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Enteritis: Still a Problem in Dairy Calves

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Abstract

The neonatal phase of calves is a phase that needs extra care due to newborns' vulnerability. Enteritis - an inflammation of the intestinal mucosa, resulting mainly in diarrhea - stands out among the conditions that affect animals in this period. Enteritis are responsible for huge losses in cattle breeding, especially in the early stages of rearing. Besides the losses caused by mortality, there are also expenses with veterinarians, treatments and decreased performance of the animal throughout its productive life. The present study aimed to perform a review of diarrhea in newborn calves.

Keywords: Neonatal diarrhea; Infectious agents; Dairy cattle

Abbreviations: ETEC: *E. coli* enterotoxigenic; EHEC: *E. coli* enterohemorragic; BVDV: Bovine Viral Diarrhea Virus

Introduction

The neonatal period in cattle - that goes from birth to 28 days of age - is especially important from a health point of view, since approximately 75% of losses in young calves occur in this phase [1], and the first week of life is considered the most critical phase, with 50% of losses. Therefore, maintaining the health of calves is highly related to the hygiene of the place where they live, as they are extremely sensitive to environmental pathogens [2]. Lorenz [3] report that there are several measures to maintain calf health from birth to weaning, including the provision of good quality colostrum in adequate quantity in the first hours after birth and the need to emphasize the prevention of diseases of the gastrointestinal tract and respiratory system. Among the main conditions that cause loss in the early stages of calves development are pneumonia, malformations, central nervous system diseases, and enteritis [4]. Enteritis is clinically mainly manifested by diarrhea and stands out due to its high mortality rate [2,3,5,6], since it is commonly difficult to recover because it is almost always accompanied by malnutrition [7].

Diarrhea is a complex multifactorial disease involving animal, environmental, nutritional, and infectious agents and it is a major cause of mortality, morbidity, and economic loss in cattle worldwide [8], because the treatment of affected calves is slow and impacts on growth, weight gain to weaning and loss of genetic potential of recovered animals [9]. Due its clinical and economic importance and due the preventive measures are often neglected, it is necessary an approach on this subject, to broaden the knowledge and to promote a better conduct regarding the prevention, diagnosis and treatment of the affected animals. Therefore, the present study aimed to review diarrhea in newborn calves.

Diarrhea in Newborn Ruminants

Table 1: Incidence of diarrhea in calves in different countries.

Country	Incidence Rate	Year	Researchers
Australia	4,5%	2013	Lievaart et al.[12]
Bangladesh	34,82%	2015	Islam et al. .[13]
Belgian	1,5%	2013	Pardon et al. .[14]
Brazil	25,7	2014	Fagundes et al. .[15]
Canada	23%	2018	Galarza et al. .[16]
USA	29%	1997	Donavan et al. .[17]
Ethiopia	10%	2009	Megersa et al. .[18]
Ethiopia	52,3%	2017	Hussen et al. .[19]
France	5%	1999	Bendali et al. .[20]
India	52,51%	2012	Malik et al. .[21]

Newborn calf diarrhea is a disease of great impact on the economic viability of cattle herds worldwide [10] (Table 1). The economic impact caused by this condition is significant, although many new intervention strategies, such as vaccine development,

drug development and herd management, have been developed and implemented to minimize it [2]. In this sense, the veterinarian needs to assess the status of immunoglobulins in calves, feeding, shelter, environmental disinfection, hygiene and sanitary management, to prevent neonatal deaths caused by the disease [11]. The processes involved in the pathophysiology of diarrhea are related to intestinal secretion/ hypersecretion, nutrient bad absorption and digestion, osmolarity, abnormal intestinal motility, increased hydrostatic pressure, and gastrointestinal inflammation [12-21], which may occur singly or, more commonly, by the combination of two or more factors of these mechanisms [22,23].

Secretory diarrheas occur due to abnormal stimuli to the intestinal mucosa crypts that may be caused by the action of enterotoxins and/ or the action of inflammation mediators such as prostaglandins, causing an imbalance in physiological processes, like secretion and intestinal resorption, with consequent diarrhea [24]. Diarrhea is typically profuse without blood or effort, and signs in affected calves include depression, weakness, and sometimes shock and death secondary to hypovolemia and mild acidemia [25]. The difference in osmolarity with increased concentration of solutes within the intestinal lumen, promotes greater absorption of water by the lumen, thus resulting in dehydration of the animal. Osmotic particles include poorly digested disaccharides and increased levels of D-lactate from bacterial fermentation of unabsorbed nutrients entering the colon. Reduced intestinal transit time can lead to poor digestion and malabsorption due to inadequate time for digestion and absorption of ingested food, impaired fluid resorption has a major impact on fluid balance [23].

When a calf has diarrhea, there is a huge loss of fluids and electrolytes from its body. Thus, the consequent dehydration and the appearance of metabolic acidosis are the main causes of death of these animals [26]. This happens partly because the evaluation of the animal is generally based only on clinical examination, and a more detailed approach to assessing the degree of electrolyte disturbance and acidosis through blood gas analysis is lacking or not [27]. Although this condition being common in rural properties, treatment is usually inadequate and / or insufficient, because the administration of antibiotics and anti-inflammatory drugs do not correct the hydroelectrolytic disorders and acid-base [28]. Therefore, in order for the recovering of the animal, these parameters must be measured and corrected quickly, enabling the return to homeostasis. The high frequency and persistence of calf neonatal diarrhea has attracted the interest of many researchers. The multifactorial etiology (bacteria, viruses and protozoa) influenced by nutritional and environmental factors, as well as difficulties in the precise diagnosis of the agent and the failure of treatment has required the adoption of prophylactic measures, such as cow hygiene, management and vaccination [8].

Diarrhea Infectious Agents

Diarrhea is a condition of complex multifactorial etiology, influenced by infectious, nutritional and environmental factors, as well as improper management practices. Causes include toxins, bacteria, protozoa, viruses, and management / environmental factors such as overfeeding, low temperature, poor hygiene, colostrum deprivation, and individual susceptibility of the animal [8]. Numerous infectious agents have been implicated in diarrhea of calves, such as *Escherichia coli, Salmonella spp., Cryptosporidium spp*., Rotavirus and coronavirus. Coinfection is commonly seen in diarrheal calves, although a single primary pathogen may be the cause in some cases. The non-infectious causes of origin are related to improper management and poor hygiene of the environment in which the animals are placed. The incidence of the disease may vary according to the geographical location of the farms, farm management practices and herd size [2]. Rotaviruses, coronaviruses and cryptosporides, the most commonly recognized enteric pathogens of calves, all produce intestinal villi atrophy, intestinal bacterial overgrowth, malabsorption, and osmotic diarrhea [25].

Table 2: Aetiological agents that cause diarrhea in calves according to age group [23].

Agent	Age of the animal
E. coli (ETEC, K99)	0-7 days
E. coli (EHEC)	2 days-4 weeks
Rotaviruses	5-14 days
Coronaviruses	5 days-1month
Cryptosporidium	1-4 weeks
Clostridium perfringens	Varies with type
Salmonella	5-14 days, anytime
Giardia	2 weeks-2 months
BVDV	First month of life, anytime
Nematodes	After the 3 first weeks of life
Coccidians *(Eimeria)*	After the first week of life

In general, infections caused by viruses and protozoans tend to damage the intestinal mucosa promoting alteration in intestinal absorption due to damage to intestinal cells, compromising the normal absorption of nutrients, fluids and electrolytes, without alteration in intestinal secretion [22]. Rotaviruses are the most common cause of diarrhea in newborn calves and are often involved in co-infections with other agents [11,23,25]. Clinical signs usually appear 1 to 3 days after infection lasting 5 to 9 days [23]. High environmental contamination, herds with high numbers of animals and management that favors the transmission of the agent, associated with an inexpressive immunization rate, provide favorable conditions for the spread of rotavirus in dairy herds in Brazil, justifying the prevalence and difficulty to control the infection and the spread of the virus [28]. The incidence of many etiological agents varies with the calf's age (Table 2) and this is useful for establishing the probability of a particular agent being involved and it is generally impossible to establish a definitive field diagnosis [11].

Diarrhea may result from hypersecretion or decreased absorption. Enteropathogenic strains of *E. coli* are occasionally causing diarrhea in calves [29]. Enterotoxigenic *E. coli, Salmonella*

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spp, Campylobacter spp. and rotavirus cause diarrhea by secreting enterotoxins that stimulate increased intestinal secretions, while protozoa and enteric viruses cause epithelial destruction of the absorptive cell villi. Enterotoxigenic E. coli produces profuse watery diarrhea, mainly in calves older than 4 days of age and occasionally in older calves. The F5 antigen may produce a mild clinical syndrome characterized by diarrhea, dehydration and weakness in calves from 1 to 4 days of age with rapid course and may progress from healthy to decubitus and death from 6 to 12 hours [11]. Salmonella spp. is an important causative agent of diarrhea and septicemia in dairy calves and the depression caused in the animal is probably due in part to endotoxemia, not just dehydration and acidosis. Campylobacter jejuni and Campylobacter fecalis are believed to be of minor importance in calves and lambs [11].

Cryptosporidium is cited as the main agent of diarrhea in calves, not only as an opportunistic agent, but also as a primary agent. Preventive measures should be taken related to the management of cows at the time of giving birth, avoiding the agglomeration of animals and environmental contamination to reduce economic losses, and to avoid the risks to public health arising from infection [24]. The recognition of enteropathogens guides the adoption of effective prevention and control measures, besides alerting to public health reflexes, due to the zoonotic potential of several of these enteric pathogens [29,30].

Treatment

Table 3: Parameters for determining the degree of dehydration in newborn calves [11].

%Dehydration	Eyeball Shrunk In Orbit	Skin turgor (seconds)	mucous membranes
0	No	<1	Wet
1-5	Shrunk / Slight	1-4	Wet
6-8	Slight separation of eye and globe	5-10	Slimy
9-10	Aperture <0.5cm between eyeball and orbit	11-15	Slimy or dry
11-12	Aperture, 0.5 to 1cm, between eyeball and orbit	16-45	Dry

Physical examination of the diarrheal calf comprises the first step in establishing the therapeutic approach, requiring the determination of the presence of any intercurrent disease. Treatment of simple cases depends on the estimative of dehydration (Table 3), severity of acidosis, likelihood of concomitant infection, presence or absence of hypothermia and hypoglycemia [11]. The most common causes of death are dehydration and acidosis. Blood gas analysis will accurately determine the degree of metabolic acidosis [29] (Table 4). Therefore, the immediate goal in treating depressed calves is to restore them to physiological systemic status. The estimated severity of dehydration can be combined with estimates of diarrhea loss and maintenance of essential functions to manage total daily fluid requirement [11,29].

Table 4: Reference values for venous blood hemogasometry in Holstein calves.

Parameter	Reference value
pH	7.31 – 7.38
pCO_2 mmHg	49.23 – 58.57
pO_2 mmHg	22.80 – 33.16
HCO_3- mmol/L	26.8 – 30.74
TCO_2 mmol/L	27.63 – 32.35
BE mmol/L	0.8 – 5.5
StB mmol/L	24.35 – 28.47
$SatO_2$ (%)	30.12 – 53.84

Abbreviations: pCO_2, carbon dioxide pressure; pO_2, oxygen pressure; HCO_3-, plasma bicarbonate concentration; TCO_2, total carbon dioxide in plasma; BE, base excess in the blood; StB, standard bicarbonate blood concentration; $SatO_2$, blood oxygen saturation. Fonte: Lisbôa et al. [31]. Replacement may be administered intravenously or orally, reminding that for the latter one should be increased by 60 to 80% for partial fluid absorption [11,29]. If performed early in the disease, oral replacement can be highly effective and inexpensive. In animals with severely impaired intestinal motility, the intravenous way may be more effective in correcting hydroelectrolytic imbalances than oral administration [23]. Success of therapy is monitored based on clinical signs of calf and restoration of urination [11]. Another point to consider in chronically diarrheal calf is the need for nutritional support. When a samll quantity of milk or solid food is ingested, energy-rich oral electrolytes may be used to maintain the body condition of the animal. Stop giving milk can reduce the severity of diarrhea and depression in severe diarrhea, because malabsorption exacerbates diarrhea by the osmotic effect of unabsorbed milk nutrients and also promotes bacterial proliferation and possibly poor fermentation generating organic acids. However, stop giving milk reduces weight gain [11].

Antibiotic use is frequent in the treatment of diarrhea, although few agents respond to antimicrobials, viral and parasitic agents are not directly sensitive to antibiotics. Their indiscriminate use promotes the selection of resistant strains and complicates future therapeutic efforts. However, they can attenuate clinical disease, decrease the release of pathogens to the environment and animal mortality [11,29]. Some treatment protocols include the use of anti-inflammatory drugs to help reduce the secretory effects of some agents [11]. The use of non-steroidal anti-inflammatory drugs (NSAIDs) should be restricted in dehydrated animals and administered only when the patient is sufficiently hydrated [23]. The use of probiotics, oligosaccharides and intestinal protectors is also cited, and the use of gastrointestinal motility modifiers is contraindicated, as the reduction in motility will lead to the accumulation of bacteria and pathogenic toxins [29].

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Prevention

The principles of prevention are based on ensuring adequate colostral intake, specific help and nonspecific immunity, reduction of the possibility of introduction / dissemination of infectious agents [11]. Colostrum is important in preventing morbidity and mortality of diarrheal calves. Colostral antibody is responsible for the low incidence of rotavirus infections in calves under 4 days of age. Vaccination of pregnant cows is important to increase colostral immunity. Colostrum privation, lack of maternal instinct, and early separation of cow and calf are major causes of failure to transfer immunity in dairy calves [11]. Prophylactic measures include separating calves from each other with enough space to prevent contact and infection through contaminated feces and urine. All feeding facilities and equipment (buckets and bottles) must be maintained with strict hygiene conditions. There is not much difference between the patterns of disease development and the prevention of calf diarrhea according to each etiological agent. Knowledge of the causal pathogen (s) is important to accurately avaliate the current status of the affected property and to develop new interventions [2].

Final Considerations

Diarrhea in newborn calves is a complex disease involving animal, environmental, nutritional and infectious agents that is of great clinical and economic importance for ruminant breeding, especially for dairy cattle. It is responsible for significant economic losses related to reduced productivity, treatment costs, growth retardation, discard of future breeders and death of animals in more severe cases. Care of calves should be considered even before birth (vaccination of pregnant cows), and maintained after birth, with the provision of quality colostrum in adequated quantity, hygiene of facilities and utensils, early diagnosis and treatment thus avoiding fatal cases.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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