

Basic Toxicology Concepts
Erin Freed, CVT, BAS
ASPCA Animal Poison Control Center, Urbana, IL

Toxicology is the branch of science concerned with the nature, effects, and detection of poisons. Veterinary clinical toxicology encompasses this definition, but it's more related to the diagnosis and treatment of a poisoned pet.

COMMON TERMS USED IN TOXICOLOGY

Toxic: poisonous.

Toxin: a poisonous material produced by an animal or plant (e.g. snake venom).

Toxicant: a poisonous material introduced into the environment or body (e.g. pesticide).

Agent: alternative word for a specific toxin or toxicant (e.g. pet ate ibuprofen; ibuprofen is the agent).

Toxicosis: a condition caused by the action of a poison or toxin. Also known as a poisoning or intoxication.

Toxicity: the degree to which something is poisonous (e.g. LD₅₀).

LD50: the amount of a toxic agent that is enough to kill 50% of a population (also known as median lethal dose).

LOC (Level of Concern): the threshold or concentration of a toxic agent that can cause an effect; most of the time it is stated in mg/kg (e.g. the level of concern for most canines to develop liver damage from acetaminophen [Tylenol®] is 100 mg/kg).

Dose: the quantity of the agent administered at one time irrespective of body weight (e.g. owner induced emesis with 1 tbsp of H₂O₂. 1 tbsp = the dose administered).

Dosage: the size, amount, frequency and number of doses of an agent administered to a pet, based on body weight (e.g. A dog was given a dosage of 2 mg/kg of diphenhydramine for treatment of allergies).

Mg/kg: dosages are reported in milligrams per kilogram. Most pharmaceutical drugs used in veterinary medicine are reported in mg/kg and the same applies to toxicology.

Exposure: the introduction of a toxin or toxicant to a host (e.g. pet eats medication).

Risk: the likelihood that a toxin or toxicant will cause harm under certain circumstances.

Management: a planned approach taken once a pet has been exposed to a poison. This can range from removing the pet from the source of the poison, to decontamination, to an antidote, or to symptomatic and supportive care.

Symptomatic care: treatment aimed at relieving signs without necessarily affecting the basic underlying cause of the symptoms (e.g. administering diazepam to a seizing pet, anti-emetic if the pet is vomiting, intravenous fluids to assist the body in excreting the drug faster).

Supportive care: nursing care provided to the pet (e.g. nutritional support, assisting the pet with moving or taking the pet out to use the restroom, keeping the pet comfortable, intravenous fluids to help maintain the pet's hydration).

WHAT DOES TOXIC REALLY MEAN?

1. **Anything has the potential to be toxic under the right circumstance.** Water, a necessity needed to live, can be poisonous under the right circumstances. If too much water is ingested, it can alter electrolytes in the body and cause a water intoxication.
2. **There are NO specific signs a pet will develop that will indicate a poisoning.** Signs depend on the type of poison ingested, the amount ingested, the pet's information, and how the pet was exposed.
Example: A client reports his vomiting cat has been poisoned because the signs came on suddenly. Although it may be natural to blame the pet's signs on a poison, it's best to ask a few more questions. Vomiting does occur in a lot of poisoning cases, but it can also be a sign of a virus, parasite, or recent change in diet.
3. **Signs related to a toxicosis can vary** and range from drooling, to vomiting, to hind end weakness, to dilated pupils, to cardiac arrhythmias, and so on. Not all pets exposed to a poison will develop signs and not all signs will lead to death.

BASIC TOXICOLOGY CONCEPTS

There are 3 main concepts that can be applied in a pet poisoning emergency. Applying these concepts can make your job easier, save time and allow the pet to receive appropriate medical care.

1. **Treat the pet, not the poison.** True or false? If the poison is unknown, the pet cannot be treated. The answer is false. Knowing what the pet was exposed to makes the job easier, but it does not mean the pet's signs cannot be treated.
Example: A seizing dog is presented to the clinic. Can you assist your DVM with treating the seizures and stabilizing the pet? If the owner presented the same seizing dog to the clinic and mentioned the dog ate onions off a hamburger, would that change your approach to stabilizing the pet? Focusing on the poison and not on the pet can potentially deprive that pet of life saving care. In this case, the pet's signs were not related to the onions. Onions can cause Heinz body hemolytic anemia 3-5 days post exposure. We would not expect seizures.
2. **Species can react differently.** A pet's response to an agent can vary tremendously between different species. Some agents may be relatively non-toxic in one species whereas they could be very toxic to another species.

Example 1: Cats are more sensitive to onions and garlic compared to dogs. Cats have 8 free sulfhydryl groups on their hemoglobin (compared to 4 in dogs and 2 in humans) and this results in feline hemoglobin being 2-3 times more sensitive to oxidative damage compared to other species.

Example 2: Dogs with an ABCB1 (formally known as MDR1) gene mutation are more susceptible to drug toxicity. Breeds such as collies, Shetland sheepdogs, Australian shepherds and other related breeds are much more sensitive to macrolide antiparasitic agents such as ivermectin and moxidectin found in heartworm pretention.

Example 3: Cats are more sensitive to lilies than dogs. The toxic mechanism of lilies is unknown, but any exposure to a lily can cause acute kidney injury in cats, whereas it may only cause mild GI signs in dogs.

Example 4: Dogs are the only known species to be sensitive to xylitol. Xylitol can cause GI upset, hypoglycemia, and liver damage in dogs.

Example 5: Dogs are the only species known to be sensitive to macadamia nuts. Signs can cause GI upset, hind end weakness and tremors.

3. **The dose makes the poison.** Every day, pets are exposed to poisons in the air they breathe, the food they eat, and the water they drink. The fact pets don't develop signs of poisoning daily emphasizes this concept. True or false? Any pet exposed to chocolate will develop signs a chocolate toxicosis? The answer is false.

Example: A 15 lb Boston terrier, "Spock", ingested 5 milk chocolate candy kisses last year around Christmas and didn't develop any signs. This Christmas, he ate 20 milk chocolate candy kisses and developed vomiting, diarrhea, polydipsia, and hyperactivity. The only difference between these two exposures is the dose or the amount of chocolate ingested.

Let's Calculate the Chocolate Dosages. If 1 milk chocolate candy kiss is 0.16 oz and milk chocolate contains 65 milligrams of methylxanthines (toxic component) per ounce, can you calculate how many methylxanthines "Spock" ate last year and this year? The dosage should be reported in mg/kg.

Answer: "Spock" ate ~ 7.6 mg/kg last year vs. 30.5 mg/kg this year
Chocolate toxicity dosages

- <20 mg/kg – Gastrointestinal upset (vomiting and diarrhea)
- >20-40 mg/kg – Gastrointestinal upset, polydipsia, and stimulatory signs (hyperactivity, pacing, panting, restlessness, agitation)
- >40 mg/kg – cardiovascular effects (tachycardia, cardiac arrhythmias)
- >60 mg/kg – central nervous system signs (tremors, seizures)

Let's Calculate Another Dosage: An owner gave 1, 75 mg tablet of carprofen to her Husky "Diamond." "Diamond" spit the pill out and "Beau" ate it. Beau is a Yorkshire terrier weighing in at 4 pounds. Will Beau develop a carprofen toxicosis? Calculate and report dosage in mg/kg.

Answer: Beau ate ~ 41.2 mg/kg

Carpofen toxicity dosages for dogs

- <20 mg/kg: GI upset
- >20 mg/kg: GI ulcers
- >40 mg/kg: renal damage

WHY IS CALCULATING DOSAGES SO IMPORTANT IN TOXICOLOGY?

Calculating a dosage can help the DVM determine what signs the pet will develop, whether decontamination with emesis is needed, and what treatment plan should be implemented. There are cases where a dosage cannot be calculated such as an exposure to plants or certain foods. As a veterinary technician, if there is any doubt in the amount ingested, calculate a dosage based on a worst-case scenario and report it to the DVM. If a definitive dosage cannot be determined, don't sweat it. In these cases, provide your DVM with a dosage range.

Example: Lady, a 73-pound Greyhound chewed into the owner's travel size ibuprofen container. Brand new, this container held 10 tablets, but the owner believes she's taken 4 of those tablets and suspects Lady only ingested 6. A dosage calculation needs to be reported to the DVM, so a treatment plan can be put together. Calculations are performed based on 6 tablets ingested and 10 tablets ingested. The dosage provided to the DVM is a range of 36 – 60 mg/kg.

Ibuprofen toxicity dosages

- Any amount - GI upset
- >50 mg/ - GI ulceration
- >125 mg/kg - renal injury
- >350 - 400 mg/kg CNS signs

In this case, emesis was induced. Food was seen in the vomit, but no tablets. Activated charcoal was not given because the amount wasn't life-threatening. Lady was treated as an outpatient with an anti-emetic and GI protectants such as omeprazole and sucralfate. By calculating the dosage, the DVM saved time, Lady did not undergo extensive treatment, the client saved money and the client saved time with Lady at home.

WHERE CAN I FIND DOSAGES AND OTHER TOXICOLOGY INFORMATION?

There are lots of resources including veterinary drug handbooks, toxicology textbooks, journals, webinars, and when in doubt you can always call an animal poison control center.