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Enteric Pathogens of Young Calves

Karl Kersting, DVM, MS

Iowa State University, College of Veterinary Medicine

There are numerous viral, bacterial and protozoal agents that may cause alimentary tract disease in young calves. These pathogens are generally considered individually for the sake of academic organization; however, simultaneous or sequential infection with multiple agents may be the rule rather than the exception. Our understanding of the complex interplay between half a dozen pathogens isolated in a diarrhea outbreak is rudimentary at best. Our grasp of pathogen prevalence is similarly tenuous. National and state diagnostic laboratory surveys may variously report coronavirus, rotavirus, E. coli or cryptosporidiosis as Public Enemy Number One. BVD and Salmonella may assume major importance in one area and be regarded as insignificant in another. Data can vary with time, technical capabilities and diagnostic personnel.

Interest in the biology of the pathogens and their host interactions is in a growth phase as the veterinary profession evolves beyond the "shot and pill" approach to diseases of populations of animals. The frustration that veterinarians and their clients have experienced when the syringe and balling gun have failed or "the only drug that works" becomes unavailable or illegal will certainly spur us on to meet the challenge of preventative medicine

VIRUSES

1. Rotavirus

A. Characteristics

- Serogroups A-F
 - Serogroup A typical calf scour agent
 - Serotypic diversity within Serogroup A, some field isolates more common than NCDV (vaccinal) strain.
 - Serogroup B is an atypical calf scour agent, common in lambs.
 - Rotavirus of baby calves, lambs, kids, foals, pigs, children and mice morphologically identical.

B. Clinical

- Generally a disease of 5 days - 2 weeks.
- Can cause disease at 24 hours, particularly colostrum deprived calves.
- Reports of novel serogroup A up to 2-3 months of age.

C. Transmission

- Primarily fecal-oral

D. Pathogenesis

- Enterocyte invasion leading to villous atrophy and malabsorption
- Infections short lived. After destruction of villous epithelial cells, the lack of further target cells halts the infection.
- Primarily a disease of small intestine.

E. Reservoirs

- Sturdy virus - fomite potential
 - Can survive in water for 2 weeks
 - Viable in damp environment at room temperature for months.
- Recovered calves can become reinfected and shed virus
- Experimental cross transmission between calves, pigs, dogs and deer.
- Virus can persist in asymptomatic adults

F. Prophylactic Considerations.

- Serum antibodies not protective aside from enteric recirculation
- Locally present colostrum antibodies generally protect calves for 48-72 hours
- Primary protection conferred by actively stimulated local IgA. Active immunity impaired by presence of passively acquired maternal antibodies
- Continuous colostrum feeding may suppress virus
- Colostrum suppresses MLV oral vaccine replication
- Vaccinal strain of virus may not protect against diverse field strains.
- Parturient vaccine may not uniformly stimulate colostrum antibodies.

G. Zoonotic Potential

- Speculative, close resemblance to rotavirus in children

2. Coronavirus

A. Characteristics

- Little antigenic variance, considered a single entity

B. Clinical

- Generally causes disease 5-30 days of age.
- May infect day old calves if colostrum deprived
- Upper age limit may be open. Associated with Winter Dysentery of adults.
- Typically more severe and protracted clinical course than rotavirus

C. Transmission

- Fecal-oral
- Aerosol
- Oral or respiratory inoculation can result in GI and/or respiratory infections. Pneumonia usually mild but act as viral source.

D. Pathogenesis

- Infects small and large intestine.
- Pathology more severe than rotavirus yielding - mucohemorrhagic enterocolitis.
- Primarily a protracted malabsorption diarrhea

E. Reservoirs

- Fragile virus, environmental persistence is low
- Major viral source are feces and respiratory secretions of carrier cattle.
 - Viral excretions in cows increase at parturition
 - Clinically recovered calves may shed virus for months

F. Prophylactic Considerations

- With the exception of antigenic uniformity of coronavirus, considerations are similar to rotavirus

G. Zoonotic potential

- One reported case of lab worker dealing with infected calves.

3. BVD

Despite conventional wisdom to the contrary, BVD can cause enteritis in young calves outside the confines of the persistently infected disease model. Colostral antibodies generally protect young calves from BVD infection, but disease may occur due to failure

of passive transfer or the introduction of novel BVD strains with new cattle or viral mutation in persistently infected home-grown cattle. BVD has been recovered from other ruminants, but not man.

4. Other Viruses

- These viruses have periodically been incriminated in calf diarrhea episodes, but knowledge is scant:
 - Parvovirus
 - Calicivirus
 - Breda virus
 - Astroviruses

BACTERIA

1. Salmonella

A. Characteristics

- Over 2,000 serotypes - ubiquitous
- Common bovine isolates by Serogroup

Serogroup B - S. typhimurium

Serogroup C - S. newport, montevideo

Serogroup D - S. dublin

Serogroup E - S. anatum

- S. dublin is host adapted to cattle
- A facultative intracellular agent

B. Clinical

- Usually calves over 7 days of age
- Diarrhea - all serotypes
- Septicemia/diarrhea - especially S. dublin and typhimurium

C. Transmission

- Primarily fecal-oral
- Can invade nasal mucosa if aerosolized

D. Pathogenesis

- Produces enterotoxins, endotoxin, and is invasive leading to secretory diarrhea, inflammatory bowel disease, bacteremia and endotoxemia
- Intracellular nature allows organisms to avoid humoral antibodies and antimicrobials
- Can infect small and large intestine
- Salmonella enterocytic attachment is enhanced by bowel stasis (concurrent disease) and altered alimentary flora (indigestion, oral antimicrobials)
- Invasive nature leads to septic sequelae.
 - Pneumonia
 - Arthritis
 - Extremity necrosis
 - Meningitis

E. Reservoirs

- Primary sources are:
 - 1) Carrier cattle
 - Lateral spread among calves can be explosive
 - Recovered older animals may shed continuously or intermittently for months to years (esp. S. dublin).
 - 2) Contaminated foods containing animal by-products
 - Generally serotypes others than S. typhimurium or S. dublin
 - 3) Environment
 - Other species of animals (rodents, cats, dogs, etc), many serotypes lack species specificity
 - Ground water
 - Salmonella is environmentally hardy - can remain infectious for months and withstands drying.

F. Prophylactic considerations

- Salmonellosis notoriously a disease compounded by management errors including malnutrition, overstocking, parasitism, concurrent disease, high stress, and poor hygiene.
- Potential for virtually life-long asymptomatic shedders
- Serologic test for detectors of S. dublin carriers available.

- Hardiness mandates stringent attention to hygiene, cleaning and disinfection of environment and calf feeding utensils.
- ALL clinicals should be isolated
- Vaccine problems
 - Adverse reactions to bacterins
 - Short lived humoral response (2-4 months)
 - Sequestration of intracellular organisms from humoral antibodies makes cell mediated immune response important
 - Bacterins generally are poor stimulants of cell mediated immunity.
 - Calves under 12 weeks of age fail to make anti-LPS antibodies in response to Bacterins.
- Modified live vaccines available overseas appear promising

G. Zoonotic Potential

- High
- Salmonellosis often described as most common zoonoses in the world.
- On farm concerns include direct contact, infections of household pets, and consumption of raw milk.

2. Enterotoxigenic *E. coli* (ETEC)

A. Characteristics

- Multiple serotypes bearing common pilus antigens, K99, K88 or F41. K99 isolates predominate in North America

B. Clinical

- Watery diarrhea
- Primarily a disease of calves less than 5 days old
- Ability to adhere to enterocytes lost rapidly after birth
- Some viral pathogens may alter enterocytes sufficiently to prolong period of ETEC binding allowing for disease in older calves.

C. Transmission

- Fecal-oral

D. Pathogenesis

- A purely biochemical lesion and resultant secretory diarrhea. Cell

- morphology and absorptive capacity unaltered
- Restricted to small intestines

E. Reservoirs

- Hardy, can survive in moist environment for months.
- Lateral transmission among calves
- Fomite spread

F. Prophylactic Considerations

- Reasonable control has been delivered via K-99 prepartum vaccines if colostrum management adequate.
- K99 antibody preps for oral use in calves are widely available.

G. Zoonotic Potential

- Not described.

3. Septicemic E. coli (including enteroinvasive E. coli)

Invasive E. coli capable of entering calves via GI tract, respiratory tract and naval resulting in septicemia. Diarrhea may result from endotoxemia. Incidence of this disease is strongly correlated to failure of passive transfer.

4. Attaching and Effacing (Enterohemorrhagic, Verotoxigenic) E. coli (AEEC)

A. Characteristics

- Multiple serogroups
- Do NOT have K-99 pilus antigen
- Produce a verotoxin (Shiga-like toxin - SLT)

B. Clinical

- Usually older calves than ETEC, peak incidence 2 weeks of age (5-30 days)
- More severe signs than ETEC, mucohemorrhagic diarrhea, straining, colic.

C. Transmission

- Fecal-oral

D. Pathogenesis

- Distal small intestine and colonic disease.
- Non-invasive
- Attacks and produces verotoxins which destroy microvilli, cause enterocyte effacement and microvascular damage.
- May result in severe hemorrhagic colitis/proctitis

E. Reservoirs

- Probably inapparent older carriers

F. Prophylactic considerations

- K-99 *E. coli* products are NOT protective.

G. Zoonotic Potential

- Difficult to assess with respect to calf diarrhea.
 - Cattle are an identified reservoir of AEEC 0157:H7 which causes colitis and hemolytic uremic syndrome in man - primarily via undercooked meat.
 - There are at least 57 verotoxin producing serotypes of *E. coli*.
 - 0157:H7 in man reports tend to be biased due to use of diagnostic tests that detect only this serotype
 - Frequently identified AEEC from calves include 0111, 026, 05
- AEEC isolates from calf diarrhea should be considered potential zoonotic agents at present

5. *Clostridium perfringens* Type C

A. Characteristics

- Antigenically uniform

B. Clinical

- Calves less than 10 days old
- Colic, neurologic signs, terminal bloody scours.

C. Transmission

- Primarily fecal-oral

D. Pathogenesis

- Disease of small intestine
- Production of exotoxins yielding locally necrotizing and hemorrhagic enteritis and systemically shock and CNS dysfunction

E. Reservoirs

- Normal inhabitant of bovine alimentary tract, adult carriers.
- Very hardy, can persist in environment for months to years
- May be locally endemic on some farms.

F. Prophylactic considerations

- Prepartum use of toxoid yields protective colostral antibodies
- Antitoxin useful in outbreaks

G. Zoonotic potential

- Low

6. Other Bacteria

Several species of Campylobacter have been isolated from or implicated in calf diarrhea. These organisms produce an ETEC-like enterotoxin, but their importance as a pathogen is currently unclear.

PROTOZOA

1. Cryptosporidia

A. Characteristics

- C. parvum is the cause of calf enteritis, in contrast to C. muris, which is an abomasal parasite of mature cattle.
- C. parvum has no known host specificity and thus is more akin to Toxoplasma than Coccidia.
- All mammalian C. parvum are indistinguishable and likely the same organism.
- Some evidence for strain variance in pathogenicity

B. Clinical

- Generally a disease of calves under 30 days of age
- Notorious for chronicity and relapses

C. Transmission

- Fecal-oral AND aerosolization, inhaled oocysts can complete life-cycle on respiratory epithelium , be coughed up, swallowed and infect the GI tract.

D. Pathogenesis

- Unlike coccidia, excreted oocysts are fully sporulated and immediately infective.
- Infects enterocytes of distal small intestine and large intestine.
- Organism occupies site just under cell membrane and disrupts the enterocytes' surface. This leads to villous atrophy and fusion and a malabsorptive/fermentative diarrhea.
- Organism capable of autoinfection by sporulating within the intestine and immediately infecting adjacent cells. Result is protracted course and relapses
- Autoinfection can yield huge parasite burdens following very small infective doses.

E. Reservoir

- Virtually any mammalian species, particularly young animals.
- Adult cows rarely shed C. parvum.
- Recovered calves may shed for 10-12 weeks
- Contaminated ground water
- Organism environmentally hardy, can survive at least 6 months in moist environments.

F. Prophylactic Considerations

- Colostral antibodies are not protective
- Frustratingly resistant to antimicrobials
- Unusually resistant to disinfectants, formaldehyde and ammonia have demonstrated efficacy.
- Very sensitive to drying 4-5 days
- Promising modified live vaccinal trials suggest immunity is not mediated by antibody.

G. Zoonotic Potential

- **High**
- Unlike animals, people of any age may contract enteritis, possibly due to lack of recurrent exposure and low immunity.
- A potentially devastating disease in immunosuppressed humans.
- C. parvum can pass through many archaic water filtration systems making ground water contamination a public health concern.

2. Giardia

The organism is occasionally reported as causing herd problems with calf diarrhea, particularly in association with poor water quality. Giardia usually infects the small intestine of calves 2-4 weeks old. Immunity develops slowly and recovered animals may shed for weeks to months. They are susceptible to drying and quaternary ammonium disinfectants. Giardia, like C. parvum, lack host specificity and so may have reservoirs in many species of animals and represent a distinct zoonotic threat.

3. Coccidia

Despite their importance as cattle pathogens, coccidia are not commonly incriminated in cases of diarrhea in dairy calves under 30 days of age.