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Calf scour: An obstacle in successful dairying: A review

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Abstract
The success of any dairy enterprise and its future depends on the survival of the calf crop. Calf scour has been regarded as the most common cause of neonatal morbidity and mortality. Infectious agents i.e. *Rotavirus, Coronavirus, Salmonella species, Clostridium* species, enteropathogenic *Escherichia coli*, *Cryptosporidium* and *Coccidia* species are mostly attributed to calf scour. Other potent non-infectious causes of calf scour include herd size, unhygienic housing, colostrum deprivation, unprompt treatment of clinical cases, vaccination deprivation of the dam, and faulty management conditions. The diarrheic calves suffer from the electrolyte imbalance causing mortality of the calves. Holistic restraint of clinical diarrheic cases can be achieved through prompt fluid and antimicrobial administration, hygienic housing, adequate colostrum feeding and prepartum vaccination of the dam.

Keywords: calf diarrhea, infectious agents, noninfectious agents

1. Introduction
Calves are the future assets of the dairy industry. The success of any breeding programme, dairy enterprise and its future depends on the survival of the calf crop and better management practices [3, 12, 44]. Neonatal calf diarrhea (NCD) is the most common cause of morbidity and mortality in pre-weaned dairy calves, causing huge economic and productivity losses to dairy industry worldwide and is the greatest single cause of death [8]. The economic losses occur due to impaired growth rate, chronic ill thrift, veterinary interventions of diagnostics, drugs, mortality and thereby decreased number of replacement stock [5]. Calf diarrhea has the prevalence of 63.3 % [1] and incidence risk of 42.9% [44] and 34.82% [15, 28, 24]. NCD is a multifaceted and multifactorial syndrome including pathogen (infectious NCD) as well as non-infectious factors related to the animal (immunological and nutritional status), the environment or the management [16]. The aim of the review is to elucidate the infectious and non-infectious causes of calf diarrhea and its control and therapeutics.

2. Time of occurrence of diarrhea
The high incidence of diarrhea (78.9 %) among the diarrheic dairy calves occurred at the age of less than two months [1], however, [33] stated that most cases of diarrhea occurred in calves less than 30 days of age; acute diarrhea causing 75% calf deaths was three weeks [39]. The incidence of diarrhea had been assigned under three periods: postnatal (1-4 days), weaned and the transition to a newborn calf period [38]. Normally, illness lasted about a week, and the recovery period was 3-5 days. *Rotavirus, Coronavirus, Salmonella* and *Cryptosporidium parvum* affects the calves between five and 14 days of age. *E Coli, Salmonella, Eimeria* and *Giardia* affect the calves older than 14 days [1, 22]. The incubation period for enteric pathogens ranged from 12 hours to five days [26].

3. Etiology of diarrhea
It involves infectious factors like viral (coronavirus and rotavirus), bacterial (enterotoxigenic *Escherichia coli* (ETEC), *Salmonellae* species, *Campylobacter* species, *Clostridium* species), protozoal (*Cryptosporidium parvum, Coccidia* species), parasites, etc. [16, 7] and non-infectious factors (managemental factors like: nutrition, herd size, hygiene of barn, colostrum, stocking rate, etc.).

3.1 Infectious factors of diarrhea

i) Bovine *Rotavirus*

Rotavirus has an important etiological role in neonatal calf diarrhea, present upto 3 weeks of age in feces of diarrheic calves [37], however, rarely found during the first week of life [2]. Pathogenesis proceeds through replication of virus in epithelial cells of villi apices of the small intestine leading to desquamation of the epithelial lining and replacing the cuboidal epithelial cells by flattened squamous cells [34]. Death occurs mainly due to dehydration [29]. The interrelationships between the changes in body water, electrolytes and acid-base balance occurring in diarrhea is presented in figure I. Loss of appetite, drooling of saliva, profuse watery diarrhea, colour of faeces varies from yellow to green were the common clinical signs in infected cases, with a mortality rate of about 50%. Necropsy findings revealed increased volume of fluid in intestine with no pathognomic lesion in the intestine [22].

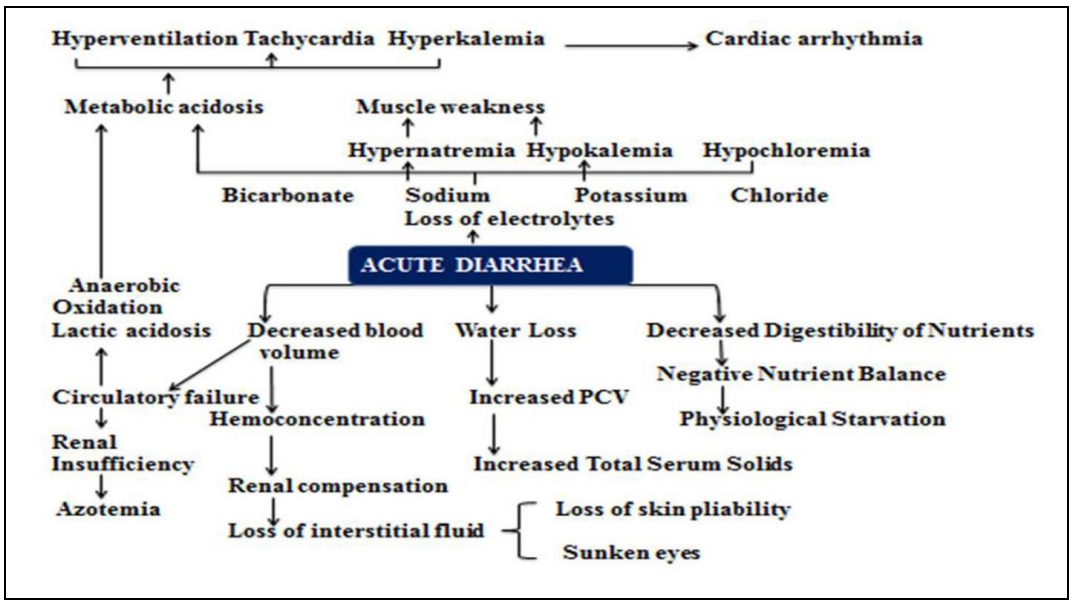

Fig I: Interrelationships between the changes in body water, electrolytes and acid-base balance in diarrheic cases.

ii) Bovine *coronavirus*

Bovine *Coronavirus* being the component of the acute diarrheal complex of neonatal calves causes serious economical problem in dairy and beef operations. The disease occurs in calves at 1 to 3 days or more weeks old [21, 30]. Calves are infected through both the oral and respiratory routes. Virus replication occurs in the surface epithelium of the villi in the lower small intestine leading to sloughing off of the infected cells, blunting of villi and severely diminishing the absorptive capacity of the gut. The decrease in digestive and absorptive capacities leads to water and electrolytes loss through diarrhea. In severe cases, diarrhea may lead to acute shock and heart failure [29, 37]. Clinical findings reveal profuse watery diarrhea, yellow to white coloured faeces, egg white like mucus in the faeces, infected lungs and upper respiratory tract and mortality rate varies from 1-25%. Necropsy findings reveal intestine fully loaded with liquid feces for several days, sometime gross lesions are found in the intestine, but they may be due to secondary [22].

iii) *Escherichia coli*

All calves get colonized by many varied strains of *E. coli* within a few hours of birth. This constantly changing population of organism inhabits the calf's intestine for life and is entirely normal and healthy [2, 32]. Among *E. coli* patho-groups, the most common cause of NCD is ETEC stains that produce the K99 (F5) adhesion antigen (*E. coli* K99+) and heat stable (*STa* or *STb*) and/or heat labile (LT1 or LT2) enterotoxins [18]. High prevalence of *E. coli* in diarrheic calves (75.6%) where serogrouping of *E. coli* isolates showed 10 Osero groups with O26 and O103 were the most prevalent (17.7% of each). The enterotoxigenic *E. coli* is shed into the environment by infected animals in the herd and are transmitted to the newborn calves through oral, respiratory system and naval cord soon after birth. Calves which have not enough amounts of immunoglobulins are highly susceptible to colibacillosis [29]. Clinical findings reveal weakness in 1–4 day old newborn calves, diarrhea and progressive dehydration, high temperature, foul-smelling white or yellowish to tarry black coloured faeces. Death usually occurs within 24 hours due to severe dehydration [7]. Diarrhea accounted for 63.3 % of the morbidity and *Escherichia coli* excreted by 26.3 % of the diarrheic calves [1]. Necropsy findings revealed several non-specific lesions in the intestine compounded with fluid and yellow coloured faces [33].

iv) *Salmonella*

Salmonella is a gram negative, rod shaped, motile, most common bacteria and of great importance in young animals. Overall prevalence of *Salmonella* was 18.1% while Serotyping of *Salmonella* isolates revealed that *S. Enteritidis* and *S. typhimurium* were the most prevalent serotypes, representing 60.9% and 30.4%, respectively, while *S. Dublin* was 8.7%. *Salmonella enteric* infection was usually recorded in the first 3 months of age causing severe symptoms [11]. The organism *Salmonella Dublin* or *Salmonella typhimurium* were the main cause of salmonellosis in calves [8]. *Salmonella typhimurium DT104* was highly pathogenic to calves with a range of antibiotic resistance [2]. Salmonella had morbidity of 20% in neonatal calves (28 days) and produces diarrhea in 2-12% calves [37]. Infected cattle and carriers can serve as source of infection for other animals or even human through food borne routes or direct contact and so the determination of *Salmonella* strains in fecal samples is not only important for

the diagnosis of salmonellosis, but also essential to identify the carriers [43]. Clinical findings reveals gastroenteritis with nausea, vomiting, foul-smelling and pasty to fluid fibrinous diarrhea with mucus, depression and elevated temperature and there will be endotoxic shock after antibiotic treatment of the ailment [29, 11]. Necropsy finding reveals membrane-like coating in the intestine is strong presumptive evidence of Salmonella infection [33].

v) *Clostridium perfringens*

Clostridium perfringens resides in the intestinal tract of domestic animals and produce the lethal toxins like alpha, beta, epsilon, iota, enterotoxin and cytotoxic beta -2 toxin that result in enteric and histotoxic disease. *C. perfringens* isolates are classified into one of five types, types A-E, depending on their ability to produce toxins. Enterotoxemia due to *C. perfringens* type B or C usually occurs as outbreaks of severe dysentery with some deaths in calves 7 to 10 days old, although calves up to 10 weeks of age may be affected [33]. The overall prevalence of microorganisms associated with diarrhea was 69.2% in which *Clostridium perfringens* was the highest (38.5%) within the first month of age [15, 35]. Clinical findings reveal affected calves become listless and shows straining and kicking at their abdomen with bloody diarrhea in some cases. Necropsy finding reveals hemorrhagic intestinal tract 'purple gut'. Types B and D may produce diarrhea without the usual postmortem lesions [22].

vi) *Cryptosporidium*

Cryptosporidium is an intestinal protozoan parasite that commonly infects dairy calves in the first month of life [2, 1]. The overall prevalence of microorganisms associated with diarrhea was 69.2% in which *Cryptosporidium* spp accounts for 7.7% within first month of age [15, 8, 21]. Diarrhea accounted for 63.3 % of the morbidity where *Cryptosporidium* gets excreted by 52.6 % of diarrheic calves [1]. *Cryptosporidium parvum* is the commonest species affecting calves and humans, and is readily transmitted to new born species of animals by the fecal oral route [2]. Infection with *Cryptosporidium* is generally self-limiting [41]. Clinical findings reveal yellow to brown coloured faeces and mixed infection with others producing syndrome of symptoms depending upon infection. Necropsy findings reveal there is damage in the micro villi of the small intestine [22, 33].

vii) *Coccidia*

Coccidiosis has the seasonal incidence and occurs most commonly in young animals showing a prevalence of 46% in calves, 43% in yearlings, and 16% in adult cows. Winter coccidiosis occurs in beef calves 6-10 months of age. The pathogenic coccidial species affecting calves include *Eimeria zuernii, E. bovis* and *E. ellipsoidalis*. Species of *E. alabamensis E. auburnensis* and *E. wyomingensis* may also cause disease in calves. *E zuernii* and E. bovis are most pathogenic to cattle [33]. Clinical signs include diarrhea, dysentery, tenesmus, appetite normal or inappetence, nervous signs in calves with coccidiosis in cold climates, loss of body weight, anemia in some cases but not common. Epidemics occur in calves especially feedlot animals. Blood stains may be in the faeces. Death may occur during the acute period or later due to secondary bacterial complication [22, 33]. Necropsy findings reveal Ileitis, cecitis, colitis, congestion, hemorrhage, and thickening of the mucosa of the cecum, colon, rectum, and ileum. Small, white cyst-like bodies, formed by large schizonts, may be visible on the tips of the villi of the tenninal ileum. Ulceration or sloughing of the mucosa may occur in severe cases [33].

3.2 Non-infectious factors of diarrhea

i) Nutritional diarrhea

It is caused by the change in milk quality, overfeeding, poor milk quality, stress and sudden change in diet. It is characterized by white colour watery diarrhea with sweet sour odour containing undigested feed articles. No significant necropsy lesion is observed [22, 33].

ii) Herd size

The occurrence of diarrhea was significantly associated with herd size [42] and time which the calf spends with a mother in the calving area [4]. Moreover, grouping relatively late in the calves' life (4-8 weeks) positively influenced morbidity, because the risk for diarrhea is the highest in the first three weeks of their life [40]. Intensification of livestock farming leads to a high concentration of animals in a small area favoring the spread of infectious diseases, particularly in calves [6].

iii) Cleanliness of the barn

Among the management risk factors investigated, cleanness of the calf house was found important [1, 25, 44] in relation to calf diarrhea thereby calf mortality and morbidity. Manure is an important source of pathogens and accumulation of it in the stall might contaminate calves feed and water exposing the calves to overwhelming pathogens and higher risk of diarrhea [1, 31]. Calves raised in free stalls had a higher incidence of diseases than those raised in tie stalls [14]. Burden of gastrointestinal nematodes was lowest at the end of the dry season, increased gradually through the rainy season to reach a peak at the end of the rainy season [20]. In calves, a higher plane of nutrition improves immune function [10] and also lowers mortality and the incidence of diarrhea [19].

iv) Colostrum

Calves are born agammaglobulinemia. Optimal passive transfer occurs within the first four hours post-partum and gradually declines until hour 24 when it stops [23]. Immunoglobulins play the most crucial role in the complete development of the calf's immune system [9]. There are three main classes of immunoglobulins present in colostrum, "IgG, IgA and IgM" accounting for approximately 85% to 90%, 5%, and 7%, respectively [13]. A sufficient amount of immunoglobulins would be greater than 50g/L of colostrum. For each hour delay in colostrum feeding in the first 12 hours of life, the chance of a calf becoming ill increases by 10% [17]. Calves that had their first colostrum meal after six hours of age had experienced increased mortality and morbidity [1, 44].

v) Vaccination

Due to the complexity and immaturity of the calf's immune and management systems, developing an effective vaccination program is essential. Vaccinating causes stress on the calf internally because it is building up the immune system. Vaccinating calves when they are comfortable, healthy and feel safe in their environment is the best time [26]. Also vaccinate the cow in prepartum condition (Table 1).

Table 1: Prepartum cow vaccination schedule to check calf diarrhea

Causal organism	Form of vaccine	Time of vaccination
Rota virus	Attenuated live virus vaccine	First at 1.5 to 3 months before calving. Booster vaccination next year just before calving
Corona virus	Attenuated live virus vaccine	Bovine viral Diarrhea 1 to 2 months before breeding
Bovine viral Diarrhea	Attenuated live virus vaccine	1 to 2 months before breeding
Escherichia Coli	Oil adjuvant K99 antigen vaccine	6 weeks and 3 weeks prior to calving
Clostridium perfringens (B, C, D)	*Clostridium perfringens* toxoid	60 and 30 days before calving

4. Treatment of Calf diarrhea

The main aim is to restore the water and electrolyte balance and can be achieved through the use of oral electrolyte solutions, as dehydration of 12 to 14% in diarrheic calves is considered fatal [36]. Usually 2 litres of the oral fluid solution are given 1 to 3 times per day to a sick calf. If the calf is not able to drink, esophageal probe or stomach tubes can be used for administering oral rehydration fluid. Broad spectrum antibiotics including Amikacin, Gentamicin, Sulfadimidine, Metronidazole and Penicillin G are commonly used to treat calf diarrhea in order to check the secondary bacterial complications.

4.1 Management strategies for checking diseases and improving health standard Management of the dam:

Management of calving plays a critical role in perinatal mortality in dairy or beef herds [27]. Occurrence of diseases neonatal period can be prevented

- By proper prepartum feeding management
- Offering dams with supplements like vitamins premixes and minerals to prevent their deficiency
- Keep the dam in calving pen one month before the calving
- Taking care of the hygiene of the environment in the calving pen
- Disinfection of premises and mulch, specific active immunization of pregnant cows
- Udder of dam should be washed using standard antiseptics before colostrum feeding
- Good record keeping and easy access to veterinarians
- Prepartum vaccination schedule for preventing calf diarrhea and is presented in table 1.

4.2 Management of the calf

- Proper handling of the calf after birth
- Caring for 3 Q principle namely: good Quality, sufficient Quantity, and Quickly colostrum feeding
- Encourage early rumen development through restricting access to raw milk or quality calf milk replacers so the calves will seek out solid feeds
- Provide clean drinking water within their first week of life
- Remove the calf from calving pen and keep in calf pen and disinfection of calf pen
- Increase specific and non-specific resistance of the new born
- Good record keeping and easy access to veterinarians [17, 39, 38].

5. Conclusion

Neonatal calf diarrhea is a multifactorial syndrome having etiology of infectious as well as noninfectious factors, the environment and the management factors. Prepartum feeding and vaccination of the pregnant cows, 3 Q's principle of colostrum feeding to the newborn, good housing and hygiene to minimize pathogens, developing appropriate feeding protocols to encourage early rumen development, restore the water and electrolyte balance through use of oral electrolyte solutions, check the secondary bacterial complications through use of broad spectrum antibiotics can help to prevent neonatal calf diarrhea.

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