Electrolytes – oral rehydration solutions for scouring calves

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Oral rehydration solutions, or electrolytes, replenish fluids and electrolytes lost during episodes of diarrhoea. Oral rehydration therapies are used to improve acid-base balance by providing electrolytes and water. Many brands of electrolytes are commercially available; however, products are variable and the right one needs to be chosen for each individual dairy. Although generally easy to treat, neonatal calf diarrhoea is still a major cause of death and economic loss in the dairy sector.

A recent survey of US calf mortality found an average of 8.7% annually, 62.1% of that due to scours. In past surveys, mortality due to scours averaged 60.5% in 1996 and 52.5% in 1991, indicating an expanding problem in the US dairy industry.

The use of oral rehydration for treatment is limited when farm protocol is lacking. Farms should have a standard operating procedure for treatment of scouring calves that includes when to use oral rehydration solutions, how much to give and other care issues.

Causes of scouring

Scouring in neonatal calves has two causes: nutritional and pathogenic. Causes of nutritional scours can include changing milk replacer brand, changing from waste milk to milk replacer, transport, weather, vaccinations and dehorning.

Nutritional scours are caused by stress and are usually temporary. Because there is minimal damage to the intestinal villi, the calves' condition can improve even without treatment by removing the source of stress. However, nutritional scours can cause as much water loss and dehydration as pathogenic scours; these calves should be monitored closely and possibly treated, especially if young.

Virtually any bacteria or virus found on a farm can cause pathogenic scours. Calves begin showing clinical symptoms between one and three weeks of age. Infection can occur from contact with other calves, farm workers, or environment. Common causes for pathogenic scours include rotavirus, coronavirus, E. coli, salmonella and cryptosporidia. After birth, passive immunity is provided by colostrum; however this immunity decreases while the calf's immune system develops. Calves become vulnerable to infection when passive immunity has decreased but their own immune system has not yet fully strengthened.

Treating with electrolytes

Calves can lose 5-10% of their bodyweight as water within one day of scouring. Fluid loss in excess of 8% requires IV treatment, and over 14% loss can result in death. This makes daily calf monitoring and quick treatment essential. The amount of water lost by scouring calves can be estimated by skin tenting, gum condition, attitude, and ability to stand or suckle (Table 1).

Table 1. Clinical symptoms that help evaluate amount of dehydration in calves.

Dehydration (%)	Symptoms
5-6	Diarrhoea, no clinical signs, strong suckling reflex
6-8	Mild depression, skin tenting 2-6 seconds, calf still suckling, sunken eyes, weak
8-10	Calf depressed, laying down, eyes very sunken, dry gums, skin tenting >6 seconds
10-14	Calf will not stand, cool extremities, skin will not flatten when tented, comatose
Over 14	Death

Scoring of scours can be based on a 1 to 4 or 5 scale:

- The lowest number is better, so a 1 should be normal faeces, with the consistency of pudding.
- A 2 should be slightly less firm, such as yoghurt.
- A 3 should be considered scours and have the consistency of syrup, loose to watery with a strong odour.
- With a 1-4 scale, a 4 can then be anything more fluid than syrup, such as water. For a 1-5 scale, a 4 should have the consistency of fruit juice, with faecal matter still visible.
- A 5 should be the consistency of water with no faecal matter or with mucous and/or blood.

Table 2. Scoring of scours.

To evaluate hydration using skin tenting, pinch a fold of skin (best done on the neck) and count the seconds it takes to flatten.

Flattening of skin in less than two seconds indicates normal hydration. If skin takes 2-6 seconds to flatten, the calf is about 8% dehydrated. Over six seconds indicates severe dehydration above 10%. Gums are evaluated by colour and moisture. Normal gums should be pink and damp; gums that are white and dry indicate 8-10% dehydration.

One of the best estimates of dehydration and illness in calves is their attitude during milk feeding. Calves may show no symptoms of dehydration but if they need encouragement to drink, they should be monitored closely for scouring or other illnesses.

Protocol

Protocols for managing sick calves are critical to consistency. Because water loss in calves occurs rapidly, all employees must be able to diagnose and treat calves quickly and efficiently to prevent mortality. Evaluation of calves should include scores given for

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scours, respiration and appearance (see Tables 2, 3 and 4).

A calf's scores should be totalled daily. When scores reach a threshold value, the protocol should consist of taking a temperature reading, treating with oral rehydration solution and/or giving antibiotics. This will ensure proper, consistent treatment for all calves and should decrease mortality.

Calculating the amount

Although there is little detriment in feeding excess oral rehydration solution, feeding too little may not alleviate dehydration and can prolong scouring. Although individual calf weights may not be available, approximate amounts to feed should be established. For example, small calves (or breeds other than Holstein) can be estimated at 60lb and fed less than high birth weight calves (110lb) or even medium size calves (80lb).

To estimate how much to feed a calf:

- Multiply weight of calf by (dehydration percent/100). This will give you the pounds the calf needs to drink in addition to its milk or milk replacer feeding. Then divide by two to get quarts of liquid needed.
- Example: A 100lb calf is dehydrated 6%. 100 × 0.06 = 6lb. 6lb/2 = 3 quarts to be fed per day in addition to her usual milk.

Different methods are used in feeding milk or milk replacer while feeding oral rehydration solution to scouring calves. Some cease milk feeding completely and only feed oral rehydration solution for the entire treatment period. Another method is to feed only oral rehydration solution for two days then feed half and half with milk the last day. The third way is to feed the rehydration solution and milk as well in separate feedings.

Calves need enough energy to maintain their weight as well as their immune system, especially when they are sick. Oral rehydration solutions cannot provide enough energy because they are limited in the amount of glucose that can be added in order to keep the osmolarity of the solution low.

Therefore, feeding milk or milk replacer increases energy and protein intake, allowing calves to maintain weight. Garthwaite et al, 1994, showed the benefit of milk feeding while treating with rehydration solution.

Once scouring occurred, calves received one of three treatments. Treatment 1 was rehydration solution alone for two days, after which milk was slowly incorporated back into the diet for seven days.

Treatment 2 consisted of a partial removal of milk during therapy, and Treatment 3 was a full feeding of milk as well as rehydration solution for seven days. Faecal scores did not differ between treatments and bodyweights were higher for treatments that included milk and oral rehydration solution, especially the treatment with a full feeding of

Respiration should be scored on a 1 to 5 basis:

- A 1 is normal breathing, no problems.
- A slight cough, runny nose but regular breathing is score 2.
- A 3 should have a moderate cough and rapid breathing.
- A 4 should have a severe cough that is frequent with rapid breathing.
- A 5 should have a severe cough that is chronic with irregular breathing.

Table 3. Scoring of respiration.

Table 4. Scoring of appearance.

Appearance scores should range 1 to 5 with a 1 being alert and active:

- A 2 should have droopy ears and be slightly unresponsive.
- A moderately depressed calf with head and ears drooping is score 3.
- A 4 should be depressed with drooping ears and head and no interest in getting up.
- A 5 should be flat on its side.

milk for the entire treatment period. If scouring becomes a regular occurrence a veterinarian should be consulted to determine the source and whether antibiotics are appropriate. Also, a few faecal samples should be taken and sent to a diagnostic laboratory to evaluate the cause of enteric infection. This may help establish a preventative program and save time and labour in treatment of scouring calves

Oral rehydration solution

Oral rehydration solutions used for treatment of scouring calves are different from those used for electrolyte supplementation. The latter provide supplemental electrolytes to older, usually weaned, calves or cattle during times of stress from transport, weather or other situations likely to cause loss of fluids and electrolytes. It is easy to confuse the two types of product; however, if the directions require small amounts of powder being mixed into gallons of water, this indicates that the solution is only supplemental and should not be used for treatment of scours.

One of the most important components of oral rehydration solutions is water.

- **Water** is the essential ingredient in any rehydration solution.
- **Sodium** should be included in the solution at 70-145mmol/L. Sodium is tightly regulated by the body; both low (from diarrhoea, for example) and high levels of sodium in the body can cause problems. Excess sodium means calves will need to drink more water to dilute the sodium; extra water may not be available or the calf may be too weak to reach it. Sodium should be at an average ratio of one to one with glucose to be absorbed efficiently.
- **Glucose** serves as an energy source (dextrose may be listed as this is just another name for glucose). Glucose is transported into the intestine on a one to one ratio with sodium, helping sodium absorption. However, no more than 200mmol/L should be included because this may change the osmolarity of the solution. A solution with high osmolarity will draw water out of the intestine instead of into it in order to equalise osmolarity on both sides of the intestine.
- **Glycine** is a non-essential amino acid that is commonly added to oral rehydration solutions to enhance absorption of glucose. To calculate the amount to be included, the levels of glycine and sodium should be added and the total should not exceed 145mmol/L. The total of glycine and sodium should also equal the glucose level.
- **Alkalinising agents** are added to decrease metabolic acidosis and may also provide some energy. They are usually attached to sodium and include bicarbonate, citrate, lactate, acetate or propionate. One of the most common alkalinising additions is bicarbonate, which should be fed about four hours after milk feeding. Bicarbonate and citrate inhibit casein curd formation in the abomasum. Acetate is the most easily metabolised. Alkalinising agents should be included at 50-80mmol/L.
- **Potassium and chloride** are needed to maintain pH of the blood and for muscle contractions, especially in the heart.

Although little research has concentrated on evaluating amounts of potassium and chloride needed to replenish electrolytes in scouring calves, the range of potassium found in most solutions is 20-30mmol/L and chloride is 50-100mmol/L.

Other additions can include gelling agents such as guar gum, pectin and others. These have not been shown to be largely beneficial nor detrimental.

Oral rehydration solutions containing gelling agents reduce diarrhoea within hours of feeding and may coat inflamed intestinal mucosa. Slowing down the passage rate of the rehydration solution may also allow the intestine to absorb more nutrients. However, this may also reduce the body's ability to flush toxins out.

Many rehydration solutions add direct-fed microbials. These bacteria are meant to re-establish the correct ratios of gut microflora. Usually these probiotics consist of lactobacillus and bifidobacterium species, both of which work against E. coli and benefit the intestinal environment.

No published research has yet evaluated direct-fed microbials in rehydration solutions. An oral rehydration solution should be chosen based on its ability to provide correct levels of electrolytes and to rehydrate rather than whether it contains microbials. ■

Ingredient	Molecular weight (g/mol)	Mmol/L	g/L
Glucose	180	<200	<36
Sodium	23	<145	<3.3
Glycine	75	<145	<10.9
Sodium bicarbonate	84	50-80	4.2-6.7
Sodium citrate	294	50-80	14.7-23.5
Sodium acetate	136	50-80	6.8-10.9
Potassium	39	20-30	0.8-1.2
Chloride	35	50-100	1.8-3.5

Table 5. Requirements of ingredient concentrations included in oral rehydration solutions in different units.