Diarrhea and Enteritis in Calves

Acknowledgment

- We would like to acknowledge the committee of National Egyptian Guidelines for Veterinary Medical Interventions, Egyptian Health Council for adapting this guideline.
- Executive Chief of the Egyptian Health Council: Prof. Mohamed Mustafa Lotief.
- Head of the Committee: Prof. Ahmed M Byomi
- The rapporteur of the Committee: Prof. Mohamed Mohamedy Ghanem.
- Scientific Group Members: Prof. Nabil Yassien, Prof. Ashraf Aldesoky Shamaa, Prof. Amany Abbass, Prof. Dalia Mansour, Dr.Essam Sobhy Dr.Mohamed Elsharkawy, Prof. Gamal A. Sosa., Dr. Naglaa Radwan, Dr. Hend El Sheikh
- Editor: Prof. Dr Mohamed Ghanem

Summary

Calf diarrhea is the major cause of productivity and economic loss to cattle and buffalo producers worldwide where half of the deaths among unweaned calves is attributed to diarrhea. Multiple pathogens contribute to calf diarrhea development. Other factors including both the environment and management practices influence disease severity or outcomes. The multifactorial nature of calf diarrhea makes it hard to control effectively in modern cow-calf operations. Various bacterial, viral, and protozoal agents are recognized as causative agents, and failure of transfer of passive immunity is considered an important predisposing factor. Clinical presentation can range from loose stools to severe dehydration, recumbency, coma, and ultimately death. Treatment includes eliminating the causative agent and correcting and maintaining the water, acid-base, and electrolyte balance of affected animals through oral and parenteral fluid therapy. Diarrhea is characterized by more liquid being secreted than being resorbed. However, diarrhea is not a disease but only a symptom. Diarrhea has a protective function for the organism: the higher liquid volume in the gut increases motility, and pathogens and toxins are more readily excreted. However, precise diagnosis and treatment are essential to avoid mortalities and economic loss.

Scope:

This guideline is directed to all veterinarians working in the field of large ruminants including farms of meat and milk production. The guideline will present the most common cause of diarrhea and enteritis in calves which is one

of the most common diseases facing ruminant production. The methods of clinical and laboratory diagnosis are presented with the treatment and prevention protocols.

Economic importance of calf diarrhea and enteritis

- Calf diarrhea (also known as calf scouring) is a commonly reported disease that is considered as the major cause of economic losses to cattle producers.
- The 2007 National Animal Health Monitoring System (NAHMS) for U.S. dairy reported that 57% of weaning calf mortality was due to diarrhea and most cases occurred in calves less than 1 month old.

Field diagnosis of diarrhea and degree of dehydration

1- Evaluate the calf's attitude and vigor. Dehydrated calves don't stand up quickly and show a reduced interest in nursing.
2- Assess the suckle reflex by placing a finger in the calf's mouth and see how it responds. The suckle reflex will be strong in well-hydrated calves but weak in calves experiencing dehydration.
3- Look at the eyeballs of the calf. As the calf becomes dehydrated the eyeballs pull inward and there is a gap between the eyelid surfaces and the eyeballs.
4- Check the calf's skin tent by pulling up the skin and then releasing it. As dehydration progresses it will take more time for the skin to snap back into place (more than 2 seconds) With a severely dehydrated calf, that skin will take 10 seconds or more to return into place.
5- Examine the mucous membranes by checking the calf's gums. They are moist in a normally hydrated calf and they will be sticky as the calf becomes dehydrated.
6- Capillary refill time: pressing the gum of calf by a finger and check for the color change of gum from pale to rose. In dehydrated calf the time is prolonged than 2 seconds

The Fecal score

- The fecal scoring system for calves is a tool used by farmers, veterinarians, and researchers to assess the health and well-being of calves, particularly in relation to their digestive health. This system helps in identifying calves that might be suffering from diarrhea or other gastrointestinal problems. The fecal score is typically based on the consistency, color, and odor of the feces, and it can be used to monitor calf health, especially in dairy and beef operations.

- This scoring system is crucial for early detection and intervention, reducing the risk of severe health issues in calves, especially during the critical early stages of life.

The fecal Score System:

Score number	**S**core **Description**	**Interpreting score**	**Veterinary interference**
Score 1:	Normal Consistency: Firm and well-formed, original form is distorted slightly after dropping to floor and settling similar to a cow patty. Color: Dark brown to greenish. Odor: Normal, not particularly foul.	The calf is healthy with no signs of digestive troubles	Continue regular feeding and care
Score 2:	Soft Consistency: Softer than normal, may lose shape slightly but still has some form. Color: Light brown to yellowish. Odor: Mildly stronger than normal.	There might be mild stress or a slight change in diet, but it's generally not a concern	Monitor closely, ensure clean water and proper nutrition
Score 3:	Runny or Loose Consistency: Loose and unformed, spreads out on the ground. Color: Light brown to yellow. Odor: Stronger than normal, somewhat unpleasant.	This indicates a problem, possibly due to diet, stress, or the beginning of an illness. Monitoring and possibly treatment are recommended.	Consider adjusting diet, and hydration, and if persist, medical intervention may be required.
Score 4:	Watery Consistency: Watery, no form at all, resembles liquid.	This indicates severe gastrointestinal problem that may caused by viral, bacterial or other etiological factors.	Immediate veterinary intervention is necessary; rehydrate the calf and administer

	Color: Yellow to greenish, possibly with mucus or blood. Odor: Very strong, foul odor, indicating possible infection or disease.		medications is necessary

Classification of diarrhea

1- Secretory diarrhea,
   a. The fluid accumulation comes from an increased secretion into the gut caused by toxins activating enzyme systems.
   b. The gut mucosa can no longer resorb this higher amount of liquid.
2- Malabsorptive diarrhea
   a. Occurs due to destroyed enterocytes and shortened villi, the enzyme activity and absorption capacity are reduced.
   b. Less liquid can be absorbed and has to be excreted via the gut.
3- Inflammatory diarrhea,
   a. The gut mucosa is damaged.
   b. Higher amounts of mucus, protein, and blood are released into the gut lumen.

Etiology of calf diarrhea

Calf diarrhea is attributed to both infectious and non-infectious factors. Multiple enteric pathogens (e.g., viruses, bacteria, and protozoa) are involved in the development of this disease. Co-infection is frequently observed in diarrheic calves although a single primary pathogen can be the cause in some cases. The prevalence of each of pathogen and disease incidence can vary by geographical location of the farms, farm management practices, and herd size.

I-Infectious causes

1-Viral causes of calf diarrhea

1- Bovine rotavirus is a primary etiological agent of calf diarrhea.

- 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 intestinal epithelial cells.
- The virus has a very short incubation period (12~24 h) and induces peracute diarrhea in affected calves. Once infected, the calves shed a large

amount of virus via feces for 5~7 days, thus contaminating the environment and allowing the virus to be transmitted to pen mates.

2- Bovine coronavirus

- This pathogen is a member (Betacoronavirus 1) of the genus Betacoronavirus that was formerly classified as group 2a coronaviruses.
- Virus infection can present as three distinct clinical syndromes in cattle: a) calf diarrhea in calves at 1 to 2 weeks of age; b) winter dysentery with hemorrhagic diarrhea in adult animals; and c) respiratory diseases including bovine respiratory disease complex in both young and adult cattle.
- The spike (S) protein of the virus plays an important role in virus entry and pathogenesis besides the ability to neutralize antibody. The S protein consists of two subunits (S1 and S2) and is crucial for virus-host interaction. While the S1 subunit facilitates binding of the virus to host cell receptors, the S2 subunit functions in the fusion of the viral envelope to host cellular membranes.

3- Bovine viral diarrhea virus

- The clinical symptoms of BVDV infection vary from subclinical to fatal disease depending upon host immune status, pregnancy and gestation period, and the presence or absence of co-infection with other pathogens.
- Most infected animals develop mild clinical signs such as low-grade fever, leukopenia, anorexia, and decreased milk production.
- Acute BVD infection is characterized by diarrhea, pyrexia, depression, anorexia, decreased milk production, oral ulcerations, hemorrhagic syndrome, and lymphopenia/leucopenia leading to immunosuppression.
- Immunosuppressed cattle become susceptible to other diseases due to the concurrent infection with other pathogens (e.g., bovine respiratory disease complex).
- Although most immunocompetent animals eventually clear the virus and recover from the disease, some infected cattle occasionally harbor the virus for a long time with periodical appearance of transiently detectable viremia from time to time (e.g., transiently infected animals).

2- Bacterial causes of calf diarrhea

1-Salmonella

- 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.

- 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 is associated with S. dublin. Calves less than 3 weeks of age are commonly infected by Salmonella. The lesions frequently observed in affected calves involve the pseudomembrane 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.
- 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.
- Calves can shed the organism for variable periods of time and intermittently depending on the degree of infection (e.g., clinical or subclinical infection).

2- Escherichia coli

- The E.coli can be classified into different pathogroups based on virulence scheme: enterotoxigenic E. coli (ETEC), shiga toxin-producing E. coli (enterohaemorrhagic E. coli), enteropathogenic E (EPEC). coli, enteroinvasive E. coli, and enteroaggresive E. coli.
- Among these bacteria, the most common cause of neonatal diarrhea is ETEC strains that produce the K99 (F5) adhesion antigen (commonly referred to as E. coli K99+).
- Neonatal calves are most susceptible to ETEC infection during first 4 days after birth and develop watery diarrhea if infected. Following ingestion, ETEC infects the gut epithelium and multiplies in enterocytes of the intestinal villi. The distal portion of the small intestine provides the most favorable environment for ETEC colonization due to the low pH (less than 6.5).

3- Clostridium perfringens

- Gram-positive, spore forming anaerobic bacterium that causes a wide range of diseases. 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).
- Enterotoxin causes diarrhea and intestinal cramping due to its effects on epithelial tight junction protein. Beta-2 toxin, which is produced by all

types of C. perfringens, has been recently postulated to synergistically function with enterotoxin.

3- Protozoa

1. Cryptosporidium parvum is a protozoan parasite that is frequently associated with gastrointestinal tract disease in humans and neonatal cattle. 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
2. Coccidiosis: Eimeria zuernii and Eimeria bovis are the two most common Eimeria species which cause coccidiosis in calves 6 to 12 months of age. In cattle, oocyst counts of greater than 500 per gram of feces in combination with typical clinical signs are highly suggestive of coccidiosis

II- Non-infectious causes diarrhea

1- Nutritional cause of diarrhea
Nutritional deficiency of copper related to excess molybdenum in diet (secondary deficiency) can cause profuse diarrhea in calf called teart or peat scour.

2- Dietetic diarrhea
- Milk replacers with poor quality, heat-denatured proteins or with excessive amounts of soybean or fish protein or carbohydrates of nonmilk origin have a higher risk of producing diarrhea.
- Incorrectly prepared oral electrolyte solutions or mixtures of milk with electrolyte solutions with excessively high osmolarity of the final solution can result in osmotic diarrhea.

3- Antibiotic-related diarrhea
- oral administration of antimicrobials such as neomycin or tetracycline to young calves for 3–5 days can result in villous change with resultant malabsorption and mild diarrhea.
- Prolonged and high-dose antibiotic treatment of calves can lead to diarrhea associated with intestinal dysbiosis (destroy normal microflora)

Clinical Diagnosis of Calf Enteric Pathogens

1- The clinical presentation can range from mild diarrhea without systemic disease to profuse, acute diarrhea associated with rapid dehydration, severe

disturbance of acid-base and electrolyte balance, and death, sometimes in as few as 12 hours.

2- Dry mouth and cold skin and extremities
3- Enophthalmos (retraction of the eyeball)
4- Diarrhea can be fatal to neonatal calves due to dehydration and acidosis that may result in anorexia and ataxia
5- Weight Loss: Rapid loss of body condition due to dehydration and poor nutrient absorption.
6- Depression and Lethargy: Reduced activity and reluctance to nurse or feed.
7- Fever: Common in bacterial infections, not always present in viral or parasitic cases.
8- Abdominal Pain: Indicated by calf arching its back or grinding teeth.
9- The progression of diarrhea can be rapid required critical interference and quick diagnosis.

Diagnostic tests for calf diarrhea

1- Fecal examination for demonstration of parasitic enteritis
2- Pathogen isolation and characterization along with histopathology as the gold standard for etiologic agent and disease confirmation
3- Direct visualization (e.g., light microscopy) of pathogens in feces or intestinal contents as well as the detection of antigens (e.g., Ag-ELISA).
4- Post-Mortem Examination: In severe cases where calves die, a necropsy can help identify the underlying cause.

Sampling and specimen submission

1- Proper specimen collection and delivery to a diagnostic lab is commonly neglected, and significantly impacts the diagnostic outcome.
2- samples for diagnostic testing should include
   A. faces from acutely diarrheic animals prior to therapy
   B. blood samples.
   C. Necropsy specimens from freshly sacrificed, moribund, or euthanized calves are of great value for diagnosis during severe outbreaks.

Guidelines for sample collection for diagnosis of diarrhea.

1- Fresh fecal samples should be directly recovered from diarrheic animal into a specimen container with either rectal swabs or by rectal stimulation while avoiding environmental contamination (by soil, urine, or other feces). Once collected, the sample should be stored in a transporting medium or special stool container with refrigeration to maintain pathogen viability and sample integrity (e.g., reduced

overgrowth of undesired bacteria and prevention of nucleic acid degradation). Samples of anaerobic bacteria (e.g., C. perfringens) should be kept in an oxygen-free transport medium during shipping if possible.

2- Fresh and formalin-fixed gastrointestinal tissues (abomasum, small intestine, or colon) including regional lymph nodes and liver should be collected along with colonic contents.

Differential diagnosis of diseases causing diarrhea and enteritis in calves

Category	Specific causative agent	Characteristic signs	Other specific characters
Viral	Bovine rota virus	- Diarrhoea in calves at 1 to 2 weeks of age very short incubation period (12~24 h) and induces peracute diarrhea in affected calves.	- the calves shed a large amount of virus via feces for 5~7 days, thus contaminating the environment and allowing the virus to be transmitted to others
	Bovine coronavirus	Three distinct clinical syndromes in cattle: a) calf diarrhea in calves at 1 to 2 weeks of age; b) winter dysentery with hemorrhagic diarrhea in adult animals; and c) respiratory diseases including bovine respiratory disease complex in both young and adult cattle	
	Bovine viral diarrhea	- Most infected animals develop mild clinical signs such as low-grade fever, leukopenia, anorexia, and decreased milk production - Acute BVD infection is characterized by diarrhea, pyrexia,	some infected cattle occasionally harbor the virus for a long time with periodical appearance of transiently detectable viremia from time to time

Category	Specific causative agent	Characteristic signs	Other specific characters
		depression, anorexia, decreased milk production, oral ulcerations, hemorrhagic syndrome, and lymphopenia/leucopenia leading to immunosuppression	
Bacterial	Salmonella	S. enterica serovar Typhimurium (S. typhimurium) and serovar Dublin (S. dublin) are the most common etiologic agents that cause salmonellosis in cattle Acute diarrheal disease is most common with S. typhimurium and systemic disease is associated with S. dublin. Calves less than 3 weeks of age are commonly infected by Salmonella watery and mucoid diarrhea with the presence of fibrin and blood	The lesions frequently observed in affected calves involve the pseudomembrane on the mucosa of the small intestine as well as enlargement of the mesenteric lymph nodes. Calves can shed the organism for variable periods of time and intermittently depending on the degree of infection (e.g., clinical or subclinical infection).
	Escherichia coli	The most common cause is ETEC stains that produce the K99 (F5) adhesion antigen (commonly referred to as E. coli K99+) and heat-stable enterotoxin	six pathogroups based on virulence scheme: enterotoxigenic E. coli (ETEC), shiga toxin-producing E. coli, enteropathogenic E. coli, enteroinvasive E. coli, enteroaggresive E.

Category	Specific causative agent	Characteristic signs	Other specific characters
		Neonatal calves are most susceptible to ETEC infection during first 4 days after birth and develop watery diarrhea	coli, and enterohaemorrhagic E. coli.
	Clostridium perfringens	- 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). - Enterotoxin causes diarrhea and intestinal cramping due to its effects on epithelial tight junction protein. Beta-2 toxin, which is produced by all types of C. perfringens	The affected calf is usually in good health condition
Parasitic	Coccidiosis In cattle, oocyst counts of greater than 500 per gram of faeces in combination with typical clinical signs are highly suggestive of coccidiosis	- diarrhoea, typically containing blood and mucus. - Mild cases have watery diarrhoea without blood. - Calves may prolapse their rectum from repeatedly straining. - Reduced feed intake and poor growth rates.	- Typically affects group reared calves at 8-12 weeks. - E. bovis E. zuernii - E. auburnensis are the the most common Eimeria species encountered
	Cryptosporidium parvum	- 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	C. parvum is considered the primary cause of calf diarrhea and is a potential zoonotic agent
II- Non-infectious causes diarrhea	Nutritional cause of diarrhea	- Nutritional deficiency of copper related to excess molybdenum in diet (secondary	History of feeding high concentrates

Category	Specific causative agent	Characteristic signs	Other specific characters
		deficiency) can cause profuse diarrhea in calf called teart or peat scour.	
	Dietetic diarrhea	• Milk replacers with poor quality, heat-denatured proteins or with excessive amounts of soybean or fish protein or carbohydrates of nonmilk origin have a higher risk of producing diarrhea	History of change of diet
	Antibiotic related diarrhea	• oral administration of antimicrobials such as neomycin or tetracycline to young calves for 3–5 days can result in villous change with resultant malabsorption and mild diarrhea. • Prolonged and high-dose antibiotic treatment of calves can lead to diarrhea associated with intestinal dysbiosis (destroy normal microflora)	History of treatment with antibiotics for prolonged periods

Treatment of diarrhea in calves

1- Rehydration and Electrolyte Replacement

- **Oral Rehydration Solutions (ORS):**
  - Given frequently to replace lost fluids and electrolytes.

    - Should contain sodium, potassium, chloride, glucose, and bicarbonate or acetate.
    - Given in mild cases of calf diarrhea
- **Intravenous Fluids:**
    - Used in severely dehydrated calves who cannot drink or are in shock.
    - Control of acidosis by sodium bicarbonate IV solution.

2-Nutritional Support

- **Continue Feeding (mild cases):**
    - Calves should continue to receive milk or milk replacer to provide energy.
    - Feed smaller, more frequent meals if necessary.
- **Withholding Milk:**
    - In severe cases, milk may be withheld for 12-24 hours while providing electrolytes, then gradually reintroduced.

3- Antimicrobial Therapy

- **Antibiotics:**
    - Used if a bacterial infection is confirmed or strongly suspected.
    - Broad-spectrum antibiotics are commonly used, but targeted therapy is preferred based on culture and sensitivity results.
- **Probiotics:**
    - Can help restore normal gut flora and improve recovery.

4-Antiparasitic/ antiprotozoal therapy

- Broad spectrum antiparasitic drugs must be used (thiabendazole, ivermectin).
- Halofuginone and azithromycin have efficacy in calves with diarrhea due to Cryptosporidium parvum, and their administration should be considered in calves documented or suspected to have cryptosporidiosis.
- For coccidiosis: Toltrazuril and diclazuril can be used for both treatment and prophylaxis of coccidiosis.

5-Anti-inflammatory Medications

- **Non-Steroidal Anti-Inflammatory Drugs (NSAIDs):**
    - Used to reduce fever, inflammation, and discomfort in sick calves.

- Must be used under careful veterinary attention due to potential side effects.

Prevention of Diarrhea in Calves

1- Colostrum Management

- **Adequate Intake:**
  - Ensure that calves receive high-quality colostrum within the first few hours of life.
  - Minimum of 10% of body weight in colostrum within the first 12 hours must be received by the calves.
- **Colostrum Quality:**
  - Test colostrum for antibody levels using a colostrometer or refractometer.

2-Hygiene and Sanitation

- **Clean and safe Environment:**
  - Regularly clean and disinfect calf pens, feeding equipment, and water sources.
- **Isolation of Sick Calves:**
  - Separate sick calves in isolated well-equipped pen to prevent the spread of infectious agents to healthy calves.

3-Vaccination

- **Vaccinate Pregnant Cows:**
  - Vaccinating cows against common pathogens (e.g., *E. coli*, rotavirus, coronavirus) boosts the immunity passed through colostrum.
- **Calf Vaccination:**
  - In some cases, vaccinating calves directly can help prevent certain diseases.

4-Proper Feeding Practices

- **Consistent Feeding Schedule:**
  - Feed calves at regular intervals and avoid sudden changes in diet.
- **Quality Milk Replacer:**

    - Use high-quality milk replacers with appropriate nutrient composition.
- **Avoid Overfeeding:**
    - Feed appropriate amounts based on the calf's age and weight.

5- Stress management

- **Minimize Stress:**
    - Avoid overcrowding, ensure proper ventilation, and provide adequate bedding.
- **Manage Environmental Factors:**
    - Protect calves from extreme weather conditions, especially cold and wet environments.

References

Cho, Y. I., & Yoon, K. J. (2014). An overview of calf diarrhea - infectious etiology, diagnosis, and intervention. *Journal of veterinary science*, *15*(1), 1–17. https://doi.org/10.4142/jvs.2014.15.1.1

Constable P. D. (2009). Treatment of calf diarrhea: antimicrobial and ancillary treatments. *The Veterinary clinics of North America. Food animal practice*, *25*(1), 101–vi. https://doi.org/10.1016/j.cvfa.2008.10.012

Renaud, D.L, Buss, L, Wilms, J.N, and M. A. Steele, 2020, Is fecal consistency scoring an accurate measure of fecal dry matter in dairy calves?, J. Dairy Sci, 103.

Tamrat, H., Mekonnen, N., Ferede, Y. et al. Epidemiological study on calf diarrhea and coccidiosis in dairy farms in Bahir Dar, North West Ethiopia. Ir Vet J 73, 14 (2020). https://doi.org/10.1186/s13620-020-00168-w

Wilson, D. J., Habing, G., Winder, C. B., & Renaud, D. L. (2023). A scoping review of neonatal calf diarrhea case definitions. *Preventive veterinary medicine*, *211*, 105818. https://doi.org/10.1016/j.prevetmed.2022.105818