



REVIEW PAPER

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Neonatal calf diarrhea induced by rotavirus and coronavirus: a review

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Abstract

Diarrhea is one of the most serious diseases in neonatal calves. It causes serious economic damages by reducing of weight gain and increasing mortality rate. Calves are at the greatest risk of diarrhea in a first month of life. Neonatal calf diarrhea is a complex syndrome with various etiologies. Several families of viruses cause diarrhea. However, rotavirus and coronavirus are two major causes of diarrhea in newborn calves. This review study summarizes the results of some studies on rota and corona viral diarrhea in calves. Most of these results indicate that rotavirus and coronavirus are widespread in diarrheic calves with considerable differences in prevalence rates in various geographical regions and seasons.

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Introduction

Calf diarrhea has been recognized for decades as a serious problem. The incidence risk of calf diarrhea in calves less than 30 days old, estimated by several studies between 15% to 20 % with mortality rate between 1/5% to 8% (Bendali *et al.*, 1999; Waltner Towes *et al.*, 1986). Diarrhea in neonatal calves causes poor growth and even death because of dehydration and electrolyte imbalance. Calf diarrhea is a complex syndrome (Fuente *et al.*, 1998; Reidy *et al.*, 2006). The etiology of diarrhea is multifactor and may include infective (Table 1), environmental, nutritional and management factors such as calves being born from a heifer, being born during summer, low serum IgG concentration and large herd size (Blom *et al.*, 1982; Frank and Kaneene, 1993; Svensson *et al.*, 2006). Some of studies show that the most important pathogen agents in calf diarrhea are rotavirus, coronavirus, enterotoxigenic E.Coli, salmonella species and cryptosporidium (Reynolds *et al.*, 1986; Steiner *et al.*, 1997). 75% to 90 % of calf diarrhea is related to rotavirus, coronavirus, enterotoxigenic E.Coli and cryptosporidium (Radostits *et al.*, 2007).

Several families of viruses cause diarrhea in neonatal farm animals include: Reoviridae, Corona viridae, Toroviridae, Parvoviridae, Calciviridae and Astroviridae (Deng *et al.*, 2003).

Rotavirus and coronavirus are the most common causes of viral neonatal calf diarrhea (Mayameei *et al.*, 2010). Rotavirus and coronavirus can produce high-morbidity outbreaks of diarrhea in neonatal calves. In some reports, rotavirus is the most prevalent pathogen in less than one month old diarrheic calves (Radostits *et al.*, 2007; Reynolds *et al.*, 1986; Snodgrass *et al.*, 1986). In a study in Britain, rotavirus and coronavirus were detected in 208 (42%) and 69 (14 %) of 490 calves respectively (Reynolds *et al.*, 1986).

The prevalence of pathogens can vary in different geographical location of the farms. Calf diarrhea is a complex disease because of multifactorial nature. So considering the risk factors of each pathogen along with detecting the pathogens by laboratory diagnostic tests and farm management can be useful for controlling of calf diarrhea.

The aim of this study is to evaluate the role of rotavirus and coronavirus in diarrheic calves in various aspects. Also the prevalence of rota and corona viral diarrhea in different

studies and the main risk factors of disease outbreaks are described.

Virus structure and transmission

Rotavirus

Rotaviruses of family reoviridae are the most causes of diarrhea in farm animals. This pathogen is double stranded RNA virus. The genome of this virus consists of 11 unique double helixes molecular of RNA. Each helix is segment numbered 1 to 11. The RNA is surrounded by a three-layered of protein capsid. Virions are about 60-80 nm in diameter. Virus replication occurs in cytoplasm. Seven serogroups of rotaviruses have been recognized (A to G). Each of these serogroups are classified by specificity of the outer capsid proteins, Vp7 (G serotype) and Vp4 (P serotype). Group A rotaviruses are the most frequently detected virus in farm animals especially neonatal calf diarrhea. However, group B rotaviruses are usually isolate from adult diarrheic calves (Fenner *et al.*, 1993; Radostits *et al.*, 2007).

Coronavirus

This pathogen is a member of coronaviridae family. The genome is a single stranded RNA. The most important protein of virus is a nucleocapsid protein. Also, several envelope and spike proteins have been recognized for this pathogen. Coronaviruses replicate in the cytoplasm (Fenner *et al.*, 1993; Radostits *et al.*, 2007).

Newborn calves are usually infected from feces of other diarrheic calves, especially in calving season (Fields *et al.*, 1995).

Pathogenesis

The main place for rotavirus infection is brush border of villous epithelial cells in the small intestine. The infected cells are rapidly replaced with undifferentiated crypt cells and results in reducing activity of lactase in villous (McGavin and Carlton, 1995).

The pathogenesis of coronavirus and rotavirus are similar. However, the coronavirus infections are more virulent and atrophy of both small and large intestines are more common (McGavin and Carlton, 1995).

Coronavirus in adult cattle leads to winter dysentery which is closely related to the coronavirus causing neonatal calf diarrhea (Radostits *et al.*, 2007; Smith, 2009).

Table 1. Main pathogenic causes of calf diarrhea (Millemann, 2009).

Bacteria	Viruses	Parasites
E.Coli:ETEC ¹ ,EPEC ² ,EHEC ³	Rotavirus	Cryptosporidium
Salmonella	Coronavirus	Giardia
Clostridium	Torovirus(Breda)	Eimeria bovis or zuernii
Campylobacter	BVD ⁴	Candida
	Calcivirus(Norovirus)	Toxocara
		Strongyloides
1-Enterotoxigenic E.coli.	3-EnterohemorrhagicE.coli.	
2-Enteropathogenic E.coli.	4- Bovine Viral Diarrhea.	

Clinical diagnosis

Viral diarrhea usually occurs in explosive outbreak by a sudden onset of a liquid diarrhea. Feces are usually mucoid and voluminous. Nevertheless, some studies showed that there was no significant correlation between characters of feces and clinical signs with the enteropathogens (Barrington *et al.*, 2002; Radostits *et al.*, 2007).

In some cases of corona infection, clinical signs of mild respiratory disease occur between 2 and 16 weeks of age, because bovine coronaviruses addition to intestinal disease, can replicate in respiratory system too (Fenner *et al.*, 1993).

Some common symptoms such as: hyperthermia, metabolic acidosis (because of bicarbonate losing that leads to high blood levels and low cellular levels of potassium) and progressive dehydration (leads to sunken eyes and reduction in skin turgor) are usually seen in diarrheic calves (Barrington *et al.*, 2002; Millemann,2009).

Laboratory diagnosis

Diagnosis is done through collecting feces of diarrheic calves by a rectal swab or intestinal content (Castro and Heuschele, 1992) and then using laboratory diagnostic tests such as: direct electron microscopic test, ELISA, latex agglutination, polyacrylamide gel (Parwani *et al.*, 1992; Radostits *et al.*, 2007) and RT-PCR (Izzo *et al.*, 2011).

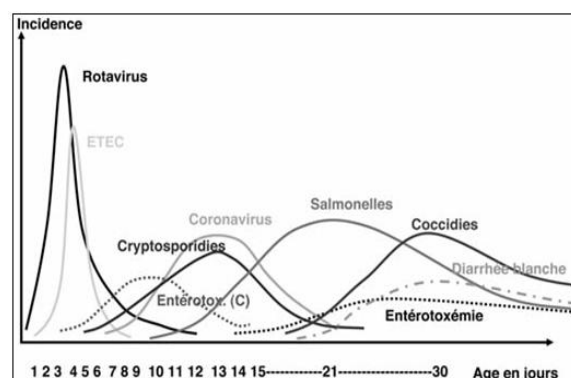


Fig. 1. Prevalence of common causes of calf diarrhea according to the age (Naylor, 2002).

ELISA is one of the essential methods for virus detection. It is used widely in calves with diarrhea for determination of

rotavirus (Al-Robaiee and Al-Farwachi, 2013; Gulliksen *et al.*, 2009; Gulliksen *et al.*, 2008; Langoni *et al.*, 2004; Moosakhani *et al.*, 2012; Okur Gumusova *et al.*, 2007) and coronavirus (Gulliksen *et al.*, 2009; Okur Gumusova *et al.*, 2007).

ELISA have some advantages than other laboratory diagnostic tests such as being inexpensive for examination of many samples and being much more sensitive (Mayameei *et al.*, 2010).

Necropsy

The length of the infected villous will be shorter and atrophy. As a result of this change, hyperplasia occurs in intestinal cells. In mixed infections of rotavirus and coronavirus with enteropathogenic E.coli, destruction is more severe (Fenner *et al.*, 1993; McGavin and Carlton, 1995).

Rotavirus and coronavirus Risk factors

There are some important risk factors for occurring diarrhea in calves such as: age of animal, immune system, presence of mixed enteropathogens and amount of pathogens (Radostits *et al.*, 2007).

Age of calves

The most common age of occurrence for rotavirus is 5-15 days and for coronavirus is 5-21 days (Fig. 1). Coronavirus is more common in older calves than rotavirus (Smith, 2009). The most percentage of rotavirus and coronavirus morbidity is in less than one month old diarrheic calves.

Immune system status in calves

Immunoglobulins of colostrum are IgG1, IgG2, IgM and IgA. 80% of the total immunoglobulins are IgG1 (Blom, 1982). In calves, passive transfer of maternal antibodies occurs in the first 20-48 hours after birth via colostrum. An important characteristic of rotavirus and coronavirus for infecting calves is dependent on the presence of colostrum antibodies in the lumen of calves. Because of antibody protection, rotavirus diarrhea does not occur in the first days of birth. Lack of specific antibody in diarrheic calves can explain the cause of increasing rate of mortality in these calves as a

result of infections (Barrington *et al.*, 2002; Kohara and Tsunemitsu, 2000).

In calves, two major serum acute phase proteins have been determined: serum amyloid A (SAA) and haptoglobin (HP) (Horadagoda *et al.*, 1993).

According to a study in Iran in 2011, SAA and HP significantly increased in diarrheic calves especially in Enterotoxigenic E.Coli (ETEC), combined rotavirus+ cryptosporidium and coronavirus+ cryptosporidium infections (Pourjafar *et al.*, 2011).

The fetal stresses as a result of dystocia or environment, immature immune system, inability to consume or an inadequate supply of colostrum are some physiological causes of immune system suppression in neonatal calves. Viral infections such as bovine viral diarrhea (BVD) destroy T and B lymphocytes and increase the susceptibility of the calf to other infections (Roussel and Hjerpe, 1990).

Seasonal effects

Rotavirus

In many studies, the rate of rotavirus incidence have been reported higher in cold season (Brandt *et al.*, 1982; Nourmohammadzadeh *et al.*, 2012), because it has determined that low temperature and relative humidity, increase the survival of rotavirus (Brandt *et al.*, 1982; Fields *et al.*, 1995). In addition, titer of IgG colostrum from dairy cows in winters is lower than IgG concentration in other seasons (Gulliksen *et al.*, 2008).

In a study made by Brenner *et al.* (1993) on 483 fecal samples from diarrheic calves, the highest incidence of rotavirus reported in the month of December, January, February and March.

Coronavirus

In a study made by Trotz Williams *et al.* (2007), prevalence of coronavirus was estimated 2% in summer and 9% in winter.

The number of coronavirus diarrhea in calves is higher during winter in some studies, because of increasing survival of coronavirus in cold season (Radostits *et al.*, 2007).

In contrast with some studies, in a research in Iran, there was no significant relationship between coronavirus prevalence and season (Moosakhani *et al.*, 2012).

Prevalence

Rotavirus

Rotavirus was detected first time in diarrheic calves by mebus in 1969 (Mebus *et al.*, 1971). Several studies in some different regions indicated that cryptosporidium and rotavirus were the most common isolated pathogens in diarrheic calves (Moosakhani *et al.*, 2012; Reynolds *et al.*, 1986; Sherwood *et al.*, 1983; Snodgrass *et al.*, 1986). Rotavirus prevalence in some countries such as: Italy, Germany, France, Japan and USA has been reported in high percent, because multiple hosts and serotypes have been recognized for this pathogen (Castrucci *et al.*, 1988; McKercher *et al.*, 1984).

Research conducted by Shah and Jhala (1992), Ishizaki (1995), Al Robaiee and Al-Farwachi (2013) reported the rate of rotavirus infection in diarrheic calves about 20%, 22% and 15.5%.

In a study in Brazil, 203 fecal samples of less than one month old diarrheic calves were examined by Capture ELISA and rotavirus was recognized as the highest prevalence pathogen alone in 25.15% and combined with cryptosporidium in 41.7% of fecal samples (Langoni *et al.*, 2004).

In another research in Australia, screened by RT-PCR, rotavirus was the most common pathogen identified in 79.9% of 597 fecal samples (Izzo *et al.*, 2011).

In contrast with many studies, prevalence of rotavirus in Norway (Gulliksen *et al.*, 2009) and Austria (Haschek *et al.*, 2006) were reported only 9.9% and 9.1%. The reduction rate of pathogen in these regions is possibly because of restrictive rules in trade of animals and high level of hygiene in farms.

Coronavirus

Coronavirus in neonatal calf diarrhea was detected first time by Stair *et al.* in 1972. In two studies in Austria, corona was the most common pathogen in diarrheic calves (Haschek *et al.*, 2006; Herrera-Luna *et al.*, 2009). There are differences in corona prevalence between various locations in some researches such as: Turkey 1/96% (Okur Gumusova *et al.*, 2007), Costa Rica 9% (Perez *et al.*, 1998) and Switzerland 7/8% (Uhde *et al.*, 2008).

According to Gulliksen *et al.* (2009) report, coronavirus was not found in any of 191 fecal samples

were collected from 135 herds in Norway. In this study researchers used antigen ELISA for first time and RT-PCR for second time, however the results were similar.

In another study in Finland, there was not any corona infected sample (Pohjola *et al.*, 1986).

Combined infections with other enteropathogens

Mixed infections of rotavirus with enterotoxigenic E.coli (ETEC) or bovine viral diarrhea (BVD) in diarrheic calves result in a more severe disease (Verdier Klingenberg., 2000).

In a study made by Fuente *et al.* (1999), rate of mixed infections from 218 diarrheic fecal samples for cryptosporidium + rotavirus and cryptosporidium + coronavirus were 87% and 11/1%.

In another study in Spain, rotavirus and coronavirus were found in 42/7% and 7/3% of fecal samples from diarrheic calves. Mixed pathogens of rotavirus and coronavirus were found in 5/1% of the total samples (Fuente *et al.*, 1998).

Langoni *et al.* (2004) found combined rotavirus + cryptosporidium infections in 17/7% from 203 diarrheic fecal samples in less than 30 days old calves.

Angus *et al.* (1983) reported that the prevalence of combined rotavirus + cryptosporidium infections were the most mixed pathogens in comparison with other enteropathogens.

Control and management

There is no specific treatment for viral diarrhea, but therapy based on rehydration and the supply of electrolyte buffer (oral or parenteral fluid therapy) is essential. Oral electrolyte treatment is ineffective in calves with severe clinical dehydration. Sodium bicarbonate is the alkalinizing agent that is a good choice for decreasing acidosis in the diarrheic calves (Radostits *et al.*, 2007).

Fasting is not recommended for more than 48 hrs. Milk feeding times should not be ignored in diarrheic calves and also milk should be fed in a small amount and more times per day (Smith, 2009).

It is necessary to decrease the stress and exposure of calves to virus. Once the environment becomes contaminated, each new case of scours significantly increases the number of environmental pathogens. Diarrheic calves should be transferred in dry and clean single boxes. Control of population density and hygiene of herd are useful for decreasing risk factors of diarrhea. High risk cattle herds for

calf scours include large herds and herds with a high percent of heifers. Boxes should be remained empty for one week before new calving. Changing and disinfecting of calves bedding once a week leads to reduction of the diarrhea risk factors (Barrington *et al.*, 2002; Maddox-Hyttel *et al.*, 2006).

The most important factor for immunity of a new born calf is amount of colostrum intake. At least, 4 liters of colostrum should be fed to neonatal calves during the first 12 hours. To improve the passive immunity of neonatal calves, twice vaccination of the pregnant dams (6 to 8 and 2 to 3 weeks) before parturition with a vaccine containing rotavirus, coronavirus and E.Coli (k99) can be effective (Radostits *et al.*, 2007; Smith, 2009).

Conclusion

The rate of rotavirus and coronavirus prevalence in diarrheic calves can be influenced by some risk factors such as: different geographical regions, seasonal effects, neonatal calf immune system status and farm management.

The results of the several studies show the differences in the prevalence of rotavirus and coronavirus in diarrheic calves in various regions.

Considering the risk factors of calf diarrhea associated with using of suitable preventive management in farms may be effective for decreasing neonatal calf diarrhea.

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