Colibacillosis of Newborn Calves, Lambs, Kids, and Foals

Etiology

- Pathogenic serotypes of E. coli, including the following:
  - **Enterotoxigenic E. coli (ETEC):**
    - The most common pathogen that causes diarrhea.
    - Colonizes in the intestinal mucosa.
    - Produces enterotoxins.
  - **Enteropathogenic E. coli (EPEC):**
    - Colonizes in the small intestine.
    - Does not produce toxins and seldom invade the intestinal mucosa.
    - Attaches tightly to the epithelial cells of the villus and causes and effacing lesions.
  - **Enterohemorrhagic E. coli (EHEC)**
    - Causes attaching and effacing lesions.
    - Produces toxins known as:
      - Shiga-toxin “Shiga-toxin-producing E. coli (STEC)” because it is similar to the one produced by Shigella dysenteriae type I.
      - Verotoxin “verocytotoxinproducing E. coli (VTEC)” because it is detected with the Vero cell-toxicity test
    - Shiga toxins may cause anything or mild diarrhea to severe hemorrhagic colitis.
    - In humans EHEC is responsible for the highly fatal hemolytic–uremic syndrome in children.
    - EHEC are highly prevalent in cattle, but do not cause clinical disease, or can be associated with diarrhea in calves.
  - **Necrotoxigenic E. coli (NTEC)**
    - Produces cytotoxic necrotizing factor (CNF)1 or 2.
    - Restricted to ruminants, particularly calves and lambs with diarrhea and septicemia.
  - **Septicemic E. coli**
    - Invasive strains, cause septicemia in calves, piglets, and lambs.
    - Their powerful endotoxins cause endotoxic shock, with a high case fatality rate.

Note:

*E. coli* is harmless bacteria, but several strains have acquired virulence factors, turning them into potentially dangerous pathogens.
**Epidemiology**

- **Occurrence**
  - Colibacillosis increases with:
    - Increased population density.
    - Shortage of qualified labor.
    - Automated livestock-rearing systems.

- **Animal Risk Factors**
  - Occurs in calves, mainly during the first few days of life, rarely in older calves, and never in adults.
  - Coliform septicemia is most common in calves during the first 4 days of life.
  - Colostrum deprivation.
    - Transfer of maternal immunoglobulin to calves depends on three successive processes:
      - Formation of colostrum with a high concentration of immunoglobulin by the dam.
      - Ingestion of an adequate volume of colostrum by the calf.
      - Efficient absorption of colostral immunoglobulin by the calf.
    - Colostral immunoglobulin is absorbed for up to 24 hours after birth in calves.
      - Maximum efficiency of absorption occurs during the first 6 to 12 hours after birth.
      - Decreases rapidly from 12 to 24 hours after birth.

- **Environmental and Management Risk Factors**
  - Overcrowding.
  - Poor housing and hygienic practices.
  - Adverse climatic conditions (cold, wet, and windy winter & hot and dry summer).
  - Milk replacers:
    - Extreme heat treatment causes denaturation of the whey protein, which interferes with digestibility of the nutrients and causes destruction of any lactoglobulins that may have a protective effect in the young calf.

- **Pathogen Risk Factors**
  - Virulence factors of *E. coli* include:
    - pili (fimbriae): allow bacteria to adhere to intestinal villous epithelial cells.
    - enterotoxins (exotoxins): damage the intestinal epithelium.
    - endotoxins: results in shock and rapid death.
    - capsules: involved in adhesion and colonization.

- **Zoonotic Implications of *E. coli* EHEC strain O157:H7.**

**Pathogenesis**

- The factors important in the pathogenesis of colibacillosis are:
  - The species of the animal.
  - The age of the animal.
  - The immune status of the animal
  - The virulence factors of the strain of *E. coli*.

- Diarrhea, dehydration, metabolic acidosis, bacteremia, and septicemia are the major pathogenetic events in the various forms of colibacillosis.
• **Septicemic Colibacillosis (Coliform Septicemia):**

  invasive strains of *E. coli* invade the tissues and systemic circulation via the intestinal lumen
  ↓
  release of endotoxin
  ↓
  hypothermia, decreased systemic blood pressure, tachycardia and decreased cardiac output, changes in WBC counts, alterations in blood coagulation, hyperglycemia followed by hypoglycemia, and depletion of liver glycogen.

• **Enteric Colibacillosis**

  adhering of the bacteria to enterocytes and colonizing in the intestinal mucosa
  ↓
  Producing of enterotoxins
  ↓
  increases intestinal chloride secretion
  ↓
  hypersecretion of electrolytes and water into the small intestine more than the absorptive capacity of the intestinal mucosa (without causing significant morphologic damage or invading tissue)
  ↓
  varying degrees of diarrhea, dehydration, electrolyte imbalances, acidemia, circulatory failure, shock, and death.

• **Enterohemorrhagic Colibacillosis**

  Attaching and effacing enteropathogenic *E. coli*
  ↓
  adhere to the surface of the enterocytes of the large intestine (without producing enterotoxin)
  ↓
  Affected calves pass bright red blood in the diarrheic feces

**Clinical Findings**

- Weakness and collapse (coliform septicemia).
- Diarrhea and dehydration.
- Colibacillosis in lambs is commonly septicemic and peracute.
  - Two age groups appear to be susceptible: lambs 1 to 2 days of age and lambs 3 to 8 weeks old.
- Hemorrhagic enteritis is a fatal syndrome characterized by anorexia, fever, diarrhea with mucus-containing feces that become bloody in the later stages, and hemorrhagic diathesis on the conjunctivae and mucous membranes of the mouth and nose.
- Complications: meningitis or polyarthritis
  - Complications occurs in animals that recover from septicemia and later develop lesions as a result of local infection of other organs at varying periods of time.
Clinical pathology
- Isolation of organism from feces or blood.
- Hematology and serum biochemistry to evaluate inflammation and acid–base and electrolyte imbalance.

Necropsy Findings
- In coliform septicemia there may be no gross lesions.
- In enteric colibacillosis: he carcass appears dehydrated, and the intestine is flaccid and filled with fluid.
- In calves affected with attaching and effacing E. coli: mucohemorrhagic enteritis.

Differential Diagnosis

| Table 19-13 Possible causes of bacteremia/septicemia and acute neonatal diarrhea in farm animals |
|-------------------------------------------------|-----------------|-----------------|-----------------|
| Calves                                           | Piglets         | Lambs and kids  | Foals           |
| Bacteremia/septicemia                           | E. coli         | E. coli         | E. coli         |
| Escherichia coli                               | Streptococcus   | Salmonella spp. | Actinobacillus equuli |
| Salmonella spp.                                | L. monocytogenes| L. monocytogenes| Salmonella abortuojequina |
| Listeria monocytogenes                         |                 |                 | Salmonella typhimurium |
| Pasteurella spp.                               |                 |                 | Streptococcus pyogenes |
| Streptococcus spp.                             |                 |                 | L. monocytogenes  |
| Acute neonatal diarrhea                        | E. coli         | C. perfringens type C | Foal-feet diarrhea |
| Enteropathogenic and enterotoxigenic E. coli   | Salmonella spp. | C. perfringens type B | Rotavirus        |
| Rotavirus                                       | Transmissible gastroenteritis virus | (lamb dysentery) |
| Coronavirus                                     | C. perfringens type C | Rotavirus |
| Bovine torovirus (Breda virus)                 | C. perfringens type C | Caprine herpesvirus |
| Bovine calcivirus                              | C. perfringens type C | Caprine herpesvirus |
| Bovine morovirus                               | C. perfringens type C | Caprine herpesvirus |
| Cryptosporidium spp.                          | C. perfringens type C | Caprine herpesvirus |
| Giardia spp.                                   | C. perfringens type C | Caprine herpesvirus |
| Salmonella spp.                                | C. perfringens type C | Caprine herpesvirus |
| Elmeria spp. (calves at least 3 weeks old)    | C. perfringens type C | Caprine herpesvirus |
| PRRSV                                          | Isospora spp.    | Caprine herpesvirus |

Treatment
In general, treatment of colibacillosis includes:

- **Antimicrobials Therapy**
  - In most cases antimicrobial therapy has to be initiated before confirmatory culture results are available.
  - A broad spectrum antimicrobials are given parenterally and may be given continuously intravenously, more than once daily and daily until recovery is apparent.
    - **Why broad spectrum antimicrobial?**
      - Calf diarrhea result of a specific etiologic agent, such as rotavirus, coronavirus, cryptosporidia, *Salmonella spp.*, or ETEC.
    - **Why oral antimicrobials is not preferred?**
      - It can alter intestinal flora and function and thereby induce diarrhea.
      - It may harm the “good” bacteria in the small intestine more than the “bad” bacteria.
• Factors affecting success of the treatment:
  o Presence of mixed infections.
  o Whether or not milk is withheld from the diarrheic calves.
  o Effects of the immune status of individual animals.
  o The time when the drugs are given after the onset of diarrhea.
  o The possible presence of antimicrobial resistance.
  o Supportive treatment such as electrolyte and fluid therapy.

• Diarrheic newborn animals should be deprived of milk “withholding the milk”?

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<th>Pro</th>
<th>Lactose digestion is impaired. “resting” the intestine for a few days will consequently minimize additional osmotic diarrhea caused by fermentation of undigested lactose in the large intestine.</th>
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<td>Con</td>
<td>Intestinal tract requires a constant source of nutrition, which it receives from the ingesta in the lumen of the intestine.</td>
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• Anti-inflammatory Therapy
  o Diarrhea can be accompanied by abdominal pain as a result of intestinal inflammation and cramping.

• Fluid and electrolyte therapy
  o Therapy required can be:
    ▪ Oral fluid therapy—calves with a history of acute diarrhea, mild dehydration, slightly dry oral mucosa, good suck reflex, good muscle tone, alert, able to stand, and warm mouth.
    ▪ Oral fluid therapy and hypertonic saline solution (7.5% NaCl) intravenously at 3 to 4 mL/kg BW—calves with moderate dehydration and slight acidosis, weak suck reflex, good muscular tone, and warm mouth. Oral fluids and electrolytes at 40 to 60 mL/kg BW.
    ▪ Intravenous fluid therapy with alkalinizing agents—calves severely dehydrated, have dry and cool oral mucous membranes, are recumbent, have no suck reflex, and are very depressed.

• Intestinal Protectants, such as kaolin and pectin.

• Probiotics
  o Probiotics are live microorganisms that, when administered in adequate amounts, confer a beneficial effect on the health of the host.
  o Such as: broad class of lactic acid bacteria, which include Lactobacillus, Bifidobacterium, Enterococcus, and Streptococcus spp.

Control
Effective control of colibacillosis can be accomplished by the application of three principles:
  o Reduce the degree of exposure of the newborn to the infectious agents.
  o Provide adequate colostrum and optimum animal management.
  o Increase the specific resistance of the newborn by vaccination of the dam or the newborn.

References: