

# Developing Fluid Administration Protocols in Bovine Practice

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## Introduction

In a variety of clinical disorders of cows and calves, dehydration develops because of fluid losses from the body. Normally, the volume and composition of body fluids are maintained in an extremely narrow range as excretion is matched to intake. Water intake from ingested water and feeds as well as endogenous water production balances water loss through the urine, gastrointestinal tract, respiratory tract and skin. The amount of a substance added by intake and endogenous production is equal to the amount eliminated by excretion or endogenous utilization. The urinary and gastrointestinal tracts are the major means by which cattle maintain water and electrolyte balance. Excesses can be managed by increased excretion but deficits must be corrected by increased intake.

The purpose of this paper is to identify the clinical conditions that are associated with dehydration in cattle, and to provide the assessment parameters that guide trained farm personnel to choose the best route of administration for an appropriate volume and concentration of rehydration fluids. The fluid protocols discussed in this paper will be based on body weight assumptions for a calf and cow of 100 and 1200 lb (45 and 550 kg), respectively.

## Clinical Disorders

Clinical disorders that reduce water and/or feed intake or accelerate water loss from the gastrointestinal system, as urine, or from the respiratory tract reduce plasma and interstitial volumes (extracellular fluid) and can cause a potentially fatal decrease in tissue perfusion. While it is easy to recognize the need for rehydration fluids in cattle with diarrhea, toxic mastitis or gastrointestinal obstruction, it is also important to recognize many other clinical conditions (Table 1) are associated with dehydration. Cattle fasted for 48 hours have more than a 20% reduction in plasma volume.<sup>9</sup> Dehydration results in rumen fluid hypertonicity and reduced feed intake.<sup>1</sup> Recognized early and treated ag-

**Table 1.** Causes of dehydration in cattle.

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A.	Gastrointestinal loss
	Diarrhea
	Choke
	Bleeding ulcer of GI hemorrhage
B.	Sequestration of fluids
	Vagal Indigestion
	Gastrointestinal obstruction
	Ileus
	Acute rumen acidosis
	Peritonitis
	Hydrops
	Generalized edema
C.	Respiratory and skin losses
	Pneumonia
	Burns
	Environmental exposure/sweating
D.	Renal losses
	Hypokalemia
	Diuretic therapy
	Severe or sustained hyperglycemia
E.	Other
	Anorexia
	Septic/Endotoxic shock – septicemia, mastitis, metritis, peritonitis
	Chronic ketosis
	Hemorrhage

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gressively with farm-friendly fluid protocols, the clinical disorders listed in Table 1 can be ameliorated or resolved prior to the development of severe acid-base or electrolyte abnormalities.

## Evaluation and Assessment of the Dehydrated Patient

Prior to fluid administration, trained personnel should record a minimum database for each patient. These data should be accessible for regular review by

the herd veterinarian. The database should include body temperature, heart rate, respiratory rate, presence of rumen activity and evaluation of udder and milk of adult cattle, abdominal size, fecal characteristics, and attitude score. Train personnel to score the degree of dehydration as mild, moderate or severe. In cattle, detection of mild dehydration may elude even the most astute clinician, but moderate and severe dehydration will be recognized by some reliable clinical parameters. Dehydration can progress from mild to severe very rapidly in some acute conditions and in very young animals so estimates should err on the side of giving more fluids rather than less.

- **Severe dehydration** is present when cows or calves have > 5 mm recession of the eyeball into the orbit, when a skin tent made in the loose skin of the neck persists for  $\geq 7$  seconds and mucous membranes of the mouth are dry and cold.<sup>4,8</sup> If isotonic or hypotonic fluids are chosen, administration of a minimum of 4.5 L to a calf and 55 liters to an adult cow are required to resolve the severe dehydration.
- **Moderate dehydration** is present when cows and calves have visible recession of the eyeball into the orbit but it is less than 5 mm. Skin turgor is reduced and a skin tent created in the loose skin of the neck persists for 6 to 7 seconds. Mucous membranes of the oral cavity are dry and cold. Correction of the dehydration with isotonic or hypotonic fluids will require a minimum of 3.6 L to a calf and 44 L to a cow.
- **Mild dehydration** is assumed to be present when cattle have not eaten or have had reduced water intake for 24 hours or more. These animals are depressed, mucous membranes are tacky and the nose may be drier than normal. A skin tent is sluggish but persists  $\leq$  to 5 seconds. There is no visible recession of the eyeball within the orbit. Treatment of mild dehydration requires administration of a minimum of 2.5 L of isotonic or hypotonic fluids to a calf and 30 L to an adult cow.

Calculation of fluid requirements to correct dehydration should recognize that if fluid administration is not accompanied by voluntary drinking, an additional daily requirement of 27.5 L (50 ml/kg body weight) and 3.6 L (80 ml/kg body weight) of fluid might be needed for cattle and calves, respectively.

Intravenous hypertonic saline administration is an appropriate alternative for the isotonic or hypotonic fluid volumes described above for treatment of dehydrated cows and calves. The protocol for IV hypertonic saline administration is 4-5 ml/kg (2,400 mOsm/L) over 4 to 5 minutes.<sup>3</sup> For adult cattle 2 L, and for calves 120-200 ml, of hypertonic saline is administered. Immediately

after administration, consumption (voluntary, forced or a combination of both) of 20 to 40 L water is required for adult cattle and 2 to 4 L of isotonic or hypotonic oral electrolyte solution is required for calves.

### Route of Fluid Administration

The choice of route of fluid administration may be dictated by medical parameters such as degree of dehydration, gastrointestinal tract function, or concomitant medical disorders such as toxemia or sepsis, or the route of fluid administration may be chosen based on non-medical factors like personnel experience, time, and availability or training, restraint facilities, product availability and economics. For the purpose of this paper, discussion is limited to choices of intravenous, oral or combined intravenous and oral fluid administration. The author recognizes that subcutaneous and intraperitoneal fluid administration can benefit dehydrated animals. The latter routes of fluid administration may, however, limit fluid choices, volume, rate of delivery and absorption.

- The **intravenous fluid route** is used to administer hypertonic saline or isotonic fluids when there is severe dehydration, abdominal distension, gastrointestinal obstruction (functional or mechanical), hypothermia, ileus, recumbency or coma. The IV route is preferred when there is toxemia or sepsis. Experienced farm personnel may choose this route when products, facilities, labor and monitoring capabilities are ideal, regardless of the severity of dehydration.
- **Oral fluids** are a cost-effective means to rehydrate cattle with mild or moderate dehydration and preservation of some functional gastrointestinal motility. Candidates for oral rehydration should be able to stand without assistance. The preservation of a suckle reflex is preferred for calf recipients of oral rehydration solutions. Commercial oral fluid rehydration products should be precisely mixed as directed by the product label.
- **Combined IV resuscitation (hypertonic or isotonic fluids) followed by oral fluid therapy** is a practical approach to rehydration therapy on the farm. An initial intravenous fluid bolus in the form of hypertonic saline, dextrose, isotonic sodium bicarbonate solution stimulates cows and calves to drink on their own or to regain enough gastrointestinal function to be candidates for ongoing oral fluid administration.

Regardless of the route of fluid administration or the age of the patient, dehydrated cattle should have access to fresh water.

## Fluid Choices

Bovine practitioners have access to a number of commercial parenteral and oral rehydration solutions.<sup>2,5,6</sup> Because of this product availability, there is limited need for custom-made rehydration solutions except for oral rehydration of adult cattle. For farm-based fluid protocols, product choices should be limited and selection should be based on guidelines established by the herd veterinarian. When on-farm fluid therapy is instituted early and aggressively, **the goal is rehydration**. Prompt attention to rehydration, will obviate the need for guesswork regarding acid-base balance and severe electrolyte abnormalities. A few fluid products can serve most farm needs provided that the guidelines for treatment modification, recognition of treatment failure and the need to call the veterinarian are clearly established.

On farms with personnel trained to administer IV medication, small-volume hypertonic saline solution (7.2%, 2400 mOsm/L) administration provides an effective means to resuscitate most dehydrated and endotoxemic cows or calves. The fluid (4-5 ml/kg body weight; 2 L to adult cattle, 200 ml to calves) is administered over 4 to 5 minutes through a needle placed in the jugular vein. Immediately after IV administration, cows and calves should be allowed to drink. Failure to consume water or electrolyte solution should prompt personnel to administer 20 to 40 L to cattle and 2 to 4 L to calves. Oral fluid administration is reserved for those cows and calves that can stand, have no abdominal distension and some evidence of gastrointestinal function (audible rumen contractions, borborygmus, and fecal output).

Intravenous isotonic fluid administration requires farm personnel to be adept at intravenous catheter placement, maintenance and monitoring and have facilities suitable for prolonged patient restraint. For these reasons, most farms will prefer that IV isotonic fluid administration be reserved for sick calves, not adult cattle. Some appropriate parenteral fluids choices are Normosol-R (Abbott) and Plasmalyte-R (Baxter), which are alkalizing and have sodium, potassium and chloride concentrations that resemble plasma. Additional potassium is added to achieve a final concentration of 10 mEq/L. Sick calves receive 4 L of IV isotonic fluids prior to changing to oral electrolyte therapy. The veterinarian should see all calves that fail to respond to 4 L of IV fluids for a detailed physical examination and evaluation of acid-base balance, glucose and electrolyte concentrations.

Oral fluid therapy as the primary rehydration protocol is practical, efficient, economical, and can be very effective in mild to moderately dehydrated calves and cows. Appropriate candidates are animals that can stand and have some evidence of gastrointestinal function (audible rumen contractions, borborygmus, and fecal output). For calves with diarrhea, total daily oral intake

should be approximately 8 L. Approximately 4 L should be comprised of milk or milk replacer and an additional 4 L of supplemental oral electrolyte solution. The best oral electrolyte products are those that are alkalizing, known to be balanced in their electrolyte composition, have a sodium concentration that does not exceed 145 mEq/L, and are isotonic or slightly hypertonic. A veterinarian should examine calves that fail to respond or deteriorate within 24 hours of initiation of therapy.

Adult cattle candidates for oral rehydration therapy should be given isotonic or hypotonic fluids. Adult cattle that are not drinking, are dehydrated or have ruminal acidosis will have an increase in ruminal osmolality.<sup>1,7</sup> Rumen hypertonicity is a deterrent to feed intake and its resolution is associated with normalized feed intake. For oral fluid therapy of adult cattle to be effective, a minimal volume of 40 to 45 L should be administered and the fluid should be nonalkalizing or slightly acidifying unless carbohydrate overload or ruminal acidosis is the established cause of dehydration. The paucity of commercially available oral rehydration packs for adult cattle has prompted many clinicians to formulate their own solutions (Roussel). In our hospital, the following electrolytes are added to 20 L of water to make a slightly acidifying oral rehydration solution

- Dextrose           200 gm
- NaCl               170 gm
- KCl                15 gm
- MgSO<sub>4</sub>           3.8 gm
- CaCl<sub>2</sub>            7.4 gm

To this formulation, additional additives like alfalfa meal, direct fed microbial preparations or additional potassium chloride can be added. In early lactation, oral rehydration therapy may be accompanied by administration of an oral calcium gel product or propylene glycol. As emphasized previously, calves and cows receiving oral electrolyte solutions should have access to fresh water.

## Summary

Farm fluid therapy protocols primarily address dehydration and are not designed to resolve more complex acid-base or electrolyte disorders. Cattle that benefit from on-farm fluid therapy are those with the clinical disorders listed in Table 1 or those that are recognized by signs of mild, moderate or severe dehydration discussed in this paper. To correct dehydration, an appropriate volume of fluids must be administered intravenously, orally or by combined IV and oral routes of fluid administration. For adult cattle, a minimum of 40 to 45 L of fluid will resolve moderate dehydration while 4 L is appropriate for a calf. Fluid therapy protocols that utilize intravenous hypertonic saline solution infusion followed by supplemental oral fluids are prac-

tical, efficient and cost-effective. Commercial fluid products provide ample choices to the bovine practitioner for parenteral and oral electrolyte fluid therapy for calves. Custom preparations can provide appropriate oral electrolyte and fluid support of adult cattle.

Successful implementation of fluid therapy protocols on the farm requires the development and communication of a clearly articulated plan with defined guidelines for volume, route and choice of fluid administration. Trained personnel must understand and share expectations of the fluid therapy plan, have appropriate monitoring of patients and records and receive constructive feedback from regular review of records, number of patient treatments, and outcomes.

## References

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## 100 mg/mL Antimicrobial Injectable Solution

For Subcutaneous Use In Cattle Only  
Not For Use In Cattle Intended For Dairy Production Or In Calves To Be Processed For Veal

### BRIEF SUMMARY:

Before using Baytril 100 (enrofloxacin) Injectable Solution, please consult the product insert, a summary of which follows.

### CAUTION:

Federal (U.S.A.) law restricts this drug to use by or on the order of a licensed veterinarian.

Federal (U.S.A.) law prohibits the extra-label use of this drug in food producing animals.

### INDICATIONS:

Baytril® 100 (enrofloxacin) injectable solution is indicated for the treatment of bovine respiratory disease (BRD) associated with *Pasteurella haemolytica*, *Pasteurella multocida* and *Haemophilus somnus*.

### WARNING:

Animals intended for human consumption must not be slaughtered within 28 days from the last treatment.

Do not use in cattle intended for dairy production.

A withdrawal period has not been established for this product in pre-ruminating calves. Do not use in calves to be processed for veal.

### HUMAN WARNINGS:

For use in animals only. Keep out of the reach of children. Avoid contact with eyes. In case of contact, immediately flush eyes with copious amounts of water for 15 minutes. In case of dermal contact, wash skin with soap and water. Consult a physician if irritation persists following ocular or dermal exposures. Individuals with a history of hypersensitivity to quinolones should avoid this product. In humans, there is a risk of user photosensitization within a few hours after excessive exposure to quinolones. If excessive accidental exposure occurs, avoid direct sunlight. To report adverse reactions or to obtain a copy of the Material Safety Data Sheet, call 1-800-633-3796.

### PRECAUTIONS:

The effects of enrofloxacin on bovine reproductive performance, pregnancy, and lactation have not been adequately determined.

Subcutaneous injection can cause a transient local tissue reaction that may result in trim loss of edible tissue at slaughter.

Baytril® 100 contains different excipients than other Baytril® products. The safety and efficacy of this formulation in species other than cattle have not been determined.

Quinolone-class drugs should be used with caution in animals with known or suspected Central Nervous System (CNS) disorders. In such animals, quinolones have, in rare instances, been associated with CNS stimulation which may lead to convulsive seizures.

Quinolone-class drugs have been shown to produce erosions of cartilage of weight-bearing joints and other signs of arthropathy in immature animals of various species. No articular cartilage lesions were observed in the stifle joints of 23-day-old calves at 2 days and 9 days following treatment with enrofloxacin at doses up to 25 mg/kg for 15 consecutive days.

### DOSAGE ADMINISTRATION:

**Single-Dose Therapy:** Administer once, a subcutaneous dose of 7.5 -12.5 mg/kg of body weight (3.4 - 5.7 mL/100 lb).

**Multiple-Day Therapy:** Administer daily, a subcutaneous dose of 2.5 - 5.0 mg/kg of body weight (1.1 - 2.3 mL/100 lb). Treatment should be repeated at 24-hour intervals for three days. Additional treatments may be given on days 4 and 5 to animals which have shown clinical improvement but not total recovery.

### STORAGE CONDITIONS:

Protect from direct sunlight. Do not refrigerate, freeze or store at or above 40° C (104° F). Precipitation may occur due to cold temperature. To redissolve, warm and then shake the vial.

### HOW SUPPLIED:

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Code: 0236 100 mg/mL 100 mL Bottle  
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