Activated charcoal—also known as active carbon, activated carbon, adsorbent charcoal, medicinal charcoal, or carbo medicinalis—is a carbon residue derived from vegetable material (e.g., wood pulp). It is produced by exposing the original material to an oxidizing gas compound of steam, oxygen, and acids at high temperatures (900°C). This activation process creates a network of fine pores (10 to 20 nm in size) in the resulting charcoal. The result is a highly porous material with an enormous surface area relative to its weight. The adsorptive capacity of activated charcoal is a function of its binding surface area. In commercial products, the surface area varies from 1000 to 2000 m² per gram.

**PHARMACOKINETICS**

Activated charcoal comes as a very fine, porous, black powder or granules measuring less than 1.0 mm in diameter. It does not contain any gritty material. It is insoluble in water and all usual solvents. Activated charcoal is not absorbed in the gastrointestinal tract, and all ingested activated charcoal is excreted in the feces. It is a stool marker, indicating that the toxin has passed through the gastrointestinal tract and no further significant toxin absorption from the original ingestion will occur.

**PHARMACOLOGY**

Owing to its large surface area, activated charcoal can adsorb many drugs and toxins (e.g., acetaminophen, salicylates, digoxin, organophosphate and carbamate insecticides, pyrethrins and pyrethroids, anticoagulant rodenticides, strychnine) in the upper gastrointestinal tract. It thereby facilitates the excretion of the adsorbed toxicant in the feces and reduces the amount of free agent available for absorption into the bloodstream. Activated charcoal maintains its attachment to toxins through covalent binding and van der Waals forces.

Adsorption of substances onto charcoal is a reversible process, with rapid adsorption and slow desorption. Optimal adsorption occurs when the ratio of charcoal to toxin is 10:1 or higher. Administration of activated charcoal can lead to a 30% to 40% drop in digoxin levels within 12 to 18 hours. In one canine study, oral administration of activated charcoal solution (2.5 g/kg) 30 minutes after a single oral dose of carprofen (16 mg/kg) effectively decreased the maximum plasma carprofen concentration (85.9 ± 11.9 mg/L to 58.1 ± 17.6 mg/L) by decreasing carprofen absorption in the gastrointestinal tract. Elimination of substances that undergo enterohepatic recirculation (e.g., NSAIDs, theobromine, cholecalciferol, tetrahydrocannabinol) may be enhanced by repeated oral doses of activated charcoal.

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Activated Charcoal

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**Indication: Emergency treatment of acute poisoning after ingestion of a large amount of toxin or drug.**

Activated Charcoal

Pharm Profile focuses on new drugs or indications in the veterinary market as well as pharmacologic products of high interest to practitioners.

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ACUTE TOXICITY
Activated charcoal is considered nontoxic. In animal studies, oral doses higher than 15,000 mg/kg produced no fatalities. Activated charcoal is not absorbed and should not have any effect on pregnancy.

ADVERSE EFFECTS
Constipation may occur with multiple doses of activated charcoal. Aspiration of charcoal into the lungs may cause airway obstruction and bronchiolitis obliterans, and corneal abrasions may occur if the material spills into the eyes. Particularly in young animals, repeated doses of charcoal and cathartics or a single large dose of a premixed sorbitol-containing charcoal product may cause serious fluid shifts to the intestine, resulting in severe diarrhea, dehydration, hypernatremia, muscle fasciculation, tremors, or seizures. Serum sodium levels should be monitored for 2 to 3 hours after administration of charcoal and sorbitol. The reference range for the serum sodium concentration in cats is 147 to 156 mEq/L; in dogs, it is 137 to 149 mEq/L. A 5% dextrose in water solution can be used to correct dehydration in hypernatremic animals.

INDICATIONS
Activated charcoal is indicated in the emergency treatment of acute poisoning after ingestion of a large amount of toxin or drug (see Contraindications for a list of toxins and drugs that cannot be treated with activated charcoal). The effectiveness depends on the time since ingestion, identification of the ingested agent, ability of the agent to bind to activated charcoal, lethality of the ingested dose, and relative or absolute contraindications to activated charcoal use. Activated charcoal should be given as soon as possible after a poison has been ingested, while a significant amount still remains unabsorbed. Administered within 1 hour after ingestion, activated charcoal can reduce the absorption of toxins by up to 75%. Administration is also recommended more than 1 hour after ingestion if the animal has clinical signs of toxicity. This suggests that absorption is ongoing, and activated charcoal may limit further absorption.

Activated charcoal may also be used as an adsorbent in hemoperfusion to remove drugs from the bloodstream. The blood is passed through an extracorporeal column or cartridge containing activated charcoal, which adsorbs the toxicant before the blood is returned to the patient. Charcoal hemoperfusion can reduce the time of recovery and can change morbidity in severely comatose animals.

Baclofen intoxication in a dog was successfully treated with hemodialysis and hemoperfusion.

DOSAGE AND ADMINISTRATION
Published dosage ranges vary, but a dose of 2 to 5 g/kg of activated charcoal administered orally is recommended. Higher dosage ranges are necessary if food is in the stomach. One or two additional doses of activated charcoal may be given at 1- or 2-hour intervals to ensure adequate gut decontamination, particularly after ingestion of a large amount of toxin or a sustained-release drug formulation. Dry activated charcoal is mixed with water to make a slurry and is administered orally with a large syringe or with a stomach tube passed nasogastrically or orogastrically. If a syringe is used, care must be taken to avoid aspiration.

Following adsorption, cathartics can be used to hasten the expulsion of the toxin-adsorbent complex. Only osmotic agents (e.g., sodium sulfate, sorbitol) are used in cases of ingestion of toxic substances. Either cathartic may be given 30 minutes after administration of the initial dose of activated charcoal. Cathartics should not be used in animals younger than 2 months. Repeated doses of activated charcoal every 4 to 6 hours at half the initial dose may be considered for removal of compounds that undergo enterohepatic recirculation. However, if the animal vomits charcoal within 1 hour, half of the original dose should be given through a nasogastric tube. In cases of severe or persistent vomiting, antiemetics should be administered parenterally.

CONTRAINDICATIONS
Activated charcoal is contraindicated if no bowel sounds are present or if the agent ingested is known to produce ileus. It is also contraindicated in nonintubated animals that have no airway protective reflexes because pulmonary aspiration of activated charcoal is hazardous.

Activated charcoal should also not be given before, with, or just after ipecac syrup because it may adsorb the ipecac and interfere with its emetic properties. Activated charcoal may also adsorb and decrease the effectiveness of specific antidotes (e.g., acetylcysteine, penicillamine) administered orally. It should not be mixed with ice cream, sherbet, milk, or sugar syrup.

Activated charcoal is ineffective in the treatment of poisoning with the following substances:

- Inorganic toxins: ammonia, borates and borax, bromide, fluoride, chlorates, cyanide, iodide, nitrates and nitrites, phosphorus, sodium chloride
• Heavy metals: arsenic, copper, iron, lead, lithium.9,14,17,20,21
• Corrosive and caustic acids and alkalies, cationic detergents, parathion, and diquat1
• Petroleum products (e.g., white spirit, kerosene, xylene)1
• Small polar molecules (e.g., alcohols, ethylene glycol, urea)3,5
• Camphor and metaldehyde9,22

In dogs, ingestion of foods containing the sweetener xylitol results in a significant, and often sustained, insulin-mediated hypoglycemic crisis.23 Although the mean percentage of binding of xylitol to activated charcoal is low (between 8% and 23% in vitro), activated charcoal administration may still be beneficial in some cases of acute canine oral xylitol exposure.23

Administration of activated charcoal may obscure endoscopic visualization of gastroesophageal injury.3,5,17

PREPARATIONS
Activated charcoal is currently approved by the US Food and Drug Administration for use in veterinary medicine. For veterinary purposes, activated charcoal is generally pharmaceutical (USP) grade. The following veterinary pharmaceutical products are available in the United States: ToxiBan (Vet-A-Mix, Shenandoah, Iowa), Liqui-Char-Vet (Jones Medical), UAA Gel (Vedco, St Joseph, Missouri), and generic activated charcoal products.1 ToxiBan comes in different formulations that contain kaolin and sorbitol as well as wetting agents to enhance the miscibility of the product when mixed with water.

Several human pharmaceutical preparations of activated charcoal are also available in the United States: powder (15, 30, 40, 120, and 240 g), liquid aqueous suspension (12.5 g in 60-mL bottles, 15 g in 75-mL bottles, 25 g in 120-mL bottles, 30 g in 120-mL bottles, and 50 g in 240-mL bottles), and liquid suspension in sorbitol or propylene glycol.1 The most convenient to use are suspensions made for pediatric use. However, keeping commercial aqueous activated charcoal products for prolonged periods can result in the inability to resuspend the activated charcoal and the retention of a substantial amount of the product in the container. The potential risk for the patient is not receiving an adequate amount of adsorbent.24

STORAGE AND HANDLING
Activated charcoal should be stored in tightly closed glass or metal containers or in the manufacturer’s supplied container.1

REFERENCES