A Review On The Importance Of Calf Diarrhea In Dairy Production System: Ethiopian Perspective

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Abstract: This seminar paper has reviewed the major causes of calf diarrhea and control options in dairy farms. Calf diarrhea causes severe financial loss to cow-calf producers through calf mortality. Calf diarrhea is a clinical syndrome associated with several diseases characterized by changes in absorption of fluids from the intestine and electrolyte imbalance leading to loses of body fluids, rapid dehydration, and acidosis which is fatal for calves. Calves at early age are more prone to diarrhea because of inadequate passive immunity and susceptibility to certain age-specific infectious diseases of the intestinal tract. Various infectious and non- infectious agents are responsible for the occurrence of calf diarrhea. Among infectious agents; bacterial (*Escherichia coli,* Salmonella spp and *Clostridium perfringens)*, viral (bovine rotavirus, corona virus and bovine viral diarrhea virus) and protozoal (*Cryptosporidium parvum* and coccidiosis) causes are major causes of calf diarrhea. Most of the agents of calf diarrhea exist in every cattle herd and infection is nearly universal. Some of the agents such as cryptosporidium and salmonellosis have public health implication. Treatments of calf diarrhea are primarily based on correcting dehydration and acidosis thorough the use of oral and intravenous electrolytes. Most of bacterial and protozoal diseases can be controlled with antibiotics and prevented by vaccination. Vaccines may help control of rotaviruses and corona virus infections. Non-infectious agents are management related; inadequate nutrition, exposure to severe environment, insufficient attention to the newborn calf and failure of passive immunity. Vaccination of the pregnant dam ensures that immunity to the responsible pathogens is passed on to the calves via intake of colostrums.
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Introduction

Ethiopia basically constitutes an agrarian society; the socio-economic activities of about 85% of the population are based on farming and animal husbandry. Livestock plays a critical role for the majority of the Ethiopian population. Domestic animals are mainly used as drought animals, source of milk, meat, hide and skin and as pack animals. Apart from this they also serve as a means of risk diversion and accumulation of wealth among the rural community (Yohannes, 2002).

Cattle production plays an important role in the economies and livelihoods of farmers and pastoralists. Dairy production and the livestock production in general have grown faster than crop production in most developing countries, and this trend is likely to continue with growth rates over the next twenty years estimated at 4.5 % per annum. The need of growing for livestock production for their products and services makes the challenge more severe (FAO, 2006). Calves are important assets for replacement of cows for the future dairy and beef herd sustainability. It is needed to rear healthy calves. In the calf, losses have been as high as 50% of calf crop because of poor management and low adaptation of exotic dairy breed to tropical environment (Thicket *et al.,* 2003).

Newly born calves are important source of animal production for either meat or breeding worldwide. Diarrhea in neonatal calves is a syndrome of complex of different diseases that causes economic losses directly through mortality and need for treatment, and indirectly from poor growth. In addition to the influence of various environmental, managements, nutritional and physiological factors, the infectious agents capable of causing diarrhea in the neonatal calf are numerous. Diarrhea is a leading cause of economic losses to the cattle industry and major cause of calf mortality and morbidity during first few weeks of life in most countries (Radostits *et al*. 2007).

In addition to its economic impact, calf diarrhea is important because of its public health implications. Many of the organisms causing diarrhea in calves, including Salmonella and Cryptosporidium species, in calves are zoonotic and people with impaired immune function are especially at risk of contracting diseases (Lund and Brien, 2011). Calf diarrhea is a syndrome of a disease which can have many causes. In diarrheas,

the intestine fails to absorb fluids and/or secretion into the intestine is increased. Enterotoxogenic *E.coli* is a significant cause of diarrhea among children and travelers in the developing world (Walz et al., 2008). The loss of electrolytes causes a condition called metabolic acidosis, which will kill the calf if it is not corrected promptly (in less than 2 days) (Vermunt, 2002).

Diarrhea commonly affects newborn calves. Young calves likely are more prone to diarrhea because of their liquid diet (milk), the higher water content in their bodies (compared to adult cattle), and their susceptibility to certain age-specific infectious diseases of the intestinal tract. The placenta of the cow separates the maternal and fetal blood supplies, preventing *in utero* transmission of protective immunoglobulin's (Ig). Due to the placenta ion of ruminants, arguably the most important of the risk factors relate to adequate colostral transfer to the calf (Zhang *et al*., 2003).

Calf diarrhea problem results from complex interactions of the environment. Infectious agents and the calf itself are the major constraints for raising replacement stock. Calf diarrhea is a multi factorial disease entity that can have serious financial and animal welfare implications in both dairy and beef buckler herds and is one of the most common diseases reported in calves up to 3 months old. Bacterial, viral and protozoal agents are frequently involved in calf diarrhea. Non-infectious factors, such as insufficient uptake of colostrums, poor sanitation, stress, overcrowding in the calf pens and cold weather, could cause young calf diarrhea (Solomon, 1994).

The most prominent virulence factors identified in bacterial diarrhea are expression of fimbrial (pili) antigens that enables the bacteria to adhere and to colonize the luminal surface of the small bowel and elaboration of one or more enterotoxins that influence intestinal secretion of fluids. Calf diarrhea is the most common symptom of illness in young calves and is usually a problem in the first month of life. The diarrhea can be white, yellow, grey or blood-stained, and is often foul-smelling. Although more common in hand-reared calves, it can also occur in calves which are being suckled by their dams (Mayameei et *al*., 2010) The objective of the review is to overview the major causes of calf diarrhea, epidemiology and highlight the prevention and control methods.

Importance Of Calf Diarrhea In Dairy Production System

The current and expected growth of the world's population warrants increased production of high-quality animal protein. Dairy farming is regarded as one of the important ways of satisfying this need, especially in developing countries (Delgado, 2003). Therefore, dairy development programs have been started aiming at increasing animal productivity by crossbreeding with high yielding breeds or their introduction, especially of the Holstein-Friesian (HF) cattle. Through continued crossbreeding, they gradually replace local cattle breeds that produce less milk but which are better adapted to local environment. Moreover, local breeds combine a variety of purposes, including production of milk, meat, traction, and manure to fertilize the fields. This common strategy of replacing local cattle breeds with HF cattle is also known as the "Holsteinization" of dairy farming (Theunissen, 2012).

Dairy production is a critical issue in Ethiopian livestock -based society where livestock and its products are important sources of food and income. The substantial demand-supply variance in milk and milk products for the major urban centers in Ethiopia is a great opportunity for the development and flourishing of peri-urban dairy farms. Peri-urban and urban dairies are intensive production systems, which keep high-grade cows and have improved management practices. This is usually associated with increased susceptibility to disease, poor survival rate and poor reproductive. The country has large potential for dairy development mainly due to large livestock population, the favorable climate for improved high yield breed, and relatively diseases-free environment (Abebe *et al.,* 2008).

The main causes of calf diarrhea are grouped into two categories: non-infectious cause and infectious causes. The important viral infectious agents include bovine rotavirus group A (BRV-A), bovine corona virus (BCoV), and bovine viral diarrhea virus (BVDV). Among bacterial causes, *Salmonella spp.* (*Salmonella*), *Escherichia coli* (*E. coli*) K99+, and *Clostridium perfringens* (*C. perfringens*) type C and among protozoa, *Cryptosporidium parvum* (*C. parvum*) and coccidiosis either singly or in combination are affected young calves (Acha *et a*l., 2004**).**

Some of the non-infectious causes are management problems; inadequate nutrition, exposure to severe environment, insufficient attention to the newborn calf and failure of passive immunity. Calf diarrhea is not a single disease entity; it is a clinical syndrome associated with several diseases characterized by diarrhea. Regardless of the cause, absorption of fluids from the intestine is altered, and life threatening electrolyte imbalances occur; that is, the diarrheic calf loses fluids, rapidly dehydrates, and suffers from electrolyte loss and acidosis. Infectious agents may cause initial damage to the intestine, but actual death from scours usually results from dehydration, acidosis, and loss of electrolytes. Identification of infectious agents which cause scours

is essential for implementing effective preventive and treatment measurement (Charles, 2013).

Infectious Causes of Calf diarrhea

Numerous infectious agents have been implicated in calf diarrhea. Bovine practitioners and cattle producers are aware of many enteric pathogens because these primary agents have been known to be involved in calf diarrhea for several decades and still greatly influence current cow-calf operations. Ten different enteric pathogens are recognized as either major (BRV, BCoV, BVDV, *Salmonella* spp, *E. coli*, *C. perfringens*, and *C. parvum*) or emerging (bovinecaliciviruses and BToV) pathogens. Characteristics of different enteric pathogens (viruses, bacteria, and protozoa) including more recent findings are briefly described below (Mayameei et *al*., 2010).

Bacterial causes

Bacteria can mediate diarrhea by producing enterotoxins that influence the crypt cells to hyper secrete, invading the intestinal mucosa and eliciting and inflammatory response that mediates hyper secretion through prostaglandins and other products of inflammation and destroying villous absorptive epithelial cells and thus causing malabsorptive diarrhea. Among these bacterial causes of diarrhea in neonatal calves, *E. coli* and *Salmonella spp* are the most common and economically important, but *Clostridium perfringens, Bacteriodes fragilis, Campylobacter spp.* and *Yersinia enterocolitica* have also been identified as causes of enteric disease in calves (Steiner *et al*., 1997).

Escherichia coli

Colonization of the mammalian intestinal tract by E. coli from environmental sources occurs shortly after birth, and these organisms persist as important member of the normal flora of the intestine throughout life. Predisposing factors which permit colonization include age, immune status, nature of diet and heavy exposure to pathogenic strain. Clinical infection in young animals may be limited to intestine (enteric, colibacillosis neonatal diarrhea), or may manifest as septicemia ortoxemia. *Escherichia coli* cause two common diseases of newborn calves. Coli septicemia in which.

The bacteria invade the systemic circulation and internal organs, and enteric collibacillosis in which the bacterial are localized in the lumen and mucosal surface of the small intestine (Quinn *et al*., 2003).

The types of *E. coli* that cause diarrhea commonly are Enterotoxogenic *E. coli* (ETEC). Under natural conditions less than 10% of beef cow colostrums contain antibodies to ETEC (K99). As ETEC diarrhea occurs during the first three days of life the neonate does not have time to mount a protective immune response to vaccination. Protection is afforded by vaccinating cows in late gestation to ensure high concentrations of colostral antibodies. The protective efficacy of ETEC bacterins needed to ensure calves receive maternal antibodies (Ashenafi, 2013).

The decision to vaccinate should be based on the cost benefit for each farm and will be influenced the most common cause of neonatal diarrhea is ETEC stains that produce the K99 (F5) adhesion antigen (commonly referred to as *E. coli* K99+) and heat-stable enterotoxins. It should be noted that other path groups of *E. coli*, which are usually identified by histopathology, can be missed if the diagnosis focuses on *E. coli* K99+ alone. Neonatal calves are most susceptible to ETEC infection during first 4 days after birth and develop watery diarrhea if infected (Karmali *et al*., 2010).

Following ingestion, ETEC infects the gut epithelium and multiplies in enterocytes of the intestinal villi. Their ability to produce entertoxins stimulates fluid secretion from the intestine and presence of Pilli (fimbriae), which allow the bacteria to adhere to epithelial cells of small intestine. *E coli* serotypes that have the ability to adhere to wall of small intestine of calves possess K99 fimbrial antigen. With their fimbriae they attach to the wall of the distal portion of the small intestine of calf and produce enterotoxins these toxins stimulate the calf to produce Excessive Quantities of intestinal secretions, thus leading to severe diarrhea. The distal portion of the small intestine provides the most favorable environment for ETEC colonization due to the low pH (less than 6.5). Villous atrophy due to a loss of infected cells and damage to the laminar propria are commonly observed in affected small intestine. The bacteria express the K99 antigen for attachment (Otte and Chilonda, 2000).

Salmonella

Salmonella infections occur worldwide in all species of animals as well as in man. It is a gram-negative, non-spore-forming facultative anaerobe, usually motile bacteria. Infections are usually limited to the digestive tract, although the musculoskeletal and nervous systems are occasionally affected too in cattle. (Fusser *et al*., 2005).

Salmonella infections comprise the second most economically important bacterial disease affecting the gastrointestinal system; following *E. coli* infections. *Salmonella enterica* colonizes the gastrointestinal tract of a wide range of hosts. *S. enterica* serovar Typhimurium (*S. typhimurium*) and serovar Dublin (*S. dublin*) are the most common etiologic agents that cause salmonellosis in cattle. *S. typhimurium* is the

most common serotype that affects calves. *Salmonella* infection has a wide variety of clinical symptoms ranging from asymptomatic to clinical salmonellosis. Acute diarrheal disease is most common with *S. typhimurium* and systemic disease associate with *S. dublin* on the mucosa of the small intestine as well as enlargement of the mesenteric lymph nodes. Infected cattle can serve as a source of zoonosis through food-borne routes or direct contact **(**Mead *et al*., 1999).

The organism *S. dublin* or *S. typhimurium* are the main causes of salmonellosis in calves. Salmonella typhimurium DT104 has been recognized as highly pathogenic to calves, resulting in a high incidence of mortality has a wide range of antibiotic resistance and it capable of rapidly developing new resistance patterns. Enteric diseases caused by *S. dublin* are usually observed in calves between 3 and 6 weeks old. The disease in calves characterized by foul smelling diarrhea, depression, anorexia, weakness and death in day or two (Bernadette, 1999).

The basic mechanism underlying *Salmonella* virulence Calves less than 3 weeks of age are commonly infected by *Salmonella*. Calves can shed the organism for variable periods of time and intermittently depending on the degree of infection (*e.g.*, clinical or subclinical infection). *Salmonella spp* initiates the disease process by migrating to the lamina propria through the microvillus of mucosal cells and the tight junctions between those cells. The mucosal cells are damaged in the process and fibro necrotic plaques are formed. Damage to the mucosal cells disrupts the integrity of the mucosal lining of the gastrointestinal tract and causes accumulation of residue materials that would ordinarily have been confined to or excluded from the gut lumen, to leak out or in. endotoxins and other materials seep out of the intestinal lumen into the body cavity while plasma proteins and other materials present in the exudates from the inflamed lamina propria leak into the intestinal lumen. The resulting acute inflammatory response is associated with an increase in vascular permeability resulting in mucosal edema. (Quinn *et al.*, 2003).

Clinical presentation of salmonellosis is characterized by watery and mucoid diarrhea with the presence of fibrin and blood. Even though Salmonella can cause diarrhea in both adult cattle and calves, infection is much more common and often causes severe symptoms in 10-day to 3-month old calves (Fusser *et al*., 2005).

The higher detection rate of salmonella in diarrheic calves might be due to environmental contamination, ineffective cleaning and disinfecting of materials used as stated by different investigators (Davies and Breslin, 2003). The housing system and herd size and the presence of calves of different ages on and in the farm could be important reasons for higher prevalence. Moreover, *Salmonella* infection of a farm is maintained by transmission of the agent from faces of infected animals into susceptible animals, which is fecal-oral route. The epidemiology of salmonellosis is primarily the epidemiology of fecal pollution. In some studies, it has been observed that most of the calves had a chance of being exposed to contaminated feed and water (Mollenhorst et al*.,* 2005).

Clostridium perfringens

Clostridium perfringens is a gram-positive, spore forming anaerobic bacterium that causes a wide range of diseases in mammals and birds. These microorganisms can be subdivided into five toxin types (A, B, C, D, and E) based on the production of four major toxins: alpha (α), beta (β), epsilon (ε), and iota (ι). Type A strains produce α toxin alone, type B stains produce α, β, and ε toxins; type C type strains manufacture α and β toxins; type D strains secrete α and ε toxins; and type E strains produce α and ι toxins. Among these groups, type C has been frequently reported in conjunction with calf diarrhea (Karmali *et al*., 2010). but not as common as some other enteric pathogens such as BRV, BCoV, *E. coli*, *Salmonella* spp., and *C. parvum*. The α toxin is the main lethal toxin and promotes cell lysis through the hydrolysis of membrane phospholipids (Mayameei et *al*., 2010).

Clostridium perfringens Types A, C & D cause enterotoxaemia, an acute intestinal infection, and kill through the production of a systemic toxin. *Clostridium perfringens* are commonly found in soil, water, housing environment, improperly preserved feeds and improperly thawed or contaminated colostrums and milk. They are normally found in the intestinal tract of cattle, and in small amounts are generally harmless. Over-eating or abrupt diet changes tend to produce indigestion, which slows gut movement, providing the sugars, proteins and lack of oxygen for rapid growth of clostridium. Wet conditions also seem to favor this organism. (Perez et al**.,** 1998).

The hungry calf may over-consume milk, which establishes a media in the gut conducive to growth and production of toxins by clostridial organisms. In many cases, calves may die without any signs being observed. Type C may colonize rapidly in the absence of normal flora. Healthy calves, usually less than 10 days of age, develop hemorrhagic, necrotic enteritis and enterotoxaemia. Often with abdominal pain (Garica *et al.,* 2000).

Viruses

A number of different viruses can be primary pathogens in the neonatal calf diarrhea complex. Rota and corona viruses are the most common identified

viral causes of diarrhea of neonatal food animals. These viruses have also been associated with diarrhea in adult animals, but their disease incidence in adults is comparably low. However, clinically and subclinically infected adults shed the virus and are a source of infection for young animals (Radostits *et al*., 2007).).

Intestinal viruses multiply within enterocytes, as epithelial cells are destroyed, villous atrophy develops. The various agents cannot be readily separated on clinical grounds. Diarrhea can vary in severity from soft to watery feces. Rotavirus and corona virus are the most common causes of viral neonatal calf diarrhea. Rotavirus and corona virus 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 (Garica *et al.,* 2000).

Rotavirus

Bovine rotavirus is a primary etiological agent of calf diarrhea. The virus belongs to the genus *Rotavirus* within the family *Reoviridae*. Rotavirus is a non-enveloped virion possessing 11 double-stranded RNA segments (16~21 kb) and is very stable over a wide pH range with heat lability (Alvarado *et al*., 1998). There are seven serogroups (A through G) of rotaviruses based on antigenic and genetic similarities of the intermediate capsid protein. Group A rotaviruses are the major cause of rotavirus infection in domestic animals. Most BRVs (95%) belong to group A, although groups B and C rotaviruses have also been identified in field cases (Murphy *et a*l., 1999).

Bovine rotavirus usually causes diarrhea in calves at 1 to 2 weeks of age. The milk uptaken by calves can provide a good environment for rotavirus survival under a wide range of gastrointestinal pH levels and infection of the intestine epithelia cells. This may explain why weaning calves are more susceptible to calf diarrhea. The virus has a very short incubation period (12to 24h) and induces per acute diarrhea in affected calves (Izzo *et al*.**,** *2011*).

Once infected, the calves shed a large amount of virus via feces for 5 to 7 days, thus contaminating the environment and allowing the virus to be transmitted to pen mates. The virus replicates in the cytoplasm of epithelial cells of the mature absorptive and enzyme producing enterocytes of small intestinal villi. Destruction of mature entrecotes in the villi, leading to rupture and sloughing of the enterocytes with release of virus to infect adjacent cells. With virulent strains of rotavirus, the loss of enterocytes exceeds the ability of the intestinal crypts to replace them; hence, the villi height is reduced, with a consequent decrease in intestinal absorptive area and intestinal digestive enzyme activity leading to diarrhea. Viral infection causes villus atrophy and usually affects the caudal part of the small intestine. (Martella *et al*., 2010).

Bovine rotaviruses group A are enteropathogenic agents more commonly associated with neonatal diarrhea in calves up to 30 days old (Alfirie *et al*., 2006). The mechanism of rotavirus-induce diarrhea is not completely known. The major mechanism appears to be a decreased absorption of salt and water related to selective infection of the absorptive intestinal villous cells, resulting in net fluid secretion (Dhama *et al*., 2009).

Corona virus

Corona virus infections can produce high-morbidity outbreaks of diarrhea in calves less than 20 days of age, with variable mortality due to secondary complications. All corona viruses associated with neonatal calf diarrhea appear to be of the same serotype. Bovine corona virus causes diarrhea in both dairy beef calves worldwide range in age of 1 to 3 months, But mostly between 1 and 2 weeks of age. Disease is more common during winter month. The virus can be shed by up to 70% of adult cows despite the presence of specific antibody in their serum and faces. Calves born to carrier cows are at high risk of diarrhea (Radostits *et al*., 2007).

Viral infection begins in the small intestine and usually spreads through the entire small intestine and colon. Microscopically, villi of the affected small intestine and colonic crypts become atrophic, and the lamina propria becomes necrotic. Initially, the S protein and Hemagglutini -esterase (HE) protein of the virus attach and fuse to the intestinal epithelial cells. (Sanderson and Dargatz, 2000).

The virus replicates in enterocytes and progeny viruses are released through a normal secretory mechanism and cell lysis. Mature villous epithelial cells are the primary target of the virus although crypt enterocytes are also affected. Clinical signs in affected animals often have a longer duration due to the damage done to crypt enterocytes by the virus. The virus has affinity for epithelial cells the villi of the small intestine. Replication of the virus in these cells is accompanied by loss of epithelial and blunting of the villi, which results in failure of digestion and absorption of nutrients. In the colon, surface epithelial cells are also attacked with loss of surface cells and cystic dilation and accumulation of cellular debris in underling crypts (Mason, 2005).

Bovine virus diarrhea (BVD)

Bovine virus diarrhea has a worldwide distribution. Infection with the virus is common, as indicated by the high prevalence of seropositive cattle and usually associated with disease in older animals; it

has occasionally been incriminated as a cause of diarrhea in neonatal calves. The virus of bovine virus diarrhea can cause diarrhea and death in young calves. (Izzo *et al*., *2011*).

Diarrhea begins 2 to 3 days after exposure and may persist for quite a long time. Ulcers on the tongue, lips, and in the mouth are the usual lesions that can be found in the live calf. These lesions are similar to those found in yearlings and adult animals affected with bovine virus diarrhea. Diagnosis is by history, lesions, and diagnostic laboratory assistance. Bovine virus diarrhea is controlled by vaccinating all replacement heifers 1 to 2 months before breeding (Campbell, 2004).

Protozoa

Enteric infection with these parasitic agents is associated with villous atrophy, villous fusion, hypercellularity of the lamina propria and decreased activity of mucosal intracellular enzymes, causing nutrient malabsorption, diarrhea and debilitation in neonatal calves. *Cryptosporidium spp* is capable of establishing clinical disease associated with watery to bloody diarrhea. However, other parasites frequently found are *Eimeria spp* and *Giardia spp* (Ashenafi, 2013).

Cryptosporidium

Cryptosporidium parvum is a protozoan parasite that is frequently associated with gastrointestinal tract disease in humans and neonatal cattle. Calves infected with *C. parvum* can be asymptomatic or develop severe diarrhea with dehydration. There are approximately 24 species of *Cryptosporidium*). Cattle are commonly infected by *C. parvum*, *C. bovis*, *C. ryanae*, and *C. andersoni*. *C. parvum* is considered to be primary cause of calf diarrhea and is a potential zoonotic agent (Chalmers et al., 2011).

There are 4 species found in cattle but only one of them, *C. parvum*, causes clinical disease and this is usually only in young calves of less than 6 weeks old. Calves are primarily infected via the fecal-oral route. And it takes less than 50 oocysts to infect a healthy calf Cryptosporidiosis caused by *C. parvum* is zoonotic which means it can be passed to humans where it can cause disease. C. *parvum* is a major cause of infectious diarrhea among young farm animals and also humans. *C. andersoni* usually infects older calves and adult cows, although have been described in pre-weaned calves (Aurich *et al*., 2005). Infection can rapidly spread from calf to calf when animals are communally housed and overcrowded or from cow to calf via the udders when they are contaminated with infected calf feces in the lying area of the dams (Nasir et al., 2009).

Cryptosporidium is a protozoan parasite much smaller than coccidia. The parasite does not invade but adheres to the apical surface of enterocytes in the distal small intestine and the colon. This result in the loss of microvilli decreased mucosal enzyme activity with villus blunting and fusion which leading to Reduce villus absorptive area and inflammatory changes in the sub mucosa. Cryptosporidium can be a primary pathogen, but they are often found to be part of a mixed infection in combination with corona virus, rotavirus, and/or *E. coli*. Calves infected with *cryptosporidium* range from one to three weeks age (Vaala and House, 2002).

In the majority of the population, the clinical signs of cryptosporidiosis are generally mild with self limiting diarrhea, abdominal pain, yellow diarrhea and dehydration. In Ethiopia, there is limited information on the status of Cryptosporidiosis. (Shiferaw *et al.*, 2002). On the epidemiological study of *Cryptosporidium* infection in dairy calves the clinical signs of cryptosporidiosis are generally only seen in very young calves of less than 6 weeks old. It is first seen as a profuse yellow diarrhea and is rapidly followed by signs of dehydration, loss of appetite, fever and abdominal pain. Weight loss or reduced weight gain, depending on the severity of the parasite burden, often occurs and severe cases can result in death (Natro and kapper, 2009).

Figure 1a

Figure 1b. Calves with cryptosporidiosis showing acute diarrhea: Source: (UK, 2012)

Coccidia

More than 20 bovine *Eimeria* species are known out of which in particular *E. bovis* and *E. zuernii* cause severe diarrhea in calves and significant economic losses. In contrast, infection with other *E. alabamensis* has been reported in outbreaks of watery diarrhea in calves on pasture in northern Europe. Coccidian oocysts (eggs) are ingested by susceptible animals when they consume contaminated feed or water, graze contaminated pasture or lick a dirty hair coat. The oocysts release sporozoites (larvae) that multiply asexually in the cells lining the wall of the small intestine and releasing thousands of merozoites (2^{nd} generation larvae). The merozoites then enter the large intestine and go through a sexual reproductive cycle to produce thousands of oocysts. These oocysts pass out with the manure to further contaminate soil, feed, water, bedding, etc. and begin the cycle again (Radostits *et a*l., 2007).

Most outbreaks are associated with stress, poor sanitation, overcrowding, or sudden changes in feed. Occasionally, affected calves may exhibit signs of brain damage but tarry or bloody diarrhea is commonly observed. Individual animal testing is of limited value because *Eimeria* spp are frequently found in the faces of healthy calves. In clinical coccidiosis, the development of diarrhea is caused by the late stages of the life cycle (second merogony and especially gamogony (Mundt *et al.* 2005).

Non-infectious causes

Noninfectious causes are best defined as flaws or gaps in management. Inadequate nutrition, exposure to severe environment, insufficient attention to the newborn calf, or a combination of these is often involved in diarrhea outbreak. The most commonly encountered non-infectious problems inadequate nutrition of the pregnant dam, particularly during the last third of gestation. Both the quality and quantity of colostrums are adversely affected by shortchanging the pregnant dam in energy and protein (Lorino *et al.*, 2005).

Nutrition causes

Nutritional diarrhea is simply the end-result of an oversupply of lactose in the intestines, caused by milk moving too rapidly out of the abomasums, so it cannot be broken down quickly enough. Pathogens use excess lactose as a nutrient source to increase in numbers. The rate of lactose digestion is then further reduced as a result of damage to the intestinal walls by these pathogens. This damage also causes body fluids to leak into the gut, thereby increasing the rate at which the calf dehydrates. Usually white scours caused by undigested milk passing through the intestinal tract (Bartels *et al.*, 2010).

When the calf eventually nurses, it is overly hungry and the cow has more milk than normal. Consequently, the calf may over consume milk, resulting in nutritional scours. Causes of nutritional scours include lack of colostrums, too much or too concentrated milk being fed, too dilute or inadequately mixed milk, incorrect milk temperature, or irregular feeding times program are causes of calf diarrhea in many intensive and extensive farm. (Bernadette, 1999).

This type of diarrhea usually presents little problem in treatment. If the affected calves are still active and alert, no treatment is required. If the calf becomes depressed or fails to nurse, it should be treated. Oral antibiotics can be used as a treatment. Both the quality and quantity of colostrums are adversely affected by not meeting the energy and protein requirements of the pregnant dam. Deficiencies in vitamins A and E, and trace minerals have been associated with greater incidence of calf diarrhea (Charles, 2013**).**

2.2.2. Management factor

When we think the effects of the environment on calves, cold stress is often the more common concern. Mud, overcrowding, contaminated lots, calving heifers and cows together, wintering and calving in the same area, storms, heavy snow, cold temperatures and rainfall are all stressful to the newborn calf and increase its exposure to infectious agents. (Thamsborg *et al*., 1999).

The wet and chilled (hypothermic) newborn calf experiences a loss of body heat, becomes severely stressed, and lacks the vigor to nurse aggressively and receive adequate colostrums early in life. One of the first effects of stress in calves is a reduction of acid secretion into the abomasums. This reduces both the ability of the clot to form, and digestion of milk protein. The rate of calf diarrhea is usually higher in calves housed indoors than outdoors. (Olson *et al. 2004*).

Epidemiology Of Calf Diarrhea

Most of the agents of calf diarrhea exist in every cattle herd, the major exception being salmonella. For agents such as cryptosporidium, rotavirus, and corona virus, infection is near-universal (all calves on all farms) at some time during the neonatal period (1-28 days of age). Thus, efforts to identify these agents provide little or no diagnostic utility in that one would expect to find one or more of these agents in over half of calves (healthy or sick) sampled between 7 and 21 days of age, even in a herd not experiencing a problem with calf diarrhea (Songer and Miskimins, 2005).

Enteropathogens associated with diarrhea are commonly found in the feces of healthy calves; whether intestinal infection leads to diarrhea depends

on a number of determinants, including differences in virulence of different strains of a pathogen and the presence of more than one pathogen. The resistance of the calf is of major importance and is largely determined by successful passive transfer of colostral immunoglobulin. Colostrums'-deprived calves are highly susceptible to infection with enteropathogens and develop severe and often fatal disease (Abebe *et al*., 2008).

The progression of infection, the severity of lesions produced, and the severity of the diarrhea can be modulated by immunoglobulin received via colostrums. Immunoglobulin acts directly on pathogens in the intestinal lumen during the period of colostrums ingestion as well as after, because significant amounts of circulating immunoglobulin are re-secreted into the intestine, especially when the concentration of circulating immunoglobulin is high. The lacks of specific antibodies in dams that have not been exposed to specific pathogens, and the use of specific vaccines, further modulate this influence. Stress caused by a poor environment, inadequate protection from the weather, or an insufficient or inappropriate diet also increases the risk of disease (Langoni *et al*., 2004).

With all of the enteropathogens, healthy adult cattle may be carriers and periodically excrete the organism in feces. Excretion may increase around parturition and be more frequent in primiparous cows. This can lead to contaminated calving areas and infection of the udder and perineum of the dam. Other sources of infection include the feces of healthy calves and the feces of diarrheic calves, which contain large numbers of organisms early in the course of infection. A few diarrheic calves can result in severe contamination of the calf-rearing area. Transmission is by fecal-oral contact, fecal aerosol, and, in the case of corona virus, by respiratory aerosol (Foster and Smith, 2009).

Incidence and prevalence

The incidence of various etiologic agents varies with the age of the calves. It is usually impossible to make definitive etiologic diagnosis on clinical grounds. The incidence of clinical disease and the case fatality rate depend on the balance between the levels of exposure to infectious agents and the resistance in the calf. Differences in herd size; availability of facilities, land, and labor limited works have been done on the incidence and causative agent of calf diarrhea in some parts of Ethiopia (Yenhewoit, 2008).

They reported variable incidence rate and causative agents of calf diarrhea in their respective study site and manage mental conditions. There are very few studies done to identify specific agents involved in disease syndromes such as the ones mentioned above tried to identify specific infectious agents associated with neonatal diarrhea in Ethiopian dairy calves. (Shiferaw et al.,2002).

They found *bovine enteric corona virus,* group A rotavirus and K99 Enterotoxogenic *E. coli* independently or in combination in diarrheic calves. Bovine enteric corona virus was the most frequently detected pathogen followed by rotavirus. Salmonella was detected in diarrheic calves and was responsible for the death of calves in different parts of the country have also isolated *E. coli* from diarrheic calves, but this did tell little about the significance of the isolated bacteria to the causation of the disease. This is because most *E. coli* strains are normal flora of gastrointestinal tract of mammals and the strain causing with ability of causing disease should be identified before incriminating them as the causes. Calf diarrhea was found to be the predominant calf health problem with incidence rate of 42.9% followed by pneumonia (4.9%) (Abebe *et al*., 2008).

Diarrhea was also the leading cause of mortality in the study herds in Ethiopia. Alemayehu et al. *(*2013) reported diarrhea with incidence rates of 10% followed by septicemia (6.4%) and gastrointestinal tract (GIT) disorder (5.4%) in smallholder dairy farms in Hawassa.

There is some suggestion that older calves are less susceptible to diarrhea than younger calves found that diarrhea was diagnosed at a significantly lower age. Calves in the first two weeks of life were more likely to develop diarrhea than their older counterparts in other overseas studies that the risk of enteritis was highest in the first three weeks of life and a some study found that the percentage of calves with 'non-normal' faces was highest in the second week of life, compared to the first and the third week (Bartels *et al*., 2010).

Study on Enteropathogens associated in calf diarrhea in dairy farms of Muke-turi, Debre -tsigie and Fitche towns of North Shewa Zone reported prevalence of *E. coli,* salmonella, cryptosporidium, eimeria and giardia as 69.5%, 25.7%, 27.6, 38.1% and 22.9%, respectively (Yenhewoit, 2008). Single and mixed infection was common in this study. Among the potential risk factors age and age at first colostrums feeding were the factors that were found significantly associated with risk of occurrence of *E. coli* causing diarrhea (Alemayehu *et al.,* 2013).

The risk of calf diarrhea has been shown to be higher in dams unvaccinated against rotavirus, bovine viral diarrhea virus and corona virus. Therefore, the protection afforded by vaccination appears to be pathogen-specific (Heckert *et al*., 2005).

Prevention And Control Of Calf Diarrhea

Factors involved in the occurrence of calf diarrhea can be summarized as ones associated with peripartum calving management, calf immunity, and environmental stress or contamination. Characteristics of major or emerging bovine enteric pathogens were previously described in this review. There is not much of difference between the patterns of disease development and prevention of calf diarrhea according to each etiological agent (Larson, 2007).

Knowing of causal pathogen (s) is important for accurately assessing the current status of the affected farm and developing further interventions. Nowadays, disease control and prevention in production animals involves animal welfare from the public or consumer's point of view, and increased productivity from the livestock producer's point of view. In order to decrease the incidence of disease in the herd, a good producer should maximize colostrums transfer, increase environmental sanitation, reduce stressors such as overcrowding or poor nutrition and vaccinate bred cows for *E. coli*, rotavirus, corona virus and *C. perfringens* at 60 and 30 days before calving (Izzo *et al*., *2011*).

Calving management

Management practice that reduces the risk of calf diarrhea also promote good health, improve growth rates, and reduces the risk of transmitting other enteric pathogen such as mycobacterium, Para tuberculosis. Cow nutrition is closely associated with weak labor, amount of milk production, dystocia, and calf growth. Sanitation is just as important as a dry, clean environment. Proper nutrition is fundamental for calf growth and for the general profitability of calf rearing enterprises. In young stock, a good nutritional strategy optimizes rumen development and growth while minimizing stress and disease. Livestock housing conditions greatly affects health and productivity (Measa *et al*., 2002).

Ideally, provide a special area used only for calving. It becomes necessary to have a special calving area separate from the wintering area. After the calf is born and has nursed, it should be move with its dam to a "nursing" area before being turned to pasture. Inadequate feed intake and macro- or micro-nutrient deficiencies during the last trimester increase calf morbidity and mortality rates because most fetal growth occurs during last 2 months of gestation (Larson, 2007).

Passive Immunity

First-milking colostrums are an important source of nutrients and of passively absorbed maternal antibodies, critical to protect the newborn calf against infectious disease in the first weeks and months of life. But colostrums can also represent one of the earliest potential exposures of dairy calves to infectious agents, including *Mycoplasma* spp, *Mycobacterium para tuberculosis*, fecal coli forms and Salmonella spp (Heinrichs, 2001).

Attention to the newborn calf is essential**,** particularly during difficult births or adverse weather conditions. The calf is born without most antibodies, including those that fight the infectious agents which cause diarrhea. The calf will acquire these antibodies only from colostrums. Because of this, any effort to prevent diarrhea by vaccinating cows is wasted unless the calf actually receives colostrums, preferably before it is two to four hours old. As the calf grows older, it rapidly loses its ability to absorb colostral antibodies. Colostrums given to calves that are more than 24 to 36 hours old are practically useless; antibodies are seldom absorbed this late in life (Edwards *et al*., 2006).

The bovine placenta does not permit the passive transfer of antibody to the fetus. As a result, the newborn calf does not receive any antibody from the dam and is very susceptible to environmental pathogens. Resistance of the calf to enteric disease is closely related to the timely consumption of high-quality colostrums in sufficient quantities (Andrews, 2004).

The neonatal calf should ideally receive 2 to 3 L (for beef calves) or 3 to 4 L (in dairy calves) of colostrums within the first 6hr after birth. The colostrums contains antibodies, immune cells (neutrophils, macrophages, T cells, and B cells), complements, lactoferrin, insulin-like growth factor-1, transforming growth factor, interferon, and other soluble factors as well as nutrients (sugars and fat-soluble vitamins) (Larson and Tyler., 2004).

Colostrums also contain other beneficial constituents in higher concentrations than normal milk: immunologically active leukocytes, fat, protein, fat-soluble vitamins (e.g. retinol, tocopherol, and β-carotene), water-soluble vitamins (e.g. niacin, thiamine, riboflavin, vitamin B12, pyridoxal, pyridoxamine, and pyridoxine), and minerals (e.g. Ca, P, Mg, Na, K, Zn, Fe, Cu, S, and Mn) and, non-specific antimicrobial factors (e.g. lactoferrin) (Kehoe *et al*., 2007).

To improve the passive immunization of calves against rota- and corona virus as well as against different strains of *E. coli* vaccination of the pregnant dam can be proposed. Usually cows are vaccinated twice (6 to 8 and 2 to 3 weeks) before parturition to stimulate the production of specific antibodies. The primary function of colostrums is to enhance the calf's immune system through the passive transfer of both antibody and cell-mediated immunity. Ideally, calves should receive colostrums from their dams although colostrums from several cows is often mixed and

administration of colostrums feeding is the transmission of BVDV, bovine leukemia us, an John's disease that can be spread by infected or purchased colostrums **(**Berge *et al*., 2006).

Specific IgG present in colostrums may protect against the more common Enteropathogens causing calf diarrhea, such as Rotavirus, Corona virus and *E.coli*. Although vaccination of the dam prior to calving may boost colostrums IgG concentrations (Heckert *et al.,* 2005; Lorenz *et al.,* 2011).

Vaccinate the cows and pregnant heifers with any necessary calf diarrhea vaccines well prior to calving**.** Vaccines that contain rota virus, corona virus, and the K99 *E. coli* antigens can be helpful in preventing calf diarrhea. These are best given to the cow prior to calving so it can make antibodies and secrete them into the colostrums. When the calf ingests this enriched" colostrums, it will be protected against these major agents. Currently, there are no effective vaccines against cryptosporidium. This management strategy can only be successful if colostrums management as well as hygiene is improving (Pithua *et al*., 2009).

Chemotherapy

Treatment should be directed toward correction of the dehydration, acidosis, and electrolyte loss. Antibiotic treatment can be given simultaneously with the treatment for dehydration. Dehydration can be overcome with simple fluids given by mouth early in the course of the disease. If dehydration is in an advanced state, intravenous fluid treatment becomes necessary. oral treatment: calves with mild diarrhea, still drinking, should additionally be fed with electrolyte fluids including buffers between milk feeding times. Intravenous (IV) fluid therapy should be implemented if the calf is severely dehydrated (>8%), depressed, has a weakened/absent suckle reflex or suffers from a dilated abomasums and/or intestinal hypo motility. The fluids should always be warmed (Barrington *et al*., 2002).

It is important to replace energy stores with oral or IV fluids containing glucose or dextrose supplements. Routine use of antibiotics in diarrheic calves cannot be recommended due to increased levels of antibiotic resistance. However, systemically ill calves (depression, anorexia, fever) often suffer from E. coli septicemia and thus parenteral Gram-negative-spectrum antibiotics are advised to treat these calves. Antimicrobial susceptibility testing methods should be performed on the herd level at a regular basis (Berge *et al.,* 2006).

A broad spectrum antibiotic may be used in some types of infection. Antibiotics only work against bacteria, but if there is a viral infection, antibiotics will prevent a secondary bacterial infection from occurring. In the case of coccidiosis, a sulfa-antibiotic (sulfaquinoxaline, sulfamethazine) or Amprolium should be used because they are effective against these parasites (Morley *et al*., 2005

Conclusion And Recommendation

Calf diarrhea is a major problem of calves that negatively affects the cattle production. The economic impact caused by this condition is significant although many new intervention strategies (*e.g*., vaccine, medications, and herd management) can be developed and implemented to minimize the economic loss. The significant problems in the field that may attribute to multifactorial nature of calf diarrhea include permutations of infectious diseases, lack of clear understanding of the disease ecology, poor environmental hygiene and biased epidemiological data collection. Colostrums feeding, house cleanliness and the age of calves are the most important determinants of calf health problems. Vaccinations may help to control rotaviruses and corona virus infection. Treatment of calf diarrhea is primarily based on correcting dehydration and acidosis thorough the use of oral and intravenous electrolytes. Therefore, based on the above conclusion the following recommendations are forwarded:-

- ✓ A more wide study should be conducted to identify the major infectious causes involved in calf diarrhea and to design cost effective and appropriate prevention and control strategies, since calf diarrhea is a great problem in farms.
- ✓ The calves should be fed the first colostrums at the appropriate time.
- ✓ Education of the farm owners and attendants on the risk of zoonotic infection should be delivered since some of the pathogens can result infection in human especially in immunocompromised individuals (young, older and HIV patients).
- ✓ Creation of awareness to the farm owners about the management systems (housing, feeding and watering) and the economic loss of the problem by the concerned professionals are needed.

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