Peertechz


Animal Husbandry Archives
OPEN ACCESS JOURNAL

DOI: https://dx.doi.org/10.17352/aha

Mini Review

# Disorder of Water and Electrolyte Balance in Cattle

**Jovan Bojkovski[1] and Milan Ninković[2]***

[1]Faculty of Veterinary Medicine, University of Belgrade, Bulevar Oslobodenja 18, 11000 Belgrade, Serbia

[2]Scientific Institute of Veterinary Medicine of Serbia, Janisa Janulisa 14, 11000 Belgrade, Serbia

**Received:** 18 December, 2024
**Accepted:** 09 January, 2025
**Published:** 10 January, 2025

***Corresponding author:** Milan Ninković, Scientific Institute of Veterinary Medicine of Serbia, Janisa Janulisa 14, 11000 Belgrade, Serbia,
E-mail: milan.ninkovic1992@gmail.com

**ORCiD:** https://orcid.org/0000-0003-0173-7795

**Keywords:** Cattle; Dehydration; Electrolyte; Fluid; Water



https://www.veteringroup.com

Check for updates

## Abstract

Ruminants' water needs depend on several factors. Water and electrolyte imbalances can disrupt production and, reproductive performance as well as overall health. Fluid replacement is a key step in the treatment of diseases such as calf diarrhea. This review work aimed to describe in more detail and indicate the importance of water and electrolyte imbalance disorders in cattle, especially calves, as the most sensitive category of cattle.

## Introduction

The amount of water depends on several factors: types and categories, physiological status, nutrition, ambient conditions, water quality, and temperature [1]. The water needs of cattle are estimated according to the production category, i.e. according to lactation. In calves fed a milk diet, they contains about 87% water. The daily requirement is about 1.3 L per kg body weight. That is, 6–8 L of water per kg of dry matter. In lactating cows, it is estimated that this amount is 46 L of water per kg of dry food matter, and per 100 kg of body weight. In sheep and goats, from 2-4 L per kg of dry matter of food [2,3]. Water in the body is distributed intracellularly, extracellularly, and transcellularly (digestive system, urine, milk) [4,5]. The average water content in the body of ruminants, depending on age and body weight, is 44% in fattened cattle, about 50% in adult beef, and about 76% in calves. Regarding the distribution of water concerning body mass, water in the body e.g. in a newly calved calf is about 36% in the digestive system, and in adult cattle, it is 17% in the digestive system as well as intravascularly in a calf it is about 12% and in an adult beef about 5.5%.

Disturbance of the balance can go in two directions (increase-hyperhydration) and reduction of water-dehydration seu exsicosis) [2,5]. Hyperhydration is caused by rapid hydration after a period of dehydration. It most often occurs during long-term warm weather, in calves and steers that are deprived of water. In such moments they are offered water, which they drink excessively in large quantities uncontrollably [6]. With excessive hydration, intravascular hemolysis, and hemoglobinuria occur. Namely, erythrocytes become fragile in dehydration. The sudden introduction of water with low osmotic pressure into the digestive organs causes erythrocytes to hemolyze as they circulate through the visceral vasculature. Clinical signs observed in hyperhydration are frequent stretching of the head and neck, ataxia, and edema of the eyelids. Occurrence of cardiac arrhythmia. If the animal survives, healing occurs. In animals that die, pathoanatomical changes that can be found during autopsy are edema of the lungs and connective tissue, especially that surrounding the bile ducts, as well as brain edema [2,7].

The recommendation for such cases is to give a certain amount of hypertonic solution (5% sodium chloride) intravenously. The mentioned disorders cannot be seen as a pure



**Citation:** Bojkovski J, Ninković M. Disorder of Water and Electrolyte Balance in Cattle. Animal Husbandry Arch. 2025;1(1):001-004.
Available from: https://dx.doi.org/10.17352/aha.000001

lack of water, but as a lack of electrolytes and proteins, which are important for maintaining osmotic and oncotic pressure in all areas of the body with water, especially in the blood, that is, in the circulation. Therefore, these disorders are linked according to the Darrow-Yannet scheme and are expressed in 5 possibilities: Isotonic and hypotonic hyperhydration, and hypertonic, hypotonic, and isotonic dehydration. In all forms of dehydration, there is a decrease in extracellular space, that is, water, and with it, a decrease in the volume of circulating plasma or hypovolemia [8]. The consequence is a decrease in the volume of glomerular filtration with an increase in the components of urine in the blood (Rest-N, i.e. urea). Also, the occurrence of hypokalemia is more frequent than hyperkalemia. Hypokalemia is caused by a large loss of the kidneys and digestive system, and hyperkalemia is caused by impaired renal excretion. Losses through the kidneys occur most often after long-term use of saluretics and glucocorticosteroids, and through the digestive system due to reduced or remaining food intake or due to enteropathy (acute or chronic diarrhea) [9,10].

Isotonic tonic hyperhydration in cardiac, renal, and hepatogenic genesis is manifested by the appearance of edema and signs of the underlying disease. The appearance of difficulty breathing is a suspicion of the beginning of pulmonary edema. Hypotonic hyperhydration manifests as depression, weakness, mild cramps, pulmonary edema, slowing of heart rate, and drop in osmolarity (hyponatremia). Hypertonic dehydration is manifested by pronounced thirst, dry and wrinkled skin, dry mucous membranes of the mouth, accelerated heart rate, and increased osmolarity (hypernatremia) [11]. Hypotonic dehydration, in which, in addition to water, there is also a greater loss of sodium, manifests weak thirst, pronounced sluggishness, listlessness, CNS disorders in the form of muscle spasms, and reduced skin elasticity [2,11]. Decreased skin turgor indicates hypovolemic blood flow disorders and deterioration of kidney function. The increase in the components of urine in the blood is even higher than that corresponding to hemoconcentration. Hyponatremia with hypochloremia occurs mainly in hypotonic dehydration. Hypokalemia is manifested by disorders of the function of the brain, heart and blood flow, skeletal muscles, and kidneys (rapid heartbeat, apathy, somnolence, paresis, paralysis, adynamia, constipation, coma) [12].

It is possible to establish the diagnosis of dehydration based on clinical symptoms. We get confirmation of the diagnosis based on blood and urine parameters. Estimates of water loss are possible based on the determination of body mass loss, with the fact that the body mass is known at the beginning of the disease. In the case of a low degree of dehydration, the loss of fluid during 24 hours means a reduction in body weight of 4%, in the case of an intermediate degree of dehydration, a loss of body weight by 6% and in the case of a high degree of dehydration, a loss of body weight by 8% to 10%. The stated percentages also represent the amount of water that should be taken in for rehydration. When determining the degree of dehydration, the determination of the number of erythrocytes, hemoglobin concentration, and hematocrit value, the concentration of total proteins in blood and blood serum is also used. To determine the type of dehydration, the concentration of electrolytes in the blood serum is determined. Complete determination of electrolytes as well as blood pH provides the possibility of concluding not only about electrolyte disorders but also about the state of acid-base balance in the blood [12-14].

## Fluid and electrolyte replacement in diarrhea of calves

The method of conducting rehydration and remineralization depends on the degree of dehydration, the general condition and vitality of the calf, and other possible complications. Diarrhea in calves is the most dangerous condition in newborn bodies associated with water and electrolyte imbalance [4,7,8]. In the case of moderate dehydration and when the calf shows the urge to suck and when it is standing, decorations of mint, rosehip, chamomile, or herbal semisynthetic mucus are given orally (through a pacifier, bottle, or tube) in a dose of 4% of the body weight, i.e. 2–3 liters for calves of 35–45 kg body weight. And two to three times a day [2,7,11].

Mucilaginous substances (flax seeds, rice mucilage, oats, have multiple beneficial effects on the treatment of gastroenteritis in newborn calves. They serve as a vector of drugs, which retain longer, gradually release and transport them along the digestive system; then, with their mucous component, they coat and protect them. In addition, they retain the temperature much longer than the calves themselves, thus creating euthermia, which is an integral part of supportive therapy, because the largest number of calves are in a state of hypothermia. Due to its organic composition, mucus has a certain nutritional effect. Astringents (carbo bismuth, bismuth subgallate), adsorbents (medical charcoal), or kaolin (bolus alba, i.e. aluminum hydroxide [15].

In addition, the oral use of a 20% solution of lab ferment (chymosin) as a support in the treatment of diarrhea in newborn calves has been proven to be very successful. Lab ferments in calf rennet play a role in the process of curd formation and gradual proteolysis and therefore participate in the regulation of osmotic pressure in the intestines. By orally giving a 20% solution of lab ferment to calves that have a preserved appetite, the process of milk digestion and curd formation is supported and the duration of diarrhea is shortened [16].

Means for remineralization are also given - intravenous solutions of sodium chloride, potassium chloride, sodium bicarbonate. A bag of 27.5 g is dissolved in 1 liter of boiled water and given 50 ml per kg of body weight so that a calf of 35-50 kg is given to drink 2 sachets dissolved in 2 liters of liquid at once. Maintenance doses are 8 ml/kg body weight every 6 to 8 hours. For the successful treatment of dehydration in addition to the oral route, rehydration and remineralization should also be carried out parenterally. The type and amount of means for parenteral rehydration depend on the severity of the disease, that is, on the degree of dehydration of the calf [2,17-19]. Faster recovery and therapeutic response also depend on the method of fluid and electrolyte replacement oral and IV replacement electrolyte products remain the gold standard for resuscitating diarrheic calves with moderate dehydration than subcutaneous replacement [20].



**Citation:** Bojkovski J, Ninković M. Disorder of Water and Electrolyte Balance in Cattle. Animal Husbandry Arch. 2025;1(1):001-004.
Available from: https://dx.doi.org/10.17352/aha.000001

Administered agents should be sterile and warmed to body temperature. They are mostly applied intravenously and/or intraperitoneally, but also subcutaneously. These means should be repeated in 6–10 hours. In the case of moderate or moderately developed dehydration, 1 to 2 liters of glucose in a physiological sodium chloride solution is given. The application is repeated after 6 to 10 hours. Adding glucose parenterally is useful in any case, as an energy component and as a mild diuretic. In severe dehydration, alkaline isotonic solutions are given to prevent or correct acidosis. One of the frequently used solutions is prepared from 1 liter of 0.13% sodium bicarbonate aqueous solution per liter of distilled water + 1 liter of physiological sodium chloride solution. Application is done intravenously or intraperitoneally. In the case of moderately developed dehydration, 50 ml of these two solutions are given per kg of body weight, and to maintain hydremia another 140 ml/kg of body weight is given. Per person, over 24 hours, divided into two meals. In the case of severe dehydration, 100 ml of solution per kg of body weight is given, and to maintain hydremia, another 140 ml of solution per kg of body weight is given. For 24 hours, divided into 3 meals, e.g.4+3+3 liters per day, for a calf of 35-50 kg body weight. Severe dehydration in addition to pronounced exicosis is accompanied by irreversible acidosis and anuria. Such calves are often in a comatose state and with lost pupillary reflexes, and a weak, rapid, and arrhythmic pulse [7,17,18]. Based on the degree of dehydration of more than 8% of the calf's body weight, intravenous fluid replacement is required [21]. In addition to oral and IV fluid replacement, intraruminal administration with hiper saline hypertonic saline solution (HSS) and hypertonic bicarbonate solution promoted a faster correction of metabolic acidosis in neonatal diarrhea calves [22].

Calves whose defense mechanisms are preserved or activated by this therapy, primarily with a moderate or medium degree of dehydration, if they lie on their side, take a sternal position in a few hours, begin to urinate and in 24–36 hours show visible signs of improvement in their general condition. After the application of alkaline isotonic solutions and establishment of acid-base imbalance (second day), balanced electrolyte solutions such as Ringer's solution, and Hartmann's solution are given, to replace electrolytes [7]. Electrolyte imbalances (sodium, potassium, calcium, magnesium) have varied considerably in calves with diarrhea [21].

Given that rota, coronaviruses, and secondary causes of diarrhea such as E. coli or salmonella play a dominant role in the etiopathogenesis of gastroenteritis [23]. Antimicrobial drugs to which these bacteria are sensitive (gentamicin, tetracyclines, lincomycin-spectinomycin, and fluoroquinolones) are administered parenterally in therapy. Then, sulfonamides that are not resorbed in the intestines and remain longer in the digestive system (sulfaguanidine, sulfasalazine, sulfaquinoxaline), as well as a combination of systemic sulfonamides with trimethoprim. They are often combined with vitamins AD and E. Nonsteroidal anti-inflammatory drugs, most commonly metamizole sodium, and flunixin-meglumine are used as symptomatic therapy [7,24,25].

The best option is to passively protect calves, indirectly, through cows that are vaccinated in high pregnancy with antivirus vaccines. The last measure in very endangered calves is the serumization of calves with hyperimmune antibodies and thus the creation of passive immunity is limited to the time of the postnatal period. The immunity of the newborn calf is increased by giving them immunogammaglobulin [26].

In the case of isotonic hyperhydration, the goal is to increase the renal excretion of salt and water by using saluretics. In the case of hypotonic hyperhydration, hypertonic solutions of sodium chloride are cautiously administered and water is withheld. For hypertonic dehydration that cannot be balanced by taking water, solutions without or with little electrolytes are used, and for hypotonic dehydration, electrolyte solutions are used. The administration of hypertonic solutions of sodium bicarbonate is desirable for rehydration in states of acidosis that occur as a result of the presence of diarrhea [21,27]. A 7.2% solution of potassium chloride is used to regulate hypokalemia [28-30]. Rehydration and replacement of electrolytes is done gradually over 24 to 48 hours, according to the degree and type of dehydration and according to the body weight of the animal. The most commonly used are 0.9% sodium chloride and 5 or 10% glucose, as well as Ringer's, and Hartmann's solution for parenteral use [31].

The best way to prevent dehydration is to provide plenty of water and libitum. Rehydration of affected cattle should be the basis of therapy in all conditions in which there is a loss of a large amount of fluid from the body. Replacement of fluids and electrolytes plays an important role in therapy, especially in young animals, where defense mechanisms are not sufficient in the recovery process.

## Acknowledgment

This research was funded by the Serbian Ministry of Science, Technological Development and Innovation, grant number. 451-03-66/2024-03/200030.

## References

1. Golher DM, Patel BHM, Bhoite SH, Syed MI, Panchbhai GJ, Thirumurugan P. Factors influencing water intake in dairy cows: a review. Int J Biometeorol. 2021;65(4):617-625. Available from: https://doi.org/10.1007/s00484-020-02038-0

2. Radojičić B, Bojkovski J, Jonić B, Ćutuk R. Bolesti Preživara, 2nd ed. Beograd: Akademska Misao; 2017.

3. Winchester CF, Morris MJ. Water intake rates of cattle. J Anim Sci. 1956;15(3):722-740. Available from: https://doi.org/10.2527/jas1956.153722x

4. Jaiswal M, Shukla PC, Mishra A, Bisht P, Nazeer M, Kumar P, et al. Study the efficacy of different rehydration electrolyte solutions in acute calf diarrhea. J Pharmacogn Phytochem. 2019;8(3):612-616. Available from: https://www.phytojournal.com/archives/2019/vol8issue3/PartL/8-3-69-879.pdf

5. Murphy MR. Water metabolism of dairy cattle. J Dairy Sci. 1992;75(1):326-333. Available from: https://doi.org/10.3168/jds.s0022-0302(92)77768-6

6. Silanikove N. The struggle to maintain hydration and osmoregulation in animals experiencing severe dehydration and rapid rehydration: the story of



**Citation:** Bojkovski J, Ninković M. Disorder of Water and Electrolyte Balance in Cattle. Animal Husbandry Arch. 2025;1(1):001-004. Available from: https://dx.doi.org/10.17352/aha.000001

ruminants. Exp Physiol. 1994;79(3):281-300. Available from: https://doi.org/10.1113/expphysiol.1994.sp003764

7. Constable PD, Trefz FM, Sen I, Berchtold J, Nouri M, Smith G, et al. Intravenous and oral fluid therapy in neonatal calves with diarrhea or sepsis and in adult cattle. Front Vet Sci. 2021 Jan 27;7:603358. Available from: https://doi.org/10.3389/fvets.2020.603358

8. Carpenter RH. Beyond the Darrow-Yannet diagram: an enhanced plot for body fluid spaces and osmolality. Lancet. 1993;342(8877):968-970. Available from: https://doi.org/10.1016/0140-6736(93)92007-g

9. Trefz FM, Lorenz I, Lorch A, Constable PD. Clinical signs, profound acidemia, hypoglycemia, and hypernatremia are predictive of mortality in 1,400 critically ill neonatal calves with diarrhea. PLoS One. 2017;12(8):e0182938. Available from: https://doi.org/10.1371/journal.pone.0182938

10. Sattler N, Fecteau G. Hypokalemia syndrome in cattle. Vet Clin Food Anim Pract. 2014;30(2):351-357. Available from: https://doi.org/10.1016/j.cvfa.2014.04.004

11. Stamatović SM, Jovanović M, Šamanc H. Dehydration, rehydration, in domestic ungulates. Vršac: Inex Hemofarm; 1988.

12. Kells NJ, Beausoleil NJ, Johnson CB, Chambers JP, O'Connor, et al. Indicators of dehydration in healthy 4- to 5-day-old dairy calves deprived of feed and water for 24 hours. J Dairy Sci. 2020;103(12):11820–11832. Available from: https://doi.org/10.3168/jds.2020-18743

13. Taguchi K. Relationship between degree of dehydration and serum electrolytes and acid-base status in cows with various abomasal disorders. J Vet Med Sci. 1995;57(2):257-260. Available from: https://doi.org/10.1292/jvms.57.257

14. Jarvis AM, Harrington DWJ, Cockram MS. Effect of source and lairage on some behavioral and biochemical measurements of feed restriction and dehydration in cattle at a slaughterhouse. Appl Anim Behav Sci. 1996;50(1):83-94. Available from: https://doi.org/10.1016/0168-1591(96)01070-2

15. Constable PD. Treatment of calf diarrhea: antimicrobial and ancillary treatments. Vet Clin North Am Food Anim Pract. 2009;25(1):101–120. Available from: https://doi.org/10.1016/j.cvfa.2008.10.012

16. Ninković M, Zdravković N, Nikolic M, Pavlović M, Jezdimirović N, et al. Rotavirus diarrhea in calves before and after vaccination - experience. In: 28th Annual Conference of Doctors of Veterinary Medicine of the Republic of Srpska (Bosnia and Herzegovina); 2023 BC 68-70.

17. Roussel AJ. Fluid therapy in mature cattle. Vet Clin North Am Food Anim Pract. 2014;30(2):429-439. Available from: https://doi.org/10.1016/j.cvfa.2014.04.005

18. Adams J. Fluid therapy in adult cattle. Livestock. 2015;20(1):32-37. Available from: http://dx.doi.org/10.12968/live.2015.20.1.32

19. Erdogan H, Voyvoda H. Effects of rapid and ultra-rapid fluid resuscitation guided by blood lactate clearance rate in diarrheic calves. J Hell Vet Med Soc. 2019;70(1):1413-1420. Available from: https://doi.org/10.12681/jhvms.20349

20. Doré V, Foster DM, Ru H, Smith GW. Comparison of oral, intravenous, and subcutaneous fluid therapy for resuscitation of calves with diarrhea. J Dairy Sci. 2019;102(12):11337-11348. Available from: https://doi.org/10.3168/jds.2019-16970

21. Berchtold J. Treatment of calf diarrhea: intravenous fluid therapy. Vet Clin North Am Food Anim Pract. 2009;25(1):73–99vi. Available from: https://doi.org/10.1016/j.cvfa.2008.10.001

22. Santos MM, Bregadioli GC, Santos LG, Curti JM, Duarte CA, Cerri FM, et al. Treatment of acute rumen lactic acidosis with intravenous hypertonic sodium chloride or bicarbonate solutions followed by intraruminal water. Res Vet Sci. 2020;128:24-34. Available from: https://doi.org/10.1016/j.rvsc.2019.10.009

23. Ninković M, Zdravković N, Žutić J, Nikolić M, Jezdimirović N, et al. Application of lab ferment (chymosin) in the therapy of neonatal diarrhea in calves. In: V Symposium with international participation - Health protection and reproduction of ungulates, ungulates, poultry and carnivores; Belgrade; 2023.

24. Pempek JA, England Z, Habing GG, Niehaus A. Rehydration post-transport: duration of oral fluid therapy on behavior, biochemical measures of hydration, and health of neonatal dairy calves. J Anim Sci. 2024;102:skae011. Available from: https://doi.org/10.1093/jas/skae011

25. Constable PD. Principles of treatment of diarrhoea in calves: SIVAR National Congress-Cremona 7-8 May 2010. Large Anim Rev. 2010;16:139-142. Available from: https://www.researchgate.net/publication/297429356_Principles_of_treatment_of_diarrhea_in_calves

26. Weaver DM, Tyler JW, VanMetre DC, Hostetler DE, Barrington GM. Passive transfer of colostral immunoglobulins in calves. J Vet Intern Med. 2000;14(6):569-577. Available from: https://doi.org/10.1892/0891-6640(2000)014%3C0569:ptocii%3E2.3.co;2

27. Lewis LD, Phillips RW. Treatment of the calf with diarrhea. Vet Clin North Am Food Anim Pract. 2017;1(2):395-409. Available from: https://doi.org/10.1016/s0196-9846(17)30191-x

28. Abutarbush SM, Petrie L. Treatment of hypernatremia in neonatal calves with diarrhea. Can Vet J. 2007;48(2):184-187. Available from: https://pubmed.ncbi.nlm.nih.gov/17334033/

29. Aydogdu U, Yildiz R, Guzelbektes H, Naseri A, Akyuz E, Sen I. Effect of combinations of intravenous small-volume hypertonic sodium chloride, acetate Ringer, sodium bicarbonate, and lactate Ringer solutions along with oral fluid on the treatment of calf diarrhea. Pol J Vet Sci. 2018;21(2):273-280. Available from: https://doi.org/10.24425/119048

30. Byers SR, Lear AS, Van Metre DC. Sodium balance and the dysnatremias. Vet Clin Food Anim Pract. 2014;30(2):333-350. Available from: https://doi.org/10.1016/j.cvfa.2014.03.003

31. Hallowell G, Remnant J. Fluid therapy in calves. In Practice. 2016;38(9):439-449. Available from: http://dx.doi.org/10.1136/inp.i4668





**Citation:** Bojkovski J, Ninković M. Disorder of Water and Electrolyte Balance in Cattle. Animal Husbandry Arch. 2025;1(1):001-004. Available from: https://dx.doi.org/10.17352/aha.000001