Getting the Most from the Universal Antidote

Activated charcoal has been called the most important "universal antidote" in the treatment of intoxification by chemical agents. The term antidote may be misleading since activated charcoal does not directly counteract the effects of a poison and may not be effective with some toxicants such as heavy metals. However, finely ground activated charcoal is useful in the treatment of many poisons in animals and humans.

Activated charcoal is an amophorous form of carbon in that it has no regular atomic structure and differs from common charcoal that contains other organic residues. Charcoal is obtained by burning carbon-containing materials. Charcoal becomes activated by heating it to extremely high temperatures in the absence of oxygen thereby removing the residual non-carbon elements and producing a porous internal microstructure having an extremely high surface area. A single gram of activated charcoal USP contains about 15% water and has 1,500 square meters of surface area, 98% of it internal.

The chemical nature of amorphous carbon combined with a high surface area and porosity makes it an ideal medium for the adsorption of organic chemicals. Activated charcoal is administered orally and functions by adsorbing molecules of complex organic compounds, thereby preventing the absorption of the potential toxicant from the GI tract and sequestering it to be eliminated in the feces.

Activated charcoal is normally used as an oral adjunct to more direct antidotal therapy during treatment of poisoning in animals. Animals showing signs of acute intoxication should be treated with a more specific antidote initially. In many cases there will not be a specific antidote and preventative measures such as gastric protection and antibiotics may be needed. Activated charcoal should not be given simultaneously or shortly before the oral administration of other therapeutic agents such as antibiotics, vitamins or amino acids. Antibiotic therapy should be administered parenterally when activated charcoal is used. Fluids to correct acid/base, hydration and electrolyte imbalances should be administered.

Emesis

If an oral emetic such as syrup of ipecac, hydrogen peroxide or apomorphine hydrochloride is used, activated charcoal should not be administered until after emesis (vomiting). Emesis is most productive if performed within 2-3 hours post ingestion. Feeding the animal a small moist meal before inducing vomiting can increase the chances of an adequate emesis. Emetics generally empty 40-60% of the stomach contents.

Emesis is contraindicated with ingestion of alkalis, acids, corrosive agents or hydrocarbons due to the risk of chemical burns or aspiration. Dilution with milk or water in combination with a demulcent is recommended in cases of corrosive ingestion.

Activated Charcoal

Adsorption of toxicants by activated charcoal is surface-active and reaches its maximum rate of adsorption rapidly, acting like a magnet, attracting and holding the toxicant to its surface so it passes through the GI tract without being absorbed into the body. Activated charcoal facilitates the excretion of the absorbed toxicant via the feces.

Adsorption of substances onto charcoal is a reversible process, with rapid adsorption and slow desorption, because substances bind to charcoal by weak covalent forces. Enterohepatic recirculation occurs with some compounds that are metabolized in the liver. The metabolites are emptied into the bile and are reabsorbed in the intestines, which will allow for a persistent pharmacological effect. The metabolites excreted via the biliary route may be more actively absorbed than the parent compound. Multiple dosing of activated charcoal is indicated when metabolized toxicants are recirculated via biliary secretion and reabsorption.

Prepared by the Veterinary Technical Service Department of LLOYD, Inc., Shenandoah, Iowa

Cathartics

Cathartics augment the elimination of substances by moving them through the gastrointestinal tract. Without cathartics, the toxicant bound to activated charcoal may eventually be released and reabsorbed. Cathartics should not be used if the animal has diarrhea or is dehydrated. However, if the animal is not displaying either of these signs, a mild cathartic should be used in combination with activated charcoal when the initial dose is administered. If subsequent doses are required, it would be better if activated charcoal without a cathartic was administered to ensure an adequate fluid and electrolyte balance is maintained to prevent dehydration and possible hypernatremia and, in some cases, hypotension.

There are bulk, saline and osmotic cathartics. Bulk cathartics such as psyllium can be used in mammals and birds. The saline cathartics, sodium sulfate (Glauber's salts) and magnesium sulfate (Epsom salts), should not be used in birds or reptiles. Sorbitol is an osmotic cathartic that is commonly combined with activated charcoal that pulls electrolyte-free water into the gastrointestinal tract. Sorbitol does not compromise the adsorptive capacity of activated charcoal. Osmotic cathartics can be used in mammals, birds and reptiles.

Demulcents

A demulcent is an agent that coats and soothes the stomach. Products containing aluminum hydroxide, magnesium hydroxide, milk of magnesia or hydrated aluminum silicate (kaolin) have demulcent properties. These compounds protect an inflamed intestinal lining and help reduce absorption of toxic compounds from the GI tract. Kaolin also has adsorptive properties in removing bacterial and endotoxins from gastro-intestinal contents.

Dosage

The initial dose of activated charcoal for most animals is 1-3 grams per kilogram body weight. It is recommended to use the lower end of the dose schedule (1-2g/kg), if possible, to reduce the chances of dehydration.

It is recommended to use about ½ of the initial amount when giving subsequent doses This reduced dose is recommended due to the potential for large fluid shifts into the GI tract, especially with products containing the hyperosmotic cathartic, sorbitol. Large fluid shifts that can cause hypernatremia and other electrolyte abnormalities are usually seen when high doses of activated charcoal products containing sorbitol are administered in dogs that get repeated doses of activated charcoal and those that are not on fluids.

The recommended psyllium dose for dogs and cats is 1 teaspoonful mixed with food every 12-24 hours. The dose for saline cathartics is 0.25 g per kilogram body weight mixed in water or activated charcoal. The recommended dose for the osmotic cathartic sorbitol is 1-2 g per kilogram body weight.

Oral Activated Charcoal Product Review

There are several products containing activated charcoal on the market, but they generally fall into three categories; powder or granular products, liquid products, and gel or paste-based products.

Activated Charcoal Powder Products

The only dry product currently available on the veterinary market is ToxiBan® Granules (Vet-A-Mix, a division of LLOYD, Inc.). Bulk powdered activated carbon products are used for many industrial applications and food grade quality products could be used for veterinary decontamination purposes. While bulk activated carbon USP powder may be more potent in its adsorptive properties, it does not mix well in water and is very difficult to administer. In addition to activated charcoal, ToxiBan® Granules also contains kaolin and sorbitol as well as wetting agents to enhance the miscibility of the product when mixed with water.

Activated Charcoal Gel and Paste Products

There are several activated charcoal gel and paste products marketed. All but one of the products have added electrolytes. Most of the gel and paste products contain 100 mg of activated charcoal and 200 mg of attapulgite clay per mL in addition to 35 mg of the electrolytes, sodium chloride and potassium chloride. However, one of the products does not

have a guaranteed amount of activated charcoal on its container label.

Activated Charcoal Liquid Products

There are several liquid activated charcoal formulations available on the human market, but only ToxiBan® Suspension and ToxiBan® Suspension with Sorbitol are labeled for animal use.

A comparison of the various types of activated charcoal products on the veterinary market show all of the gel/paste products with a guaranteed analysis and all of the suspensions contain the same amount of activated charcoal per mL. All of these products contain either attapulgite clay or kaolin. See table 1.

However, there is a distinct difference between the products when the actual activated charcoal dose intoxicated animals receive is compared. The difference is the wide variation in the actual amount of activated charcoal each product provides when they are dosed according to the label recommendations for companion animals. See table 2.

Table 1: Activated Charcoal Product Formulation Comparison

Formulation	Activated Charcoal	Attapulgite or kaolin	Sorbitol Cathartic	Na and K Electrolytes
Activated Charcoal Gel with Electrolytes	100 mg/mL	200 mg/mL	None	35 mg/ mL
Activated Charcoal Paste	100 mg/mL	200 mg/mL	None	35 mg/ mL
(UAA) Gel Universal Animal Antidote	N/G	N/G	N/G	N/G
ToxiBan® Granules	500 mg/g	100 mg/g	300 mg/g	None
ToxiBan® Suspension	100mg/mL	60 mg/mL	None	None
ToxiBan® Suspension with Sorbitol	100mg/mL	60 mg/mL	100 mg/mL	None

N/G: No guaranteed analysis on the labeling

Table 2: Activated Charcoal Product Companion Animal Dose Comparison

			Charcoal dose per kg body Weight	
Formulation	Species	Dose	Minimum	Maximum
Activated Charcoal Gel with Electrolytes	Dogs & cats	1-3 cc/lb	220 mg	661 mg
Activated Charcoal Paste	Dogs & cats	1-3 cc/lb	220 mg	661 mg
(UAA) Gel Universal Animal Antidote	Dogs & cats	1-3 mL/kg	N/G	N/G
ToxiBan® Granules	Small Animals	2-4 g/kg	1,000mg	2,000 mg
ToxiBan® Suspension	Small Animals	10-20 mL/kg	1,000mg	2,000 mg
ToxiBan® Suspension with Sorbitol	Small Animals	10-20 mL/kg	1,000mg	2,000 mg

N/G: No guaranteed amount on the labeling
NOTE: The normal recommendation by the ASPCA Animal Poison Control Center toxicologists is 1-3 g (1,000 to 3,000 mg) of activated charcoal be given per kilogram of body weight.

Discussion

The advantages of the gel formulations are the ease of administration and the low dose volume. While the gel products are much less messy and do not require the clean up time the granules and liquid product do, the lower recommended dose could pose a problem. There are concerns that, by using the recommended gel or paste dosage, a sub-therapeutic level of activated charcoal would be provided.

For example, the recommended dose for dogs and cats is 1-3 mL per pound of body weight, which would provide 220 mg to 661 mg activated charcoal per pound or 100-300 mg (0.1-0.3 g) of activated charcoal per kilogram of body weight (Table 2). This dose is much less than the ASPCA Animal Poison Control Center's recommendation of 1-3 grams of activated charcoal per kilogram. While it is certainly understandable that a lower volume would be helpful, there should be considerable concerns that the amount of activated charcoal being given to an intoxicated animal is substantially less than is needed for effective decontamination.

While the recommended initial dose of activated charcoal for most animals is 1-3 grams per kilogram body weight, it is also recommended to use the lower end of the dose schedule (1-2g/kg) if possible to reduce the chances of dehydration. The dosing schedule for ToxiBan® Granules and the liquid products, ToxiBan® Suspension and ToxiBan® Suspension with Sorbitol, will meet the lower recommended range of 1-2 grams of activated charcoal per kg of body weight for companion animals.

It has been shown animals can be successfully decontaminated using the lower end of the recommended dose range. In cases when lower volumes are desired, the granules can be used if the veterinarian is concerned about the volume and if an osmotic cathartic is not needed.

Bibliography:

ASPCA Animal Poison Control Center personal communications.

Gwaltney-Brant S, Clinical toxicology lecture notes. The District of Columbia Academy of Veterinary Medicine, November 2004.

Huang JD, Tzou MC: The effect of activated charcoal on the volume of distribution of drugs. J Pharm Sci 1986; 75:923-924.

Lloyd, WE: Adsorbent detoxification therapy with activated charcoal. Current Veterinary Therapy XI Small Animal Practice, Kirk, ed, 1992.

Mahutte CK, True RJ, & Michiels TM: Increased serum theophylline clearance with orally administered activated charcoal. Am Rev Respir Dis 1983; 128:820-822.

Rosendale ME, Decontamination strategies. Vet Clin Small Anim, 2002; 32:311-321.

Wax PM, Wang R, & Mercurio M: The prevalence of sorbitol in repetitive dose activated charcoal regimens in emergency departments. Vet Hum Toxicol 1991; 33:368.