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Ancillary Therapies for Calf Diarrhea: Medical Use of Activated Charcoal

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History

The adsorbent property of charcoal was first documented in 1791, and the use of charcoal in medicine as an antidote for poisoning started in the 1830's (Andersen, 1946).

Pharmacokinetics

Activated charcoal is charcoal that has been heated in the presence of a gas which results in a network of pores of different sizes with an internal surface area larger than the external surface area. Its functions have been to filter liquids and adsorb drugs and toxins (Neuvonen, 1982). The adsorption potential of activated charcoal depends on the drug or toxin, quality and dose of the charcoal, pH of the medium in which it acts, and gastric contents (Andersen, 1946; Andersen, 1947; Neuvonen, 1982).

KEY POINT

There is no current indication for the use of activated charcoal formulations in veterinary medicine for neonatal calf.

Medical use and potential mechanism of action

Activated charcoal directly adsorbs drugs or toxic substances thereby interfering with absorption by the digestive tract. In addition, activated charcoal is thought to interfere with enterohepatic and/or gastro-enteral recirculation of drugs or toxins from systemic circulation into the gastrointestinal mucosa and contents by binding to conjugated drug/toxin or de-conjugated drug/toxin with subsequent elimination through the intestinal contents. Another hypothesis suggests presence of charcoal in the intestinal tract causes back-diffusion of absorbed drugs or toxins from systemic circulation into the intestinal lumen with subsequent elimination of charcoal-drug/toxin complex from the gastrointestinal tract (Derlet and Albertson 1986).

If used short-term, activated charcoal is safe for most adults. Side effects include constipation and, on occasion, intestinal blockage and dehydration (Watson et al., 1986). Because of its ability to adsorb drugs, oral medication efficacy will be affected (Gaudreault, 2005). Some activated charcoal products contain sorbitol which can act as a laxative or result in severe diarrhea in people (Islam and Sakaguchi, 2006). A study of people given multiple doses of activated charcoal documented hypernatremia and hypermagnesemia (Dorrington et al. 2003) and effects on fluid-electrolyte balance have been noted (Allerton and Strom 1991).

Evidence, knowledge gap and future research

The use of activated charcoal as an antidote for poisoning or drug overdose in humans and animals is well documented (Neuvonen, 1982). However, current studies on the efficacy of activated charcoal in treating diarrhea in humans or animals are few and suffer from improper study design. An in-vitro study documented activated charcoal was effective at adsorbing verotoxin and entero-hemorrhagic *E. coli* 0157:H7 (Naka et al., 2001). However, an in-vivo study reported activated charcoal was ineffective at adsorbing *E. coli* O157:H7 and *Salmonella* Typhimurium from the gastrointestinal tract of sheep (Knutson et al., 2006). Activated charcoal combined with bamboo vinegar has been found effective at reducing clinical signs and duration of diarrhea and number of oocytes excreted in calves experimentally infected and goat kids naturally infected with *Cryptosporidium* (Paraud et al. 2011; Watarai et al. 2008). Overall, evidence is insufficient to support the use of activated charcoal in treating calf diarrhea (Constable 2009).

A study of dairy farmers surveyed their use of antimicrobial alternatives in treating calf diarrhea, 18% of conventional dairy farms and 35% of organic farms reported use of activated charcoal. Furthermore, 35% of conventional farms and 55% of organic farms *perceived* activated charcoal was effective in treating calf diarrhea. Additional research is recommended to evaluate alternative therapies for calf diarrhea (Habing et al., 2016). Randomized blinded clinical trials are needed to test the efficacy of activated charcoal in treatment of calf diarrhea. However, in a recent review of acute diarrhea management in children, the authors indicated there was no reason to use activated charcoal in these cases (Guarion et al., 2012).

Drug	Study type	Main findings and/or mechanism of action	Reference
Carbo med. Merck and charcoal preparation X	In vitro	Activated charcoal was effective in adsorbing several common poisons in vitro. The adsorptive capacity of charcoal depends on the preparation.	Andersen, 1946
Activated charcoal (AC)	In vitro	This study investigated the capacity of AC to adsorb verotoxin producing *E. coli* 0157:H7 and verotoxin. AC adsorbed and reduced *E. coli* 0157:H7 cells dependent on dose with complete adsorption at 10 mg of AC. AC adsorbed and inhibited action of verotoxin. Study also investigated effect of AC on normal intestinal microflora and while there was a dose dependent reduction in the number of cells, 10mg of AC did not cause a complete reduction in normal bacterial flora. Conclusion: AC could be effective at adsorbing verotoxin producing *E. coli* 0157:H7 and verotoxin.	Naka et al., 2001
Activated charcoal	Randomized clinical trial in adults with nonspecific diarrhea	Tested the efficacy and tolerance of AC plus rehydration fluids in 100 adults with nonspecific diarrhea. Treated group had less clinical signs and short duration of diarrhea compared to control group. Conclusion: AC in combination with rehydration fluids was effective in treating nonspecific diarrhea in adult humans.	Dorn, 2004

Activated charcoal	In vivo (sheep)	Study determined if AC would effectively adsorb *E. coli* O157:H7 and *Salmonella* Typhimurium from the gastrointestinal tract of sheep. AC was not effective at adsorbing these organisms from the rumen, caecum, or rectum.	Knutson et al., 2006
Obionekk® containing activated charcoal and wood vinegar liquid	In vivo (neonatal goat kids) clinical study	Study determined the efficacy of Obionekk® in preventing *Cryptosporidium* sp. in goat kids (3-17 days old) that were naturally infected under field conditions. Obionekk® significantly reduced oocyte excretion and clinical signs of diarrhea in goat kids treated 3 times a day compared to controls.	Paraud et al., 2011
Activated charcoal and metronidazole	In vitro	AC with metronidazole caused a significant (3 log) reduction in *E. coli* O157:H7 compared to AC alone.	Ilomuanya et al., 2011

Conclusions

Charcoal comes in many formulations and is primarily sold in veterinary medicine as an adsorbent for ingested toxins. Some formulations with polysorbate or sorbitol may actually cause diarrhea and repeated doses may result in severe hypernatremia and fluid/electrolyte imbalance. Repeated doses may result in constipation or GI obstruction and because it is such an effective toxin adsorbent can affect the absorption of enteral antibiotics or other drugs. However, there is no current indication for the use of activated charcoal formulations in veterinary medicine for neonatal calf diarrhea.

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