losses, which can be increased with fever, wounds, higher metabolic demands, and other factors can increase the maintenance rate by ***15–20 mL/kg/day.***

Calculating the fluid replacement volume and fluid rate dogs and cats

The basics:

- Maintenance fluid rate for an adult dog or cat is estimated as 2mL/kg/hr OR 50mL/kg/24 hours
  e.g. 35kg dog: Maintenance = 35kg x 2 = 70mL/hour or 50mL x 35kg = 1750mL/24 hours

- Maintenance fluid rate for puppy or kitten may be estimated as 3-4mL/kg/hr

- Fluid deficit:

- If present, the fluid deficit needs to be calculated and this can be done by estimating the percentage dehydration:

e.g. A 35kg dog that is estimated to be 8% dehydrated

Percentage dehydration is estimated to be 8% of the body weight and then this is converted into fluid units:

- e.g. 35kg x 0.08 = 2.8kg. 1kg = 1L, therefore the dog has a 2800mL fluid deficit

- If the fluid lost is to be replaced over 24 hours, the maintenance requirement is added to the fluid deficit to work out the total amount to be given over a 24 hour period: e.g. 1750mL + 2800mL = 4550mL over 24 hours

- In a severely dehydrated animal the deficit may be replaced over 24 hours, but at times it may be appropriate to 'front-load' e.g. 30% in the first 3 hours, though more of less may be appropriate depending on the case and response to treatment.
- If a patient is in shock, generally a bolus of fluids will be given over a short period of time rather than increasing the fluid rate so that the fluid deficit is replaced more quickly.

Calculating the fluid replacement volume and fluid rate dogs and cats

Ongoing losses:

- ✓ Fluid rates must be adjusted according to the ongoing losses such as vomiting, diarrhoea, haemorrhage.
- ✓ The volume of fluid that is being lost should be estimated in each case and then adjusted depending on disease progression and clinical assessment.
- ✓ Once the overall fluid rate per hour has been calculated, taking into consideration maintenance, deficit and on-going loss, this information can be entered into an infusion pump if this is available.

- **If not a drip rate needs to be calculated in mL/minute:**

e.g. A dog needs 116mL/hour • 116mL/hour/60 = ***1.93mL/minute***

The amount needed per minute then has to be multiplied by the **drops/mL** that the giving set delivers.

This can be found on the giving set. Use this to convert the amount needed in mL per minute to the number of drops per minute.

e.g. A 20drops/mL giving set: 1.93mL/min x 20 = 38 drops per minute. Set up the giving set to deliver 38 drops per minute

To check, the drip rate can be measured over a shorter period of time – e.g. 19 drops over 30 seconds, ~10 drops over 15 seconds

Note: Fluid administration rates can be controlled more accurately using an infusion pump.

Current practice for fluid administration during anaesthesia: 2-4mL/kg/hr (healthy animal, minimal fluid losses e.g. blood loss or evaporation)

Faster rates may be required for individual animals i.e. for different cases and situations

- When deciding on route of administration it is also important to consider the **cardiovascular status** of the animal.
- In conditions such as **acute toxic mastitis**, **abdominal catastrophes** or severe **endometritis**, the gastrointestinal motility will also be substantially **reduced.**
- This makes oral fluid therapy **less effective**.
- For this reason, **IV fluids** are often indicated once moderate to severe signs of **hypovolaemia** are seen.

Fluid therapy for neonatal calf diarrhea

- Regardless of the etiologic organism, the metabolic changes resulting from diarrhea in calves are similar.
- They include (1) **dehydration**, (2) **acidosis**, (3) **electrolyte abnormalities**, and (4) **negative energy balance** and/or **hypoglycemia**.
- The major **cause of dehydration** of these calves is **fecal fluid loss**, which can be as much as 13 per cent of body weight in 24 hours.
- Compounding this problem is **decreased intake** from either anorexia or withdrawal of milk by the owner.
- **Acidosis** results from bicarbonate and strong cation loss in the stool, lactic acid accumulation in tissues, decreased renal excretion of acid, and increased production of organic acid in the colon in malabsorptive diarrheas.
- Along with water and bicarbonate, Na, Cl, and K are lost in the feces, which results in a total body deficit of these ions.
- **Negative energy** balance can occur in diarrheic calves owing to decreased milk intake, decreased digestion or absorption of nutrients, or replacement of milk with low-energy oral rehydration solutions.
- Increased energy demand, such as that resulting from cold weather or fever, **exacerbates** these problems.

Intravenous therapy to adult cows

- Dehydrated adult cattle need **huge** volumes of ***isotonic*** fluids.
- This is time consuming and costly.
- Instead, ***hypertonic*** fluids offer a more practical option in the field situation.
- We can safely administer 4ml/kg to 5ml/kg over five minutes, equivalent to approximately 2 to 3 litres in a 650kg cow.
- Use of a 10G catheter and wide-bore giving set allows faster administration.
- For cows in metabolic acidosis due to, for example, grain overload, alkalinising solutions are used.
- If we use 8.3% $NaHCO_3$ solution, **3** litres are required.
- If we use 5% $NaHCO_3$ solution **4.5** litres are required.
- If we use ***isotonic*** $NaHCO_3$ solution, **18** litres are required to correct the acidosis.

- Most gastrointestinal diseases of adult cattle and many other causes of dehydration (with the exception of those mentioned above) are associated with metabolic **alkalosis**, **hypokalaemia** and **hypochloridaemia**. \
- The degree of these changes may be mild (as in early **left displaced abomasum**) or severe (as in **abomasus volvulus**).
- If the gastrointestinal tract is patent and functional, oral rehydration is the method of choice.
- If obstruction, ileus or circulatory shock is present, intravenous fluids should be administered.
- ***Hypertonic*** saline (7.2% NaCl) solution may be used to correct dehydration and electrolyte abnormalities with smaller volumes of IV fluid.
- A 650kg animal requires 2.5 litres of hypertonic saline.

- **Dextrose** can be used in anorectic cows or those in ketosis.
- 500ml of 50% dextrose can be added to 5 litres of isotonic solution. **Calcium** should be added in freshly calved dairy cows.
- For the use of ***hypertonic*** **saline** fluids to be effective, it relies on the uptake of water from the rumen to restore circulatory volume. Cattle should be provided with a supply of fresh water immediately after treatment. Most cattle will drink 20 to 40 litres within 10 minutes. The animals that are not drinking should be rumen pumped

Oral therapy

- The electrolyte solutions for intraruminal use should be ***isotonic*** or ***hypotonic*** to avoid suppression of dry matter intake.
- This means that we cannot use the same rehydration solutions for calves in adult cattle.
- These **calf** "lectades" are mostly **hypertonic** and **alkalinising**.
- This would increase the level of dehydration and alkalosis, consequently depressing the food intake.
- **In most situations**, an electrolyte solution containing **sodium chloride, potassium chloride** and **calcium** and **magnesium** salts is suitable.
- The "stomach" pump has made the administration of oral fluids so much easier and quicker in adult cattle.
- Nowadays, a farm vet will feel lost without this piece of equipment. It takes only a matter of time to pump a cow with 20 to 40 litres of the appropriate electrolyte solution.

- Oral fluids alone **are not indicated** in the **recumbent dehydrated** patient.
- Note, if the rumen **is distended** with fluid, **do not administer** oral fluids.
- There is already an excess of fluid in the rumen in the face of dehydration.
- **Adding more** will only **increase** abdominal **distention**.
- The **excess fluid** should be **removed** if possible, the rumen alkalinised and intravenous fluid therapy initiated.
- Oral fluids can prove beneficial in a variety of scenarios.
- In addition to cases of obvious fluid loss, such as **diarrhea** and **abdominal surgery**, oral fluid therapy has also proved to be useful in cases of **toxic mastitis**, **acute ruminal acidosis** and immediately **after calving**.

- Administering **oral fluids** to dairy cows at risk of developing a **left displaced abomasum** is believed to **reduce** this condition.
- The rumen will be “weighed down” by the administered fluids, making it more difficult for the abomasum to pass under it.
- In the case of the fresh-calved cow a solution in which **calcium rather than sodium** is the major cation is preferable in order to **reduce the risk** of **hypocalcaemia**, and cases of **ruminal acidosis** require an additional **alkalinising agent**.
- Many commercial preparations are available to be mixed into water. They provide oral sources of energy and calcium, which can be useful in treatment of conditions such as **ketosis** and recurrent **hypocalcaemia.**

Thank You