Clinical Toxicology

Decontamination and Detoxification of the Poisoned Patient

DEFINITION/OVERVIEW

- In veterinary medicine, the primary treatment for toxicant exposure should be decontamination and detoxification of the patient, along with symptomatic and supportive care.
- The goal of decontamination is to inhibit or minimize further toxicant absorption and to promote excretion or elimination of the toxicant from the body.
- When treating the poisoned patient, the clinician should have an understanding of the underlying mechanism of action of the toxicant, the pharmacokinetics (including absorption, distribution, metabolism, and excretion), and the toxic dose (if available). This will help determine appropriate decontamination and therapy for the patient.
- As decontamination can only be performed within a narrow window of time for most substances, it is important to obtain a thorough history and time since exposure.
- Emesis induction, which is the most common route of GI decontamination, is contraindicated in symptomatic patients.
- While the GI route is the most common type of decontamination in veterinary medicine, other categories may include ocular, dermal, inhalation, injection, forced diuresis, or surgical removal of the toxicant.

Ocular Decontamination

- If ocular exposure to a toxicant has occurred, thorough evaluation and appropriate medical care of the eye may be necessary.
- Ocular decontamination is often difficult for the pet owner, as it requires restraint of the animal.
- If the product is corrosive or caustic, owners should flush the eye at home with physiological saline (e.g., contact lens solution *without* any cleaners, soaps, etc.) or tepid water for 15–20 minutes prior to transportation to a veterinarian. This will help maximize decontamination and reduce secondary injury to the cornea. Immediate veterinary care is imperative. Owners should be advised to prevent injury or rubbing of the eye until veterinary attention is sought. An Elizabethan collar should be used, if available.

- If the product is considered a *non*corrosive irritant, owners should flush the eye at home with physiological saline (e.g., contact lens solution *without* any cleaners, soaps, etc.) or tepid water for 10–15 minutes, if possible. Ophthalmic ointments or medications should *not* be used, and the pet should be monitored carefully for an extended period of time to prevent iatrogenic corneal abrasion or ulceration from rubbing the eyes. Owners should be advised to prevent injury or rubbing of the eye. An Elizabethan collar should be used, if available. Any change in condition (e.g., blepharospasm, pupil size change, pruritus, ocular discharge) should prompt immediate medical attention.

Dermal Decontamination

- The use of dermal decontamination is important to prevent transdermal absorption of the toxicant, but also to prevent oral reexposure secondary to grooming (particularly in cats).
- Owners should be advised to prevent the pet from grooming, and cautioned to protect themselves from exposure to the toxicant while transporting the pet to the veterinary clinic.
- When decontaminating a patient, it is important that pet owners and veterinary staff be protected from the toxic agent (e.g., pyrethrins, blue-green algae, organophosphates, corrosive or caustic chemicals, etc.). Appropriate protection should be used (e.g., rubber gloves, waterproof apron, face shield, etc.) as needed.
- Oil-based toxicities (e.g., high concentration pyrethrins) should be bathed off with tepid water and a liquid dish degreasing soap (e.g., Dawn™, Joy™, etc.). Pet owners should be specifically told not to use dish detergent from an automatic dishwasher; rather, they should be instructed to use liquid dish soap designated to wash dishes in the sink. The patient should be bathed and rinsed multiple times as soon after exposure as possible. Pet or human shampoos are typically insufficient to remove the oil-based product, as a follicular flushing shampoo or degreasing soap is necessary.
- Appropriate dermal decontamination is warranted to prevent continued absorption of the toxicant; this will also help minimize persistent clinical signs due to continued absorption. Avoid the use of shampoos containing insecticides (e.g., flea or tick shampoos), coal tar, antibiotics, or antifungals.
- The most common toxicant requiring dermal decontamination in veterinary medicine is high-concentration pyrethrins (e.g., used inappropriately in cats). In symptomatic cats exposed to pyrethrins, sedation with IV methocarbamol first may be beneficial prior to dermal decontamination (see chapter 94, Pyrethrins and Pyrethroids).
- Gentle clipping of the hair may also help remove the toxin, particularly in long-haired pets or patients that cannot be bathed.
- If caustic, acidic, or alkaline exposure has occurred to the skin, careful, gentle decontamination must occur. The skin should be thoroughly flushed with copious amounts of tepid water for 15–20 minutes, making sure not to traumatize the area with abrasive scrubbing or high-pressure water sprays.

- Avoid the use of "neutralizing" agents on the skin (e.g., an acid for an alkaline exposure), as this may cause a chemical or thermal reaction that results in more serious dermal injury.
- After dermal decontamination, the patient's temperature should be appropriately monitored. Due to cooling from the bathing process, patients may become hypothermic and may require appropriate heat support.

Inhalant Decontamination

- With exposure of an inhaled toxicant (e.g., zinc phosphide rodenticides, carbon monoxide, etc.), the patient should be removed from the environment and evaluated. Often, simple removal is all that is necessary.
- Further treatment may include administration of a humidified oxygen source, monitoring of oxygenation and ventilation (e.g., via arterial blood gas analysis, pulse oximetry, co-oximetry, etc.) and rarely, mechanical ventilation. Please see chapters 117 and 118 on toxic gases for more information.
- The nares and upper airway help filter particulate matter, helping prevent lower airway exposure. The use of bronchoscopy is typically unnecessary.
- The area where the inhalant exposure occurred should be adequately ventilated to prevent reexposure by persistent toxic fumes.

Injection Decontamination

- Injection decontamination is typically necessary when an animal has been exposed to an insect stinger or venom sac. If embedded in the patient's skin, gentle manipulation (e.g., tweezers) to remove the stinger or venom sac should be performed, after careful examination of the affected area. Typically, this does not require sedation.
- Snake bites should not be decontaminated via incision and "sucking" of the venom from the bite wound, nor should hot or cold compressions or tourniquet application be used. Please see chapters 53–60 for more information on envenomations.

Gastrointestinal Decontamination

- "At-home" decontamination (e.g., emesis induction) can be performed by pet owners to prevent or treat toxicosis; however, the medical recommendation to decontaminate a pet at home must be thoroughly evaluated by the veterinarian, veterinary staff, or an Animal Poison Control Center first.
- A complete history should be obtained from the pet owner *prior* to emesis induction (for home emesis or veterinary emesis induction).
- It is important to understand the contraindications for emesis induction to prevent secondary complications such as aspiration pneumonia, protracted emesis, hematemesis, or caustic or corrosive injury to the esophagus, oropharynx, and GIT.

- Prior to inducing emesis, several factors must be considered.
  - Time frame – A thorough history and time frame since ingestion must be obtained prior to recommendations for emesis induction. If several hours have passed, toxic contents may have moved out of the stomach. Emesis induction is indicated for most toxins ingested within 1–2 hours, provided the patient is asymptomatic.
  - Underlying medical problems – Dogs with brachycephalic syndrome (e.g., stenotic nares, everted saccules, hypoplastic trachea, and elongated soft palate) may be at higher risk for aspiration, and emesis induction at a veterinary facility may be safer. Dogs with a prior history of laryngeal paralysis, megaesophagus, aspiration pneumonia, upper airway disease, etc., should not have emesis induction performed due to the risk of aspiration pneumonia.
  - Symptomatic patients – Patients that are already symptomatic should *not* undergo emesis induction. Symptomatic patients that are excessively sedate may have a decreased gag reflex or a lowered seizure threshold and may be unable to protect their airway, resulting in aspiration pneumonia.
  - Corrosive or caustic agent – Emesis induction may cause additional injury to the esophagus, oropharynx, and GIT when these agents are expelled.
  - Hydrocarbons – Low-viscosity liquids (e.g., gasoline, kerosene, motor oil, transmission fluid, etc.) can be easily aspirated into the respiratory system, resulting in severe aspiration pneumonia. See chapter 10 on hydrocarbons for more information.

Effectiveness of Emesis Induction

- The effectiveness of emesis induction is based on several factors, including:
  - emetic agent used
  - time elapsed since ingestion
  - physical characteristics of the toxicant ingested
  - toxicant's effect on gastric emptying
  - presence of gastric contents.
- The more rapidly emesis is induced post ingestion, the greater yield of recovery of gastric contents. Studies have shown that gastric recovery within 1 hour after toxin ingestion was approximately 17–62%. When emesis was induced within an even shorter time span (within 30 minutes), mean recovery of gastric contents was approximately 49% (range 9–75%).
- While delayed emesis after 1–2 hours may still be successful, the amount of gastric recovery significantly decreases as time passes.
- Emesis induction performed after 4 hours is likely of no benefit, with the exception of delayed gastric emptying or ingestions of large bezoars or concretions of toxic agents (if still present in the stomach). Examples include:
  - large wads of xylitol gum
  - large amounts of chocolate
  - grapes and raisins

- massive ingestions that can form a concretion or bezoar (e.g., fish oil capsules, prenatal iron vitamins, etc.)
- ingestions that can form a bezoar or foreign body (e.g., blood or bone meal, fire starter logs, etc.)
- drugs that delay gastric emptying (e.g., opioids, anticholinergics, salicylates, TCA antidepressants).

Recommendations for Home Emesis

- The decision to recommend emesis induction at home is based on the clinical judgment of the veterinary facility.
- Numerous "antidotes" and "emetics" exist on the internet, and pet owners may find and use inappropriate information. Vegetable oil, milk, bread, and physical gagging with a finger have all been reportedly used by pet owners as antidotes or emetics.
- In addition, pet owners may use an inappropriate dose based on an estimated weight of the patient, resulting in side effects (e.g., protracted vomiting, hematemesis). Appropriate counseling by the veterinary staff or an Animal Poison Control Center is imperative (on which emetic to use, how much to use, if home emesis induction is warranted, etc.).
- As time is of the essence with emesis induction, it is often more effective to seek veterinary attention immediately rather than attempt emesis induction at home. This depends on the comfort and ability of the pet owner and availability of appropriate emetics (e.g., hydrogen peroxide) at home. Rather than send a pet owner to a local store to purchase hydrogen peroxide and wait 10 minutes for the effect of the emetic (which may or may not be productive), it may be more efficient to seek veterinary care for prompt emesis induction.
- As certain human medications have a rapid onset of action (e.g., SSRI antidepressants, amphetamines, etc.) and clinical signs can be seen as early as 15–30 minutes, the use of emesis induction at home is generally not recommended with certain toxicants. In these situations, emesis induction is best done under the supervision of a veterinarian; the patient should be assessed to confirm that it is asymptomatic prior to emesis induction. Other examples of toxicants with a rapid onset of action include baclofen and benzodiazepine or nonbenzodiazepine agents (e.g., sleep aids).
- There are no safe emetic agents for cats that pet owners can use at home.

Emetic Agents

- Currently the only recommended at-home, oral emetic agent is 3% hydrogen peroxide. Other emetic agents that have been previously recommended include table salt (sodium chloride), liquid dishwashing detergent, or 7% syrup of ipecac.
- Common veterinary emetics available at a veterinary clinic include apomorphine for dogs and alpha$_2$-adrenergic agonist agents (e.g. xylazine, dexmedetomidine) for cats. Hydrogen peroxide is also commonly used by veterinarians as an emetic, and is equally effective to apomorphine.

3% Hydrogen Peroxide

- Hydrogen peroxide is thought to act as an emetic by direct gastric irritation.
- Hydrogen peroxide is the *current* recommendation for at-home emesis induction in dogs. Only the 3% concentration should be used, as higher concentrations can result in severe gastritis.
- In cats, the use of hydrogen peroxide as an emetic is *not* recommended. It is not as effective in cats compared to dogs, and can result in significant adverse effects (e.g., hypersalivation, hemorrhagic gastritis, protracted hematemesis, etc.). Any toxic ingestion in a cat should be sent directly to the veterinarian for emesis induction under veterinary supervision.
- When using hydrogen peroxide, make sure the product is first aid grade (e.g., 3%) and nonexpired (e.g., fresh, bubbly, not exposed to light) to be most effective. Dose: 1–2 mL/kg orally, not to exceed 50 mL in dogs.
- It should be acknowledged that this dose has been exceeded by many veterinarians without ill effect; however, persistent emesis and hematemesis may result.
- Emesis induction typically occurs within 5–10 minutes. If the first dose is ineffective as an emetic, a second dose can be repeated and potentially doubled.
- Hydrogen peroxide is generally safe, but more than two doses should not be administered at home before seeking veterinary attention.
- Pet owners should be informed that they must carefully syringe hydrogen peroxide (via turkey baster, oral syringe, etc.), as most dogs will not electively drink this on their own, delaying emesis even further. Owners should be careful to prevent aspiration during administration.
- Anecdotally, hydrogen peroxide works best if a small amount of food is present in the stomach. When advising pet owners on how to perform emesis induction at home, the pet owner should be informed to feed a few dog treats or small amount of kibble prior to emesis induction.
- Another option is to soak a small amount of food or bread with the prescribed amount of hydrogen peroxide.

Table Salt (Sodium Chloride)

- Salt acts as an emetic by direct gastric irritation.
- The use of salt as an emetic is *no longer recommended* due to the risks of hypernatremia, persistent emesis, and hematemesis.
- Dose of salt in dogs and cats: 1–3 teaspoons orally, depending on the size of the patient.
- Emesis induction typically occurs within 10–15 minutes.
- In children treated with salt as an emetic, hypernatremia, secondary cerebral edema, and neurological complications have been seen. Rarely, death has been reported (see chapter 70 on salt toxicity).

Liquid Dish Detergent (e.g., Dawn, Palmolive, Joy)

- Liquid dish detergent acts as an emetic due to direct gastric irritation.
- The use of liquid dish detergent is not typically recommended, although it may be considered more benign than table salt or syrup of ipecac.

- Detergents containing phosphate are most effective (thus excluding eco-friendly products).
- Dose: 10 mL/kg of a mixture of 3 tablespoons of detergent to 8 ounces of water.
- Emesis induction typically occurs within 20 minutes.
- It is imperative that pet owners and veterinary staff ensure that the appropriate product is used, rather than products designed for use in automatic dishwashers (which can be corrosive). These types of detergents should *never* be used due to their alkaline nature, which may cause severe injury to the GIT.

7% Syrup of Ipecac
- Syrup of ipecac acts as an emetic due to direct gastric irritation and stimulation of the CTZ. This is likely due to the active alkaloid compounds emetine and cephaeline.
- Syrup of ipecac is derived from *Cephaelis ipecacuanha*, which is a dried root indigenous to South America.
- Syrup of ipecac is *no longer recommended* as an emetic in both human and veterinary medicine.
- Syrup of ipecac is not to be confused with ipecac fluid extract, which is estimated to be 14 times more potent.
- Dose: dogs, 1–2 mL/kg PO; cats, 3.3 mL/kg; cumulative dose in either species is not to exceed 15 mL; dose may be repeated once.
- Emesis induction typically occurs within 10–30 minutes but may take up to 1 hour.
- Potential complications from syrup of ipecac administration include:
  - delayed effect
  - lack of effectiveness in approximately 50% of small animals
  - distaste (particularly to cats)
  - protracted emesis, severe hematemesis, lethargy, diarrhea, depression
  - potential cardiotoxic arrhythmogenic action.

VETERINARY EMETIC AGENTS

Apomorphine
- Apomorphine acts directly on the CTZ.
- Apomorphine is an effective emetic agent for dogs that is commonly used by veterinarians.
- Dose: dogs, 0.02–0.04 mg/kg IV or IM; or direct application of the tablet form into the subconjunctival sac. The injectable apomorphine can also be administered SQ; however, this is not currently the recommended route due to delayed onset of action and a prolonged duration of effect. If subconjunctival apomorphine is used, thorough flushing of the subconjunctival sac must be performed after emesis induction, or protracted vomition may occur.
- Emesis occurs within 4–6 minutes.
- If emesis does not occur, a second titrated dose can be used. If emesis does not occur after a second dose, an additional oral dose of hydrogen peroxide may be beneficial.
- Apomorphine is not recommended for cats, as it is an ineffective emetic and may result in CNS stimulation.

- The use of apomorphine as an emetic should be carefully considered with opioid or sedative toxicosis, due to the potential for severe sedation.
- If a patient exhibits excessive CNS sedation or respiratory depression after apomorphine administration, naloxone can be used as a reversal (dose: 0.01–0.04 mg/kg, IV, IM, or SQ). However, naloxone will not reverse the emetic effect of apomorphine due to different receptor effects.
- Apomorphine tablets can be purchased through veterinary pharmaceutical companies.
- The emetic effects of apomorphine are counteracted by potent antiemetic agents such as maropitant, ondansetron, or dolasetron.

Xylazine

- Xylazine is a centrally mediated alpha$_2$-adrenergic agonist.
- Xylazine is an emetic used by veterinarians for emesis induction in cats. Occasionally, it can effective in dogs, but is generally not recommended due to more effective emetic agents being available (e.g., hydrogen peroxide, apomorphine).
- Dose: cats, 0.44 mg/kg, IM or SQ.
- Emesis induction typically occurs within 10–20 minutes but is not always effective.
- The use of xylazine often results in profound CNS and respiratory depression, and cats should be carefully monitored for excessive side effects (e.g., sedation, hypotension, etc.).
- Xylazine can be reversed with alpha$_2$-adrenergic antagonists.
    - Yohimbine: 0.1 mg/kg IM, SQ, or IV slowly.
    - Atipamezole (Antisedan): 0.2 mg/kg IM, IV.

Gastric Lavage (Fig. 1.1)

- The goal of gastric lavage is to remove gastric contents when emesis induction is unproductive or contraindicated.
- Human studies have shown that if gastric lavage was performed within 15–20 minutes after toxicant ingestion, gastric lavage recoveries were minimal (38% and 29%, respectively). If lavage was performed at 60 minutes post ingestion, only 8.6–13% was recovered.
- As most poisoned patients present to the veterinary clinic after 1 hour, the clinical usefulness of gastric lavage is debated.
- Despite low gastric recovery and labor intensiveness, the use of gastric lavage is indicated in certain circumstances.
    - A symptomatic patient that is already excessively sedate, unconscious, tremoring, or seizing that still needs controlled decontamination (e.g., metaldehyde, marijuana, organophosphates).
    - Material that is large in size or has formed a bezoar or concretion (e.g., bone meal, iron tablets, large amounts of chocolate, etc.).
    - Large toxic ingestions of capsules or tablets approaching the LD$_{50}$ or toxicants with a narrow margin of safety (e.g., calcium channel blockers, beta-blockers, baclofen, ivermectin, organophosphate and carbamate insecticides).

■ **Fig. 1.1.** Patient undergoing gastric lavage. Photo courtesy of Justine A. Lee, DVM, DACVECC, DABT.

- A newer modality is to administer AC via orogastric tube prior to lavage to prevent further absorption of the toxin, and then to lavage out the charcoal-toxin complex. Following copious lavage, AC is then readministered. There is lack of data evaluating this technique, and this modality still needs to be evaluated. Currently, the author does not recommend this technique without further evidence.
- Complications of gastric lavage include:
  - risks of sedation
  - aspiration pneumonia
  - hypoxemia secondary to aspiration pneumonia or hypoventilation from sedation
  - mechanical injury to the mouth, oropharynx, esophagus, or stomach.
- Contraindications for gastric lavage include:
  - a corrosive agent, where esophageal or gastric perforation can occur with orogastric tube placement
  - a hydrocarbon agent, which may be easily aspirated due to its low viscosity
  - sharp objects ingested (e.g., sewing needles, etc.).
- Many veterinarians may not feel comfortable performing gastric lavage, but it can be easily accomplished when organized with the appropriate supplies in a team-oriented approach.
  - Begin by preparing all materials in an organized fashion.
    - □ White tape
    - □ Mouth gag
    - □ Sterile lubrication
    - □ Gauze
    - □ Warm lavage fluid in a bucket

        □ Bilge or stomach pump
        □ Funnel
        □ Step stool
        □ Sedatives predrawn and labeled
        □ Sterile ETT, ideally with a high-volume, low-pressure cuff
        □ Empty syringe to inflate the cuff
        □ Material to secure and tie in the ETT
        □ IV catheter supplies
        □ Activated charcoal predrawn in the appropriate dose in 60 mL syringes ready for administration
        □ Sedation reversal agents if necessary

- Place an IV catheter.
- Sedate and intubate with ETT; secure ETT in place and connect to oxygen ± inhalant anesthesia source. Inflate cuff to prevent aspiration of gastric contents or lavage fluid. Place the patient in sternal recumbency.
- Premeasure an appropriately sized orogastric tube to the last rib and mark this line with white tape. This will be the maximum distance to pass the tube.
- Lubricate the orogastric tube, and pass the tube into the stomach using gentle, twisting motions. Blowing into the other end of the tube to inflate the esophagus with air may assist with passing of the tube into the stomach.
- Confirm orogastric tube placement by:
        □ palpation of the orogastric tube on abdominal palpation
        □ blowing into the orogastric tube and simultaneously ausculting for "bubbles" in the stomach
        □ palpation of the neck for two tube-like structures (trachea, esophagus with tube placement).
- Infuse tepid or warm water by gravity flow via funnel, bilge, or stomach pump. The volume of the stomach is estimated to be approximately 60 mL/kg; therefore, copious amounts of fluid can be used to gavage. Fluid recovery (by gravity) should be emptied into an empty bucket.
- The stomach should be frequently palpated to monitor overdistension of the stomach and massaged/agitated to help break up contents within the stomach; this will hopefully allow small material to be removed via gastric lavage.
- Several lavage cycles (>5–20) should be performed to maximize decontamination of the stomach. All of the gavage fluid, if possible, should be removed prior to AC administration.
- The gastric lavage fluid should be examined for the presence of toxicants (e.g., plant material, mushrooms, rodenticides, medications, etc.), and can be saved for toxicological testing at a veterinary diagnostic laboratory if needed.
- Prior to removal of the orogastric tube, the appropriate amount of activated charcoal (with a cathartic for the first dose) should be instilled.
- The AC contents can then be flushed further into the orogastric tube with water or by blowing forcefully into the tube.

- Prior to removal of the orogastric tube, it is imperative that the tube be kinked off to prevent lavage fluid from being aspirated. Once kinked, the tube should be removed quickly in one sweeping movement.
- The patient should continue to be intubated until gag reflex is present. Positioning the patient in sternal recumbency with the head elevated may help prevent aspiration.
- Administration of a potent antiemetic (e.g., maropitant, dolasetron, ondansetron) should be considered.
- A video example of gastric lavage can be found here: http://vetgirlontherun.com/veterinary-continuing-education-how-perform-gastric-lavage-dog-vetgirl-video/

Whole Bowel Irrigation (WBI)

- The goal of WBI is to clean the GIT by removing toxins and normal intraluminal GI contents.
- This is done by enteral administration of large amounts of polyethylene glycol electrolyte solution (PEG-ES or PEG; e.g., Golytely™) until effluent (e.g., stool) is clear.
- WBI is frequently done in human medicine, but is rarely necessary for treatment of the poisoned veterinary patient. Rather, WBI is more commonly used for bowel preparation (e.g., for endoscopy, colonoscopy, etc.).
- WBI may be necessary in the poisoned patient if the toxicant is suspected to be present within the small intestinal tract. Examples of toxicants may include life-threatening ingestions of prenatal iron tablets, large ingestions of sustained-release medicines, etc.
- Due to the massive amount of PEG-ES that needs to be ingested, administration must typically occur via a temporary feeding tube (e.g., nasoesophageal, nasogastric, orogastric, etc.).
- Dose of PEG-ES: 25–40 mL/kg, followed by continuous oral infusion of 0.5 mL/kg/hour. Alternatively, 30–40 mL/kg can be gavaged every 2 hours.
- Stool typically appears within 2–4 hours, and WBI should be continued for approximately 8–12 hours until the effluent is clear.
- The use of antiemetics may be necessary. Metoclopramide (0.2–0.5 mg/kg, SQ or 1–2 mg/kg/day, IV CRI) would be an appropriate choice due to its antiemetic, prokinetic, and gastric-emptying effects.
- Complications of WBI include nausea, vomiting, bloating, abdominal discomfort, and aspiration pneumonia.
- Contraindications for WBI include a foreign body obstruction, ileus, perforated bowel, shock, refractory emesis, and significant GI hemorrhage.

Activated Charcoal (AC)

- The goal of AC is to act as an adsorbent and to prevent systemic absorption of the toxicant.
- While less commonly used in human medicine, AC still remains the primary treatment of choice for detoxification of the veterinary poisoned patient.

- AC is produced by heating wood pulp to extreme temperatures (900°C), washing it with inorganic acids, and drying it. This results in "activated" charcoal particles with a large surface area that promotes absorption. One gram of AC has approximately 1000 m² of surface area.
- AC contains carbon moieties that adsorb compounds with varying affinity.
  - Nonpolar compounds bind to AC well.
  - Heavy metals (e.g., zinc, iron, etc.) and alcohols (e.g., ethylene glycol, methanol, isopropyl alcohol, ethanol) typically are not absorbed by AC.
  - Xylitol binds poorly to AC.
- The interaction between the bound toxin and AC could potentially undergo desorption (where the toxicant unbinds from the AC over time); hence, the addition of a cathartic is often used to help promote fecal expulsion and increase GIT transit time.
- Administration of AC with a cathartic as long as 6 hours out may still be beneficial with toxicosis, particularly if the product has delayed release (e.g., extended or sustained release) or undergoes enterohepatic recirculation.
  - The use of AC with a magnesium-containing cathartic should be undertaken judiciously in cats.
- Dose: 1–5 g of AC per kg of body weight orally; in general, the higher the dosage used, the more effective the adsorption.
- Certain situations or toxicities warrant multidose administration of AC. Drugs undergoing enterohepatic recirculation (e.g., ibuprofen, carprofen, etc.), with a long half-life (naproxen), or delayed-release products will require multidose administration of AC.
- Dose: for multidose charcoal (1–2 g/kg, PO q 6 hours for 24 hours).
  - Additional doses of AC should ideally not contain a cathartic, due to increased risks for dehydration via fluid losses from the GIT. If AC without a cathartic is not available, then appropriate and aggressive hydration of the patient is imperative to prevent rare complications of hypernatremia.
- There are several types of AC commercially available, and the labeled directions should be followed appropriately for each specific type. Note that not all brands are labeled correctly; when in doubt, the appropriate dose (1–5 g/kg) should be calculated and administered.
- Many types of AC contain a cathartic already present (e.g., typically 70% sorbitol).
- At-home AC tablets and capsules (typically used by humans for colonic cleansing purposes) are not as effective as veterinary AC liquid slurries.
- The use of AC granules can also be considered (e.g., Toxiban™ granules), and mixed with a small amount of food to increase palatability for dogs.
- Few animals will ingest AC voluntarily, and administration may need to occur via forced but careful syringe feeding or orogastric tube administration.
- Based on an in vitro study assessing the administration of AC with a palatable veterinary prescription canned food (Hills™ a/d), the administration of AC with food can decrease the absorptive capacity of AC; however, this was thought to be clinically insignificant. That said, when administering AC with food, ideally the smallest amount of food should be used.

- Due to the thick viscosity of AC, it is often difficult to administer via NE or NG tube administration. Oral tubing in an awake patient (e.g., with a mouth gag and careful restraint) has been successfully used to administer AC.
- Rarely, reports of hypernatremia have been clinically seen with AC administration. This is likely due to the sorbitol effect (see "Cathartics"). The patient should be assessed for hydration status.
- To prevent dehydration and hypernatremia, the patient should be appropriately hydrated with either IV or SQ fluids.
- A potent antiemetic should be administered to prevent secondary vomition or aspiration pneumonia, and to allow for rapid return to oral water (to help maintain hydration of the patient).
  - Maropitant 1 mg/kg, SQ q 24 hours; administration to cats or by intravenous administration is considered extra-label but has been used by this author successfully.
  - Ondansetron 0.1–0.3 mg/kg, SQ, IM, IV q 6–12 hours.
  - Dolasetron 0.6–1 mg/kg, SQ, IM, IV q 24 hours.
  - Metoclopramide 0.2–0.5 mg/kg, SQ, IM q 6–12 hours; or CRI at 1–2 mg/kg/day IV; generally less effective as an antiemetic than maropitant or ondansetron, but provides gastric emptying and a prokinetic effect.
- Contraindications for AC include dehydration, hypernatremia, vomiting, late-stage presentation with clinical signs already present, a compromised airway (risk for aspiration pneumonia), endoscopy, abdominal surgery of the GIT, gastric or intestinal obstruction, perforation of the GIT, lack of borborgymi, ileus, hypovolemic shock, caustic substance ingestion, and hydrocarbon toxicosis (due to increased risk for aspiration pneumonia).

Cholestyramine

- Cholestyramine, a chloride salt of a basic anion exchange resin, is recommended by the ASPCA Animal Poison Control Center over the use of charcoal.
- Cholestyramine binds with bile acids within the intestines, producing an insoluble complex and preventing bile acids from being reabsorbed (and instead, excreted through the feces).
- Cholestyramine can be dosed at 0.3–1 g/kg every 6–8 hours with toxicants that undergo enterohepatic recirculation or biliary elimination.
- Little is known about the success of cholestyramine in veterinary medicine; anecdotally, the ASPCA Animal Poison Control Center has had success with its use instead of AC for the poisoned patient.
- Cholestyramine, like AC, has fallen out of favor in human medicine.

Cathartics

- Cathartics are designed to increase the speed and transit time of the GIT, promoting fecal excretion of the toxicant; more importantly, cathartics decrease the time allowed for toxicant absorption through the GIT.

- Two of the most common types of cathartics used in the poisoned patient are:
  - saccharide cathartics (e.g., sorbitol)
  - saline cathartics (e.g., magnesium citrate, magnesium sulfate, sodium sulfate).
- Dose: sorbitol (70% solution, 1–2 mL/kg, PO, given within 60 minutes of toxin ingestion).
- Side effects of sorbitol administration: vomiting, dehydration, secondary hypernatremia, abdominal cramping or pain, and possible hypotension.
- Contraindications for cathartics are similar to those for AC listed above.
- Mineral oil is *no longer recommended* as a cathartic due to the high risks of aspiration.
- The use of cathartics alone is no longer recommended or beneficial.
- Cathartics should not be used in a dehydrated patient, due to the risks of voluminous fluid losses through the GIT and secondary hypernatremia. For patients receiving either multidoses of AC with or without cathartics, serum sodium levels and hydration status should be carefully monitored.

Fluid Therapy

- Fluid therapy is one of the cornerstone therapies of emergency management of the poisoned patient to:
  - correct dehydration
  - maintain perfusion at a cellular level
  - vasodilate the renal vessels, flush the renal tubules, and diurese the patient. This is particularly important with nephrotoxicants such as grapes, raisins, NSAIDs, ethylene glycol, lilies, etc.
  - treat hypotension (particularly with drugs like beta-blockers, calcium channel blockers, ACE-inhibitors, etc.).
- Fluid therapy can also be used to aid in detoxification of the patient by increasing renal excretion of toxicants by forced diuresis, provided the toxicants undergo renal excretion (e.g., amphetamines, etc.).
- Dose: the dose of IV fluids to administer is dependent on the clinical state and physical examination findings of the patient.
  - In a healthy patient, fluid rates of 4–10 mL/kg/hour can be used to force renal clearance of the toxicant.
  - Neonates have a higher maintenance fluid rate (80–180 mL/kg/day), and fluid rates should be adjusted accordingly.
  - Patients with cardiac disease or respiratory disease, or those who have ingested toxicants that may increase the patient's risk of pulmonary edema (e.g., phosphide rodenticide) should have judicious fluid administration.
  - Careful assessment of hydration should be made based on PCV/TS, weight gain, CVP, and physical examination findings.
- The additional use of diuretics can be undertaken in hydrated patients to increase forced diuresis. This should be *less commonly considered*, as diuretics can result in dehydration or nephrotoxicity.
  - Furosemide 1–4 mg/kg, IV, SQ, IM q 6–8 hours.
  - Mannitol 0.5–2 g/kg, IV slow over 20–30 minutes q 6–8 hours.

- Highly protein-bound toxins are not cleared efficiently by diuresis (e.g., NSAIDs).
- Drugs that respond well to forced diuresis include:
    - phenobarbital
    - amphetamines
    - salicylate
    - lithium
    - bromide.

Surgical Decontamination

- Surgical removal of toxic agents may occasionally need to be performed, particularly if the toxicant is caustic or corrosive (e.g., batteries), results in a bezoar that cannot be removed by gastric lavage (e.g., iron tablets, bone meal), results in foreign body obstruction (e.g., Gorilla Glue), or continues to leach its toxic effect (e.g., Amitraz collars, zinc pennies, fentanyl or nicotine patches, etc.). Please see chapter 72, Foreign Objects, for more information.
- Prior to surgery, patients should have radiographs done to verify presence of the agent and presence of an obstructive pattern. Keep in mind that not all foreign bodies are radiopaque. Patients should be properly volume resuscitated with IV fluid therapy and antiemetic therapy, and have their electrolyte, glucose, and acid–base imbalances corrected prior to anesthesia.

CONCLUSIONS

- Aggressive decontamination and detoxification of the poisoned patient are imperative and still considered the mainstay therapy in veterinary medicine.
- The clinician should feel well versed in appropriate decontamination methods to treat poisoned patients.

Abbreviations

See Appendix 1 for a complete list.

PEG-ES = polyethylene glycol electrolyte solution
WBI   = whole bowel irrigation

Suggested Reading

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