A number of new or improved therapeutic approaches are being applied in the field of veterinary toxicology—some extrapolated from human medicine and others based on anecdotal experience. Most veterinarians feel comfortable treating the poisoned patient, and are familiar with the common toxicants accidentally ingested by dogs and cats. However, in order to improve the quality of care and overall success in treating critically ill, poisoned patients, veterinary professionals need to be familiar with recent developments in toxicology.

Some recent updates involve the following aspects of therapy for poisoned pets:

- Use of correct emetic agents
- Indications for gastric lavage
- Monitoring for hypernatremia
- Role of intravenous lipid emulsion.

THE CORRECT EMETIC AGENT

In veterinary medicine, aggressive decontamination is the mainstay therapy for poisoned patients. If emesis is warranted, the use of appropriate, effective, safe emetic agents is imperative. Emetic agents typically work by causing local gastric irritation and/or stimulating the central nervous system chemoreceptor trigger zone (CRTZ).1,2

Emesis should not be induced:

- In patients exhibiting clinical signs of poisoning, such as agitation, tachycardia, tremors, hypoglycemia, or sedation
- If the patient has ingested a toxin for which emesis induction is contraindicated (eg, corrosives, hydrocarbons)
- After 1 to 2 hours of toxin ingestion, if the toxicant is thought to have moved out of the stomach.
The only at-home emetic agent currently recommended for dogs is hydrogen peroxide; however, note that excessive use of hydrogen peroxide may cause severe hemorrhagic gastritis. Since there are no safe at-home emetic agents for cats, immediate veterinary attention is warranted for emesis induction.

Veterinary-prescribed emetic agents include apomorphine hydrochloride for dogs and alpha-2 agonist agents (e.g., xylazine hydrochloride, dexmedetomidine) for cats. Table 1 provides recommendations for appropriate use of emetic agents.

Methods of emesis induction that are no longer recommended include digital induction, syrup of ipecac, salt, soap, and mustard powder. Side effects of these methods include oropharyngeal injury, protracted emesis or vomiting, hemorrhagic vomiting or diarrhea, lethargy, cardiotoxicity, and hypernatremia.

### INDICATIONS FOR GASTRIC LAVAGE

Gastric lavage is indicated for poisoned patients in certain situations, but veterinarians rarely perform gastric lavage as it is more labor intensive than induction of emesis.

Canine studies have shown that, when gastric lavage was performed within 15 minutes after toxicant ingestion, recovery of the ingested material was poor (38%; range, 2%–69%), and if performed 60 minutes after toxicant ingestion, only 13% of the ingested material was recovered. Since patients often present more than 1 hour after toxin ingestion, the clinical usefulness of gastric lavage is questioned. With certain life-threatening toxicants (included in Table 2), however, gastric lavage is highly recommended, especially in cases where oral emesis is contraindicated.

### TABLE 1. Recommended Emetic Agents for Use in Dogs & Cats

<table>
<thead>
<tr>
<th>Emetic Agent</th>
<th>Mechanism of Action</th>
<th>Dosage</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen peroxide</td>
<td>Local irritation of oropharynx and gastric lining</td>
<td>1–2 mL/kg PO (3% solution)</td>
<td>Bloat, Gastric ulceration, Gastric dilatation-volvulus (rare), Hemorrhagic gastritis, Protracted emesis, Vasovagal response</td>
</tr>
<tr>
<td>Apomorphine hydrochloride</td>
<td>Centrally acting, stimulation of the CRTZ</td>
<td>0.03–0.04 mg/kg IM, IV or 0.25 mg/kg tablet in subconjunctival sac</td>
<td>Corneal ulcers, Excitement and/or restlessness, Ocular irritation (subconjunctival use), Prolonged emesis, Respiratory depression, Sedation</td>
</tr>
<tr>
<td>Xylazine hydrochloride</td>
<td>Centrally acting, stimulation of the CRTZ</td>
<td>0.44 mg/kg IM</td>
<td>Bradycardia, Increased responsiveness to sharp auditory stimuli, Increased urination, Muscle tremors, Respiratory depression, Sedation</td>
</tr>
<tr>
<td>Dexmedetomidine</td>
<td>Centrally acting, stimulation of the CRTZ</td>
<td>1–2 mcg/kg IV or 40 mcg/kg IM</td>
<td>Apnea, bradycardia, sedation, Hyperglycemia, Hypothermia, Muscle tremors, Reduced tear production, Respiratory depression, Transient hypertension, Vasovascular constriction</td>
</tr>
</tbody>
</table>

### TABLE 2. Indications & Contraindications for Use of Gastric Lavage

**INDICATIONS**

- Baclofen
- Cholecalciferol
- Deadly medications with a narrow safety margin (e.g., calcium channel blockers, fluorouracil)
- Macrocyclic lactones (e.g., ivermectin, moxidectin), especially in dogs with ABCB1 gene mutation
- Massive ingestions approaching LD$_{50}$
- Materials that can form a bezoar or concretion in the stomach (e.g., aspirin pills, prenatal vitamins, bone meal, iron tablets, unbaked bread dough)
- Organophosphates/carbamates
- Patient with clinical signs (e.g., decreased gag reflex due to excessive sedation) in which aspiration is of concern if emesis is performed

**CONTRAINDICATIONS**

- Corrosive agent (e.g., batteries, drain cleaners, oven cleaners, ultra bleach)
- Ingestion of sharp objects (e.g., sewing needles, knives)
- Petroleum distillates or hydrocarbons (e.g., gasoline, kerosene, motor oil), which may be easily aspirated due to their low viscosity
- Risk for sedation or anesthetic complications
- Unstable patients (patients in shock and at risk for complications from sedation)
cially when emesis induction is unproductive or contraindicated. These toxicants typically have a narrow margin of safety or result in severe clinical signs. Table 2 outlines the indications and contraindications for gastric lavage. Visit vetgirlontherun.com to view a video demonstrating how to perform gastric lavage.

MONITORING FOR HYPERNATREMIA

Hypernatremia has been anecdotally reported in poisoned patients secondary to activated charcoal (AC) administration.4 While uncommon, secondary hypernatremia can be severe and mimic clinical signs of worsening toxicosis. Clinical signs of ataxia, head pressing, worsening lethargy, tremors, or obtundation may actually be due to hypernatremia rather than the toxicant.

If any of these clinical signs develop, the best way to determine if a patient is hypernatremic is to immediately measure its serum sodium level. If the patient is receiving multiple doses of AC per day, daily sodium levels should always be measured.

Differentiation Between Hypernatremia & Poisoning

Based on my experience, hypernatremia is seen more frequently in patients poisoned by certain toxicants—chocolate or bromethalin. Since both of these toxicants can result in clinical signs attributable to the central nervous system (eg, ataxia, agitation, tremors, seizures), it is clinically important to differentiate between hypernatremia and poisoning.

Poisoned patients can become hypernatremic due to:
- Use of salt as an emetic agent (hence, it is no longer recommended as a safe emetic agent in dogs or cats)
- Dehydration due to emesis induction, which prohibits its patient’s oral intake for several hours
- Excessive free water loss secondary to panting (eg, secondary to stress while administering AC or excitement/agitation induced by toxin)
- Other ongoing free water losses due to the toxicant (eg, vomiting, diarrhea, polyuria, polydipsia)
- Administration of AC—especially when it contains a cathartic, such as sorbitol, that can result in excessive free water loss from the gastrointestinal (GI) tract, resulting in secondary hypernatremia.

Risk factors for hypernatremia are listed in Table 3.

Minimizing Risk for Hypernatremia

Typically, a onetime co-administered dose of a cathartic, such as sorbitol, with AC is warranted in the poisoned patient to aid in fecal expulsion of the toxicant. For patients receiving multiple doses of AC, ideally sorbitol should only be given with the first dose; additional doses should not contain sorbitol. In addition:
- Monitor serum sodium levels at least daily
- Assess hydration status frequently
- Provide appropriate fluid supplementation (IV or SC) to prevent dehydration and hypernatremia.

In poisoned patients receiving IV fluids that were previously in good health, 3 main parameters should be used to assess appropriate hydration:

1. Packed cell volume (PCV)/total solids (TS): Ideally, patients on IV fluids should be hemodiluted down to a PCV of 35% and TS of 5 g/dL; evidence of normal PCV (45%) and TS (7 g/dL) in a patient receiving IV fluids is inappropriate as it demonstrates lack of adequate hemodilution.

2. Weight gain: Weight gain provides an easy way to assess hydration. The dehydration formula is:

\[
\text{Percent dehydration } \times \text{ BW kg} = \text{Amount of mLs of IV fluid to replace.}
\]

Note: the amount of mLs of IV fluid to replace is the same as anticipated weight gain (converted to kg).

For example, if a 30-kg Labrador retriever is 5% dehydrated, expected weight gain is 1.5 kg (or 1500 mL) once the patient is hydrated (hydrated weight = 31.5 kg).

3. Evidence of isosthenuria: With appropriate hemodilution, urine specific gravity (USG) is targeted at 1.015 to 1.018 in both cats and dogs. A USG greater than 1.025 may indicate dehydration. Risk for hypernatremia can also be minimized by use of a potent antiemetic (eg, maropitant, ondansetron, dolasetron), which helps treat any ongoing nausea or persistent vomiting and allows rapid return to oral water intake.

For poisoned animals being managed as outpatients that have received a dose of AC,
use of a potent antiemetic and administration of SC fluids (approximately 40–50 mL/kg of a balanced, isotonic crystalloid) prevents additional free water loss and replaces any fluid deficit, thereby helping to prevent hypernatremia and allowing rapid return to a hydrated state.

**ROLE OF INTRAVENOUS LIPID EMULSION**

Intravenous lipid emulsions (ILE), also known as intravenous fat emulsions (IFE), have been used in human and veterinary medicine as part of total or partial parenteral nutrition for several decades. ILE also has been used as a vehicle for drug delivery for emulsions (eg, propofol) and, more recently, it has been recommended as a potential antidote for lipophilic drug toxicosis.

The precise mechanism of action through which ILE increases the rate of recovery and reduces the severity of clinical signs in lipophilic drug toxicosis is unknown. See Table 4 for hypotheses regarding how ILE works.

**Indications**

ILE therapy is generally considered relatively safe; however, its use for treatment of toxicities is considered extra-label, and rare side effects can occur, including fat-overload syndrome, cholesterol deposits into the cornea, and coagulopathy. Keep in mind that the use of ILE in human medicine is typically reserved for severe toxicosis and life-threatening clinical signs when conventional therapies have failed.

Current human medicine guidelines recommend that infusion of ILE should only be:

- Attempted in patients who have suffered cardiac arrest
- Used when standard resuscitation protocols have failed to establish adequate return to spontaneous circulation.
- Cardiopulmonary resuscitation should continue during ILE administration.

In veterinary medicine, ILE is generally initiated earlier in the course of treatment, and is warranted:

- For toxicities associated with lipid-soluble compounds in which a high morbidity has been reported
- In patients with clinical signs of toxicosis
- When traditional therapies have failed or are cost-prohibitive.

**In the Literature**

A state-of-the-art review by Fernandez, et al,5 was recently published, introducing the first recommendations for use of ILE in veterinary medicine. Table 5 (page 28) lists the toxicants for which ILE therapy is thought to be helpful.

---

**TABLE 4. Hypotheses: How ILE Addresses Fat-Soluble Toxicants**

1. Provides myocytes with energy substrates, thereby augmenting cardiac performance.
2. Restores myocardial function by increasing intracellular calcium concentration, which increases contractility of the heart.
3. Increases overall fatty acid pool, which overcomes inhibition of mitochondrial fatty acid metabolism (eg, bupivacaine toxicosis).
4. Acts as a lipid sink by sequestration of lipophilic compounds into the newly created intravascular lipid compartment (a lipid or pharmacologic sink), resulting in decreased free drug concentration available to the tissues.
TABLE 5. Toxicants That Have Been Successfully Treated with ILE Therapy6-13

- Baclofen†
- Beta blockers†
- Calcium channel blockers
- Cholecalciferol‡
- Ibuprofen
- Lidocaine
- Macrocyclic lactones‡
- Pyrethrins

† The ASPCA Animal Poison Control Center has recommended ILE for these fat-soluble toxicants with a narrow safety margin.
‡ In one case report, ILE was not found to be beneficial for macrocyclic lactone toxicosis in multidrug resistant (MDR), also known as ABCB1-1delta, gene mutation dogs.

Administration
ILE (eg, Intralipid, baxter.com; Liposyn III, hospira.com) can be delivered through a sterile, peripheral catheter, and does not require placement of a central line for administration.

ILE has a long storage half-life, and can be stored at room temperature until it is opened. Once opened, aseptic handling is imperative and refrigeration necessary; the remaining product should be discarded after 24 hours.

For additional information about ILE, including current dosing recommendations in veterinary medicine, see Table 6.

CONCLUSION
The use of new and updated approaches to therapy in veterinary toxicology may dramatically improve the overall outcome in toxicities that have been previously associated with a high morbidity, mortality, and cost. However, extra-label use should be judicious, and appropriate case selection, along with continuous supportive care, is imperative in critically ill, poisoned patients.

TABLE 6. Suggested Dosing for ILE in Dogs & Cats§

1. Using a 20% solution, bolus 1.5–4 mL/kg IV over 1 minute, followed by a constant rate infusion of 0.25 mL/kg/min for 30–60 min.
2. If clinical signs are ongoing, continue:
   - Intermittent bolus dosing, 1.5 mL/kg Q 4–6 H for 24 H, or
   - Constant rate infusion, 0.5 mL/kg/H, until clinical signs improve.
3. If clinical signs do not improve after 24 H, discontinue ILE.

AC = activated charcoal; BWkg = body weight in kg; CRZT = chemoreceptor trigger zone; GI = gastrointestinal; IFE = intravenous fat emulsion; ILE = intravenous lipid emulsion; LD50 = lethal dose (dose required to kill 50% of the test population); PCV = packed cell volume; TS = total solids; USG = urine specific gravity

References
4. Personal communication, Justine Lee, DVM, Diplomate ACVECC & ABT.

Justine A. Lee, DVM, Diplomate ACVECC & ABT, is the CEO and founder of VetGirl (vetgirlontherun.com), a subscription-based podcast and webinar service that offers RACE-approved veterinary continuing education. She recently received the NAVC Speaker of the Year Award, and is the author and editor of several veterinary textbooks, book chapters, and scientific publications. She completed her veterinary training at Cornell University, Angell Animal Medical Center (Boston), and University of Pennsylvania.