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Clinical Techniques in
Small Animal Practice

The Poison-Proof Practice

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Toxicology is the medical discipline that studies the often dramatic effects that poisons can have on living organisms. The body of toxicological information that the practicing veterinarian must deal with is growing exponentially. The veterinary clinician must come to understand the source of potential toxicants, circumstances leading up to poisoning episodes, must recognize the clinical signs of a wide variety of poisons, be able to diagnose intoxications, successfully treat and manage exposed animals, and institute strategies that educate the public and help prevent future poisonings. This is a tremendously tall order and can be not a little bit overwhelming. Fortunately, the clinicians are not alone and have tremendous resources in their corner, including veterinary schools, regional poison and drug centers, national veterinary hot lines utilizing board-certified veterinary toxicologists, local toxicologists and an ever-growing body of literature concerning small animal poisoning management. This discussion will investigate ways in which to make this seemingly daunting field much more palatable to small animal practitioners.
Clin Tech Small Anim Pract 21:164-173 © 2006 Elsevier Inc. All rights reserved.

KEYWORDS **small animal poisonings, toxicological history taking, toxidromes, common small animal poisonings**

Clinical toxicology is one of the most challenging and dynamic fields of modern veterinary medicine. The practicing veterinarian is constantly faced with the diagnosis and management of accidental poisonings and drug overdoses, a continual new array of pesticides, herbicides, parasiticides, over-the-counter (and under-the-counter) drugs, and the development of new industrial molecules that are potentially toxic to both animals and humans. In addition, the public expects much more from veterinary professionals with regard to the level of care that their animal receives. Once considered rare, poisoning cases (particularly of certain poisons) have become much more common. At our emergency room in a busy 24-hour urban practice, for certain 30-day periods intoxications of some sort account for as much as 6 to 10% of total presentations. Establishing a diagnosis is the key to successful treatment of potential poisonings. Accurate and early diagnosis supplies the appropriate treatment of the poisoned animal, prevents additional cases from occurring, and increases the likelihood of a favorable and successful outcome. Animal poisoning cases require a multi-tiered approach that considers and investigates a variety of factors.

Adequate work-up includes a detailed and complete history, thorough physical examination, physical and laboratory parameters that may include blood and biochemical profiles, bioassay and histopathology, response to therapy, and sometimes, unfortunately, postmortem findings. This multi-level approach to poisonings also involves the staff familiarizing themselves with the typical presentation and treatment of the most common poisonings and gearing up to provide state-of-the-art initial care to intoxicated companion animals. This discussion will examine how veterinary clinics can "poison-proof" their practices and educate their staff to maximize their success in the accurate diagnosis and appropriate treatment of toxicology cases.

Telephone Contact

Often the first line of defense in management of cases is the telephone. For this reason, all telephone personnel in veterinary hospitals must be trained as much as possible in the most common animal poisonings, their relative toxicities, how they are managed, and what to tell people about this treatment. Our telephone staffs are only as capable as we train them and educate them about emergencies. Many veterinary hospitals have in-house training for the staff regarding various poisons. It is tremendously important that receptionists swiftly recognize what can be deadly and what is harmless (ie, the difference between ethylene glycol and blue toilet water). Training sessions of this type and refresher seminars are tremendously effective and can provide spectacular benefits. No veterinarian wants to hear that their receptionist told the owner of an animal ingesting a potentially deadly substance that it was "no big deal." Encourage telephone personnel to take every poten-

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 1096-2867/06/$-see front matter © 2006 Elsevier Inc. All rights reserved.
doi:10.1053/j.ctsap.2006.10.007

Table 1 Initial Telephone Contact

Success or failure in treatment of poisonings can stem from the initial telephone contact.
Telephone personnel must establish:
- ***Name, address, and phone number*** **of person they are speaking with**
- ***Who*** **has been poisoned? (e.g., species, breed, age, sex and weight)**
- ***What*** **toxin is involved? (e.g., amount, concentration; form: liquid, powder, gas, paper, etc.**

Are original containers listing ingredients, concentrations, potential antidotes or manufacturer's emergency number available?)
- ***When*** **did it happen? (How much time has elapsed since ingestion or exposure? Did the caller see it happen?)**
- ***Route*** **(e.g., ingestion, dermal, inhalation, or ocular)**
- ***Where*** **did it happen? (On the owner's premises?)**
- ***How much*** **was ingested? (Original containers allow estimation of how much was consumed and how much remains.)**
- ***What is the animal's present clinical status?*** **(What is the animal doing/ Educate the owner about the clinical signs and course of progression for that poisoning.)**
- ***Determine the mg/kg dosage for this exposure.*** **(Compare it with known therapeutic and/or toxic dose information to establish the risk for this animal); determine a timeline between exposure and onset of clinical signs for this toxin.**
- ***Other:*** **Find out: (1) other toxins that the animal could have been exposed to simultaneously; (2) medications the animal is currently taking or other underlying medical conditions (e.g., heart disease, kidney problems, pregnancy); and (3) other animals or children who might have been exposed.**
- ***Determine*** **from this information whether the animal needs to be seen and treated or can be managed conservatively at home and observed. The animal can be observed at home only if a follow-up mechanism is in place (i.e., the owner is familiar with the course of the poisoning and clinical signs and calls frequency (or is called) with progress reports.) Final recommendation to treat or observe must rest with the veterinarian.**

Finally, **the information gathered in the initial telephone interview allows the veterinarian to prepare for the animal's arrival in anticipation of what poison is involved and what clinical signs are present, and enables assembly of equipment and medications to rapidly initiate specific therapy.**

tial intoxication seriously. Also, train them to tell owners to bring in all original containers of the suspected toxic substance. Original containers may provide active ingredients and poisons, their concentration, and the original amount of the poison present. Examination of the original container in which the poison was stored and how much is left may help determine how much was ingested. Original containers may provide 1-800-numbers of manufacturers who then can provide effective treatment regimens and possible antidote information. For many poisonings, time is of the essence and this type of handling up front by receptionists can determine the successful outcome of a case or the death of an animal. Table 1 lists several facets of successful telephone contact with owners of possibly poisoned pets.

History Taking

Obtaining a complete history is essential in cases of suspected poisoning. Followed by a sound physical examination, establishing a minimum database, and ruling out differential diagnosis, it allows the clinician to narrow considerably the list of potential causes of the animal's problems. For a variety of reasons, owners in toxicology cases may give histories that are inaccurate, highly unreliable, and sometimes intentionally deceitful. Owners may feel guilty about how long a condition has been going on, how long it has been since their last veterinary visit, how long the animal is left alone each day, how the animal actually gained access to the poison, how long it took for the owner to notice it, or the careless manner in which the

Table 2 Key Items in the Toxicological History

- ***Listen*** **to the client. Avoid any bias or preconceptions.**
- **At the same time, *observe the animal.*** **Although you can't always believe the client, you can believe clinical signs of the animal.**
- **Identify and *treat immediate life-threatening problems*** **(e.g., arrhythmias, seizures.)**
- **Do not wait for confirmation of poisons involved to initiate supportive therapy.**
- ***Identify*** **the animal's entire home environment. Could other poisons or other animals or children be involved?**
- ***Identify*** **any current medications, underlying conditions, or pertinent previous medical history for the animal (e.g., heart disease, kidney problems, pregnancy).**
- ***History*** **of the exposure event. How long ago, what toxin, what concentration, how much? Does the occupation or hobby of the owner predispose to the presence of any particular poisons in the home?**
- **If possible, *identify the poison*** **(or poisons). Estimate the mg/kg dose for the animal and the possibility of a toxic or lethal exposure.**
- **Establish an exposure/onset of clinical signs *timeline.*** **Is the animal getting better, deteriorating, or showing no signs?**
- **Establish a *minimum database.***
- **Treat the patient, *not*** **the poison.**

Table 3 Sample Toxicology History Form

- Animal's name, species, breed, sex, intact/neutered.
- Age, weight.
- Medications presently receiving.
- Other pertinent medical history.
- Suspected poison involved.
- Maximum amount of toxin suspected (worst-case scenario).
- Was the original container found?
- Potential route of exposure suspected.
- When did possible exposure occur?
- When were clinical signs first noted? Describe them.
- Could other poisons be involved?
- Could other animals have been exposed?
- Describe the animal's environment (where animal kept, how long left alone, hobbies of owner, anything that might lead to poisoning).

toxic substance was stored or disposed of in the house. Often owners will falsify histories (as in the case of illicit drugs) because of fear of legal repercussions and grounds for potential prosecution. Veterinarians must recognize these factors and be adept at sifting through the available facts and construct a solid, comprehensive medical history. Also, practitioners must not be misled just because owners are convinced that their pet has been poisoned. It must never be forgotten that preexisting infections, or metabolic, congenital, and neoplastic conditions can mimic signs of various toxicoses or predispose them to poisonings. Veterinarians must never suggest that a client's animal has been poisoned unless there is adequate evidence to support such a conclusion. The accurate history is central in establishing a specific diagnosis. Table 2 summarizes the essentials in taking a toxicological history.

Some clinicians and veterinary hospitals use a prepared toxicology history form to help prompt themselves in asking the right questions and successfully directing the initial interview in suspected poisoning cases. The standardized document includes the animal's age, weight, environment, and any medications presently in use. What toxin (or toxins) is suspected is a critical concern. How much poison may have been involved, route of exposure, and when the potential exposure episode occurred are all prominent topics on such a list of questions. If and when clinical signs and their specific nature were first noted is likewise tremendously important. Also, the form helps determine if other poisons may be implicated and if other animals in the house could likewise have been exposed. This type of direct-line questioning may help the veterinarian more quickly obtain information and aid in more swiftly obtaining a diagnosis. An example of such a toxicology history form is included in Table 3. If these history-taking guidelines are followed in toxicology cases, valuable clues can be obtained allowing clinicians to establish a working diagnosis and help to determine the most appropriate course of therapy.

The Minimum Database

In obtaining a definitive diagnosis of poisoning, physical examination and assessment of clinical signs are invaluable and cannot be separated either from the history or laboratory results. Veterinarians must know the vital signs of the species they care for and come to recognize telltale clinical signs and characteristic "fingerprints" of specific poisonings. At the same time, it should be noted that clinical signs for many conditions are stereotypical and similar, and that cells, tissues, and organs can only respond in a limited number of ways that can look much the same, regardless of cause (eg, traumatic, infectious, metabolic, neoplastic, or toxicological). For this reason, poisonings are rarely diagnosed through physical examination or clinical signs alone. Furthermore, basing a diagnosis solely on clinical signs is unreliable because the clinician may be seeing only one phase of the disease and may have missed important earlier phases that help to reveal the precise identity, course and chronology of the intoxication.

In developing a minimum toxicological database, veterinarians must keep in mind what diagnostic tests laboratories are capable of running, which toxins can be detected (and which cannot), sample types required and minimum sample volumes, turn-around times in obtaining the results, and costs. To maximize the efficacy of laboratory tests, clinicians

Table 4 Commonly Seen Toxins Affecting Pulse

Bradycardia (↓)	Tachycardia (↑)
Antiarrhythmic drugs	Amphetamines
α- and β- Adrenergic agonists	Antihistamines
Baclofed	Atropine
Calcium channel blockers	Anticholinergics
Digitalis glycosides	Arsenic
Opioids	Caffeine
Organophosphates	Carbon monoxide
Carbamates	Cyclic antidepressants
	Ethanol
	Ephedrine/pseudoephedrine
	Epinephrine
	Organophosphates and carbamates
	Phenothiazine
	Theophylline
	Thyroxine

Table 5 Commonly Seen Toxins Affecting Body Temperature

Hyperthermia (↑)	Hypothermia (↓)
Amphetamines	Carbon monoxide
Anticholingerics	Ethanol
Antihistamines	Ethylene glycol
Bromethalin	Hypoglycemic agents
Cocaine	Macrolide antibiotics (e.g., ivermectin)
Cyclic antidepressants	Opioids
Hops	Pyrethrins/pyrethroids
Metaldehyde	Sedative hypnotic agents
Monamine oxidase inhibitors	
Pentachlorophenol	
Phencyclidine	
Pyrethrins/pyrethroids	
Salicylates	
Thyroxine	
Strychnine	

Table 6 Commonly Seen Toxins Affecting Respiratory Rate

Depressed Respiratory Rate (↓)	Increased Respiratory Rate (↑)
Bradypnea (↓)	Tachypnea (↑)
Barbituates	Carbon monoxide
Ethanol	Cyanide
Neuromuscular blockers	Ethylene glycol
Opioids	Methanol
Sedative hypnotics	Methemoglobin-producing agents
	Nicotine
	Organophosphates and carbamates
	Salicylates
	Sympathomimetic agents
	Theophylline

must have knowledge of the appropriate use for each test, a basic grasp of specific laboratory procedures, and an understanding of how to obtain and handle toxicological specimens properly. A common misconception of the public is that there is a single, effective, and inexpensive "poison screen" that will test for all toxicants. Surely there is no such simple procedure or test. Choice of laboratory tests must be based on a narrow index of suspicion based on the history, physical examination, and clinical signs and any other supportive laboratory results. Likewise, it must be stressed that veterinarians must never delay supportive therapy while awaiting a confirmatory laboratory test of positive toxin level in a critically ill animal. Lists of toxins affecting various vital signs (pulse, body temperature, respiratory rate, and blood pressure) are listed in Tables 4 through 7.

Veterinarians must come to rely on blood chemistries, pulse oximetry, electrocardiography, blood gas analysis, coagulation panels, electrolytes, urinalysis, and specific poison assays in an attempt to confirm toxin exposures. They must also learn to recognize the signature signs or commonly occurring poisonings. Through skilled and meticulous observation one can increase the likelihood of, or the success of, therapeutic intervention. Close observation can also help determine when adjustments to initial therapy may be required.

Practitioners must learn to recognize the most commonly occurring toxic syndromes. Clinicians can readily learn to identify a pattern of changes suggestive of a particular drug or toxin or group of drugs or toxins. A group of clinical signs that consistently result from particular toxins are known as **toxidromes** (from toxic syndromes). Some of the more commonly seen toxidromes are listed in Table 8. It should be noted that actual clinical manifestations of poisonings can be much more variable than the static list of signs included in a table in an article or textbook. Clinical signs of intoxication can be full blown, partial, or nonexistent. Absence of clinical signs or partial presentations does not automatically imply less severe conditions and as a result are no less critical to diagnose. By familiarizing themselves with the typical "look" of a toxin and its idiosyncrasies, by learning the capabilities and weaknesses of various laboratories and the specific tests they run, and by not losing sight of the actual clinical conditions of the animal, veterinarians can diagnose more effectively, treat more successfully, and provide our patients more favorable outcomes following accidental poisonings.

Most Common Poisonings

Hundreds of substances can be poisonous to small animals causing toxicological syndromes. Fortunately for the veterinary clinician, a small number of molecules are seen again and again, and are responsible for the majority of intoxications. The nature of poisonings can vary with age, species (dogs and cats experience quite different syndromes), and geographic location. For the last 10 years our emergency room experienced the following poisons most frequently. However, practitioners must thoroughly familiarize themselves with the clinical signs and therapy for the most common poisonings in their area.

Rodenticides

Each year one-fifth of the world's food supply is consumed, contaminated, or condemned through contact with rodents.[1] The quest for the "better mousetrap" has been with us since before the Pharaohs. Pesticides cause more animal exposures than any other class of toxin. Pesticides include rodenticides, insecticides, avicides, fungicides, and herbicides. The three main types of rodenticides currently in use are anticoagulants (such as warfarin, brodifacoum, and diphacinone), bromethlin-containing compounds, and cholecalciferol. Dogs are more frequently poisoned by rodenticides than cats. Modern rodenticides are much more toxic to rats and mice, but unfortunately are also more hazardous to nontarget species such as children and companion animals.

Potentially toxic agents sold in the United States are regulated by the Consumer Product Safety Commission. Depending on their relative toxic potential, labels of these products must bear the word "Danger" for the highly toxic molecules, the word "Warning" must appear for moderately toxic molecules, and "Caution" for lower toxic hazard substances.

The long-acting (second generation) anticoagulants have replaced warfarin and account for nearly 80% of rodenticide poisonings in the United States.[2] Anticoagulant rodenticides act by inhibition of the recycling of Vitamin K, to produce

Table 7 Commonly Seen Toxins Affecting Blood Pressure

Hypotension (↓)	Hypertension (↑)
α-Adrenergic antagonists	Amphetamines
Angiotensin-converting enzyme inhibitors and antagonists	Cocaine
Antiarrhythmic drugs	Ephedrine/ pseudoephedrine
β-Adrenergic antagonists	Epinephrine
Calcium channel blockers	Ergot alkaloids
Cyanide	Lead
Cyclic antidepressants	Monoamine oxidase inhibitors
Ethanol	Nicotine (early)
Nitrates and nitrites	Phenylpropanolamine
Nitroprussides	
Opioids	
Organophosphates and carbamates	
Phenothiazines	
Sedative hypnotic agents	
Theophylline	

Table 8 Toxins and Specific Toxidromes

Toxin	Vital signs	Mentation	Signs	Clinical Findings
1. Acetaminophen	Normal (early on)	Normal	Anorexia, vomiting	Jaundice (later)
2. Amphetamines	Tachycardia, tachypnea, hyperthermia, hypertension	Agitation	Anxiety, panic	Mydriasis-hyperactive peristalsis
3. Antihistamines	Hyperthermia, tachycardia, hypotension, hypertension	Agitation, altered mentation, lethargy to coma	Dry mouth, visual problems, difficulty in urination	Dry mucous membranes, mydriasis, urinary retention
4. Arsenic (acute)	Hypotension, tachycardia	Alert to coma	Vomiting, diarrhea, dysphagia, abdominal pain	Dehydration
5. Barbituates	Hypothermia, hypotension, bradypnea	Altered, lethargy to coma	Stumbling, ataxia	Hyporeflexive, cold, blank stare
6. β- Adrenergic antagonists	Hypotension, bradycardia	Altered, lethargy to coma	Ataxia	Cyanosis, seizures
7. Calcium channel blockers	Hypotension, bradycardia	Altered, lethargic, confused	Anorexic, vomiting	Slow heart rate
8. Carbon monoxide	Often normal	Altered, lethargy to coma	Nausea, vomiting, diarrhea, ataxic	Seizures
9. Cocaine	Hyperthermia, hypertension, tachypnea, tachycardia	Anxiety, agitation, delirious	Anxiety, restlessness, panic	Mydriasis, nystagmus
10. Cyclic antidepressants	Hypertension, tachycardia	Lethargy to coma	Dry mouth, difficulty in urination, confusion, ataxia	Mydriasis, dry membranes, distended bladder, seizures
11. Digitalis	Hypotension, bradycardia	Normal or lethargic	Anorexia, vomiting	None seen
12. Ethanol	Hypotension, tachycardia	Altered	Ataxia, anorexic, vomiting	Ataxia
13. Ethylene glycol (antifreeze)	Tachypnea	Lethargy to coma	Abdominal pain	Ataxia, stumbling, coma
14. Iron	Hypotension, tachycardia	Normal or lethargic	Anorexia, vomiting, diarrhea	Hematemesis
15. Lead	Hypertension	Lethargy to coma	Anorexic, vomiting, constipation, belly pain	Peripheral neuropathy, seizures, gingival pigmentation
16. Mercury	Hypotension (late)	Altered, anxiety	Anorexic, salivation, vomiting	Ataxia, stomatitis, tremors
17. Methanol	Hypotension, tachypnea	Lethargy to coma	Loss of visual acuity, blindness, belly pain	Mydriasis
18. Opioids	Hypotension, bradycardia, bradypnea, hypothermic	Lethargy to coma	Ataxia, confusion	Miosis, decreased peristalsis
19. Organophosphates and carbamates	Hypotension/hypertension, bradycardia/tachycardia, bradypnea/tachypnea	Lethargy to coma	Vomiting/diarrhea, belly pain, visual deficits	Salivation, lacrimation, urination, defecation, miosis, fasiculations, seizures
20. Phenothiazines	Hypotension, tachycardia, hypothermia *or* hyperthermia	Lethargy to coma	Ataxia, dry mouth, difficulty in urination	Miosis *or* mydriasis, decreased gut sounds
21. Salicylates	Hyperthermia, tachycardia	Agitation, then lethargy to coma	Anorexia, vomiting	Heart failures

Table 8 Continued.

Toxin	Vital signs	Mentation	Signs	Clinical Findings
22. Sedative-hypnotics	Hypotension, bradycardia, hypothermia, bradypnea	Lethargy to coma	Ataxia, stumbling	Hyporeflexia
23. Snail bait (metaldehyde)	Hyperthermia, tachypnea, tachycardia	Lethargy to coma	Ataxia, vomiting, diarrhea	Incoordination, muscle tremors, seizures
24. Theophylline	Hypotension, hyperthermia, tachycardia, tachypnea	Agitation, anxiety	Anorexia, vomiting	Tremors, seizures, cardiac arrhythmias
25. Pyrethrins/pyrethroids	Variable	Lethargy to coma	Anorexia, vomiting, diarrhea	Salivation, vomiting/diarrhea, muscle fasciculations, tremors, seizures

coagulopathy. These poisons decrease the activity of the Vitamin K-dependent clotting factors (II, VII, IX, X). When clotting factors are reduced enough, bleeding can occur spontaneously and from any site. Clinical signs most commonly observed are anorexia, weakness, epistaxis, and dyspnea. Hemarthroses with lameness and swollen joints has also been documented. Elevated coagulation times distinguish exposure from toxicity. Therapy includes Vitamin K_1 administration, cage rest, oxygen, and blood transfusions, if necessary. The prognosis depends on severity and location of hemorrhage and how long the animal has been bleeding until initiation of treatment.

Bromethalin is a newer rodenticide first marketed in 1985. This general-use rodenticide is available in pellets of a 0.01% concentration. It acts as a neurotoxin causing vacuolation and spongiosis of white matter in the central nervous system (CNS) and consequently severe cerebral edema.[3] Poisoned animals develop ataxia, paresis, hind limb paralysis, and progressively intensifying CNS depression. Bromethalin is an extremely nonselective mammalian poison. Cats are one of the most sensitive species to the toxic effects of bromethalin. There is no known antidote or physiological antagonist other than timely administration of emetics, control of cerebral edema, and supportive care.

Cholecalciferol mobilizes calcium from the bones and in toxic doses produces hypercalcemia, osteomalacia, and metastatic calcification of the cardiovascular system, kidneys, stomach, and lungs. Death typically occurs in 2 to 5 days.[4] No specific antidote is known, treatment involves emesis, reduction of hypercalcemia, and dietary calcium restriction. Prognosis is good if treated early and dystrophic calcification has not already occurred. Rodenticides are particularly hazardous to companion animals since they are so easy to obtain, used so ubiquitously, and because bait formulations using molasses and other sweets are so attractive to pets.

Ethylene Glycol

Pound for pound, ethylene glycol is the heavyweight of animal poisons. It possesses the highest fatality rate encountered in both canine and feline intoxications. Ethylene glycol is readily available, inexpensive, pleasant tasting, and requires an incredibly small amount to produce lethal results. The minimum lethal dose has been estimated as 6.6 mL/kg in the dog and an astonishing 1.5 mL/kg in the cat.[5,6] Ethylene glycol is odorless, colorless, sweet tasting, and primarily employed as antifreeze and as a de-icing agent. It is also used in photographic developing solutions, brake fluid, motor oil, and in paints and wood stains. In the most available source (antifreeze), most solutions sold commercially are 95% ethylene glycol. Most dogs lap antifreeze out of open containers or ingest street puddles, while cats obtain lethal intoxications by cleaning their feet after walking across antifreeze puddles. Once ingested, ethylene glycol is biotransformed into highly toxic metabolites that result in severe metabolic acidosis and kidney failure, which are the hallmarks of poisoning with antifreeze.

Early clinical signs include nausea, vomiting, ataxia, knuckling, and animals are depressed. Many dogs appear to recover after 8 to 12 hours whereas most cats remain severely depressed. Once the toxic metabolites have formed and cause oliguric renal failure the clinical signs come to include oral ulcers and salivation, hypothermia, coma, and seizures.

Inexpensive commercial kits are available (Ethylene Glycol Test Kit, PRN Pharmacal Inc., Pensacola FL) that can estimate ethylene glycol levels in the blood. Serum concentrations peak 1 to 6 hours after ingestion. Ethylene glycol is typically no longer detectible in serum 48 to 72 hours after ingestion.

Treatment for ethylene glycol poisoning is directed at prevention of absorption, increasing excretion and stopping the metabolism of ethylene glycol to toxic by-products. Fomepizole (4-methyl-1H-pyrazole) is the preferred antidote in dogs while ethanol is still the treatment for intoxicated cats. Fomepizole is an ADH inhibitor and it does not cause CNS depression like ethanol. It acts through inhibition of ADH the enzyme responsible for the initial portion of the ethylene glycol-toxic metabolites pathway. Prognosis is excellent in dogs treated within 5 hours of ingestion. It is still recommended that cats receive ethanol, a competitive substrate that has a higher affinity for ADH than ethylene glycol. In this fashion the toxic metabolites are prevented from formation. Ethanol causes significant CNS depression itself and results in more intensive patient care. Nevertheless, prognosis is fairly good in cats where treatment is started within three hours of ingestion.

Ethylene glycol is a very dangerous molecule with a high potential for a fatal outcome. The most critical piece in treatment of these cases is how much time has elapsed between ingestion and initiation of aggressive treatment. The importance of early diagnosis and beginning appropriate therapy cannot be stressed enough.

Nonsteroidal Anti-inflammatories

Nonsteroidal anti-inflammatories have become every increasingly more popular in both human and veterinary med-

icine. They can cause problems in animals through misuse, accidental ingestion, or idiosyncratic reaction. They are used to treat pain, inflammation, and pyrexia. The adverse effects of nonsteroidal anti-inflammatories include gastrointestinal ulceration, renal toxicity, hepatotoxicity, coagulation disorders, articular degeneration, and decreased bone healing.[7] On account of their enterohepatic recycling, nonsteroidal anti-inflammatory drugs are more toxic to cats and dogs than to humans. For animals the most common adverse effect is gastrointestinal toxicity.

Nonsteroidal anti-inflammatories are grouped according to chemical structure: salicylates (aspirin), indoles (indomethacin), propionic acids (ibuprofen, naproxen, ketoprofen, carprofen), fenamates (mecrofenamic acid), pyrazolenes (phenylbutazone and dipyrone), and oxicams (piroxicam and tenoxicam). Many drugs that are very safe for humans can induce serious poisonings in dogs and cats.

Nonsteroidal anti-inflammatory drugs are given to stop pain and inflammation. Cyclooxygenase is the enzyme that converts arachidonic acid to prostaglandins and other inflammatory molecules. There are two forms of cyclooxygenase. COX-1 participates in a variety of regular body functions such as bicarbonate secretion and gastric mucous formation.[8] COX-2 is produced in response to tissue inflammation but is also present in normal tissues such as playing a role in kidney perfusion.[9] Traditional nonsteroidal anti-inflammatory drugs work by inhibiting both COX-1 and COX-2 pathways thereby reducing the formation of arachidonic breakdown products such as prostaglandins. Blocking both pathways reduces inflammation but can lead to adverse effects such as gastric ulceration, compromise of renal perfusion and in extreme cases renal failure.

Clinical signs of nonsteroidal anti-inflammatory drugs include depression, anorexia, vomiting, ataxia, diarrhea, may have bloody stool or melena, polydipsia, polyurea, tachypnea, and panting.[10] Some animals show hematemesis only.

The gastrointestinal tract damage done is caused since mucus and bicarbonate secretion are impaired along with blood flow to the area and subsequent healing so the gastric mucosa is more susceptible to damage and less able to defend and heal itself. In addition, nonsteroidal anti-inflammatories are terrific topical irritants to the gastric lining. The combination of these two properties can be quite devastating. Gastric perforation has been reported after ibuprofen use.[11]

The renal side effects are caused by vasoconstrictive effects of this class of drug thereby impairing blood flow to the kidney and resulting in renal failure. Renal dysfunction has been reported in dogs and cats in association with many of the nonsteroidal, analgesic, anti-inflammatory drugs.

Treatment includes emetics if the animal is seen early enough, activated charcoal to minimize absorption, and intravenous fluids to facilitate perfusion to target organs. Administration of the causative drug must be stopped, perforating ulcers may need to be repaired surgically and bleeding animals may require blood transfusions. Drug therapy may include histamine H_2 receptor antagonists (cimetidine, ranitidine, and famotidine), a proton pump inhibitor (omeprazole), sucralfate (an aluminum salt of sucrose sulfate coating agent), and misoprostol (a prostaglandin analogue).[12] Animals may require intensive, aggressive support to counter the damaging effects of these drugs. Prognosis depends on dosage and length of treatment time with nonsteroidal anti-inflammatory drugs. Medical intervention, support, and surgical repair of ulcers can lead to positive outcomes. The general public does not realize the potential hazards of these easily obtainable drugs.

Chocolate

The methylated xanthines (caffeine, theobromine, and theophylline) are plant-derived alkaloids and are found in a variety of foods and beverages. These related alkaloids all cause similar effects including stimulation of both the heart muscle and the CNS, relaxation of smooth muscle, and diuresis of the kidneys.[13] All methylxanthines stimulate catecholamine release.

Theobromine is found naturally in cacao beans that are used to manufacture chocolate. The most concentrated sources are cacao beans and baking or unsweetened chocolate (often as much as 450 mg of theobromine; whereas milk chocolate usually contains about 45 mg/oz). Incidence of chocolate poisonings in dogs occurs seasonally around holidays (Christmas, Valentine's Day, Easter) and reflects amounts of chocolate found in the home. Smaller dogs eating large amounts of chocolate are much more at risk. Chocolate flavoring in medicines and coffee to enhance the taste can also be the culprit in poisonings.

The lethal dose of theobromine is 250 to 500 mg/kg.[14] Dogs have a sweet tooth and may willingly eat a toxic dose. Dogs excrete theobromine slowly, the plasma half life is about 17.5 hours. Initial signs can develop 2 to 4 hours after ingestion. Clinical signs may include anorexia, vomiting, restlessness, diarrhea, diuresis, and panting. Dogs can be markedly excited, and show hyperthermia and a dramatic tachycardia. As the syndrome progresses, cardiac arrhythmias, premature ventricular contractions, ataxia, muscle rigidity, seizures, and coma may be observed. If death occurs it is usually within 24 hours because of cardiac arrest resulting in the severity of the heart arrhythmias. Respiratory failure can also be seen.

There is no specific antidote for methyxanthines toxicity. Goals of treatment for theobromine ingestion include sustaining basic life support, decreasing further absorption, increasing excretion of the alkaloid, and providing symptomatic relief of seizures, respiratory difficulties, and any cardiac abnormalities.

Prognosis for chocolate ingestion is usually very good if emesis is induced within 2 to 4 hours of ingestion. In animals with seizures or severe cardiac arrhythmias the outcome is often guarded.

Snakes, Bees, Spiders, and Ants

Discussion of bites and stings from venomous animals is covered in detail elsewhere in this volume. Clinicians must familiarize themselves with the venomous animals in their region to help make a list of differential diagnoses.

Acetaminophen

Acetaminophen is one of the most widely used analgesic/antipyretic drugs. It is available without a prescription and is currently marketed either alone or in combination with other pharmaceuticals in over 100 preparations. It is a derivative of

coal-tar and has a variety of adverse effects. Companion animals are generally exposed through well-intentioned but ill-informed owners administering the drug to their own dogs and cats. Accidental ingestion (particularly of flavored varieties) can also occur. Cats are much more sensitive to acetaminophen than dogs. Clinical signs of toxicity in cats have been reported from ingestion of a single tablet.[15]

Metabolism of this molecule is the basis of its toxicity. Like ethylene glycol, toxic metabolites are generated through hepatic degradation. In addition to acute poisoning, chronic exposure at very low dosages can likewise lead to intoxication. The toxic by-products formed by the metabolism of acetaminophen disrupt protein function and damage cellular membranes. Peculiarities of the feline liver such as a capacity-limited sulfation pathway, poor glucouronidation capacity, and lower threshold for dose-dependent transformation make cats much more sensitive to acetaminophen than dogs and at much lower dosages.

In the canine the liver is much more sensitive to acetaminophen toxicity whereas the feline red blood cell is most susceptible to toxic injury. Clinical signs of acetaminophen poisoning may include anorexia, vomiting, tachycardia, and tachypnea.[16] Typically clinical signs in dogs reflect hepatic injury while signs in cats demonstrate methemoglobinemia and hemolytic anemia. Cats may show edema of the face and paws.

The cornerstone of therapy for acetaminophen toxicity is prevention of additional absorption, providing supportive measures and trying to counter the toxic pathways of the drug. Administration of *N*-acetyleysteine every 6 hours for five to seven doses has proven to be therapeutic.[17] Prognosis for this poisoning depends on the amount of drug ingested, the size of the animal, and the time that passes before treatment is initiated. Outcome is generally favorable if animals receive treatment in the first 14 hours postingestion. An understanding of an animal's risk of exposure is critical in identifying this toxicosis, instituting appropriate therapy, and ruling out other differential diagnoses. Client awareness of the potential hazards of this drug is surprisingly low.

Ephedra/Pseudoephedrine

Ephedrine and its optical isomer pseudoephedrine are structurally very similar to methamphetamine. Until recently, they both were common over-the-counter medications, ephedrine in weight-control aids and energy boosters and pseudoephrine in cold medicine as a nasal decongestant. The Chinese herb, Ma huang, is rich in naturally occurring ephedra and because it is natural was sold as a diet aid in health food stores. A large number of adverse effects were reported for humans taking the herbal preparation of this drug. At present there is a ban on ephedra-containing products in the United States.

Ephedrine and pseudoephedrine are both potent sympathomimetics and act through α and β-adrenergic agonist effects. They both have less CNS stimulation than methamphetamine but they are more potent in raising heart rate and blood pressure. Clinical signs include agitation, nausea, vomiting, dilated pupils, insomnia, tachycardia, hypertension, hyperthermia, myocardial ischemia, cardiac arrhythmias, and seizures.[18] The mortality rate can be high and the toxic potential is related to dose.

Treatment is supportive and the majority of these intoxications are mild. For more serious cases β-blockers can be used for the tachyarrhythmias and calcium channel blockers for the hypertension. Benzodiazepines can be given to control the agitation, hyperthermia, and seizures. Ephedra is a great example of the public thinking just because something is natural that it must be safe.

Marijuana

Marijuana is still a major drug of abuse in the United States. Generally, the drug is prepared by tobacco-like drying of the leaves, flowers, and stems of the plant *Cannabis sativa*. The active ingredient responsible for the psychoactive effects is tetrahydrocannabinol (THC). Hashish is made from the resin extracted from the flowering plant and has a higher THC content.

The mood-altering effects of marijuana are dose dependent. THC acts on unique receptors in the brain. THC is readily absorbed if marijuana is smoked and the effects are immediate. If ingested, effects are not instantaneous but they last longer. Because of extensive enterohpatic recirculation of marijuana, the half life is anywhere from 25 to 30 hours in the blood.

Clinical signs of marijuana ingestion include vomiting, depression, ataxia, dilated pupils, hypothermia, disorientation, salivation, and vocalization.[19] If ingested clinical signs begin to appear within 1 to 2 hours. Treatment is generally supportive. Marijuana intoxication is rarely fatal. After emesis activated charcoal should be given to halt the enterohepatic recirculation of marijuana. Body temperature should be closely monitored and corrected if necessary and CNS excitement can be managed with benzodiazepines. Depending on the dose ingested, recovery may be slow and take 72 hours or longer. Owners may be reluctant to give an accurate history as to the actual cause of the intoxication out of fear of legal repercussions.

Household Cleaners, Detergents, and Bleach

Soaps, detergents, and bleaches are found in virtually all residential households. They can be sprays, bars, liquids, powders, laundry products, and so forth. Soaps and detergents are surfactant agents and they lower the surface tension of water allowing it to penetrate. They also emulsify fats, disperse soil, and remove dirt and grease. Most commercial detergents and soaps are of a low toxicity. They may cause vomiting and diarrhea but cause little real irritation. Homemade soaps and soaps with high free-alkali content have a real potential for corrosive action. Soaps are not absorbed to any appreciable extent and systemic toxicity has not be reported.[20] Soaps and detergents may also contain small amounts of other ingredients such as fabric softeners, fragrances, whiteners, colorants, enzymes, and bleaches. These other additional agents may add to the irritation.

No specific treatment is indicated after soap or detergent ingestion. Dilution with water may provide symptomatic relief. Once vomiting has stopped, milk may be offered as a demulcent. If vomiting after soap ingestion is protracted an-

imals may need to be supported with fluids and electrolytes. Generally the effects seen are fairly self limiting. Rinsing with water is effective treatment for eyes irritated by soap exposure. Animals must not be made to vomit after soap ingestion if the cleaning substance is corrosive.

Bleach (hypochlorite salt) is widely used as a disinfectant, deodorizer, and water purifier. It can be found as a spray, a liquid, a powder, and impregnated into cleaning pads. The nature of hypochlorite toxicosis results from its corrosive effect on mucous membranes and on skin. The overall clinical effect of bleach ingestion depends on the product's hypochlorite concentration and resultant pH, not on ingested dose.[21] Clinical signs of bleach ingestion include surface irritation to the lips, gums, and tongue, hypersalivation, belly pain, retching, and possibly dyspnea because of pulmonary irritation. Again, the severity of the intoxication is based on the concentration of the bleach and the duration of the exposure.

Treatment for bleach ingestion focuses on dilution of the ingested substance with water or milk. Any areas of skin contact should be flushed liberally with copious amounts of clean, cool water, and washed with gentle hand soap. The incidence of severe esophageal burns or stomach ulcerations after bleach ingestion is very low and the majority of animals have a great prognosis after close monitoring and good nursing and supportive care.

Household Plants

Small animal veterinarians face a bewildering number of potentially poisonous, commonly occurring, household and garden plants. In a large number of cases the client cannot even name the type of plant the animal encountered in his house or on his property. Veterinarians should familiarize themselves with the most potentially toxic plants and their clinical signs and any naturally occurring dangerous plants in their area. A discussion of specific poisonous plants and their treatment is beyond the scope of this discussion, but the reader is directed to several excellent recent chapters concerning toxic plants.[22,23] Telephone staff must be made to realize that accurate physical identification of poisonous plants can save precious time and direct treatment. Therefore, all clients with possible toxic plant ingestion animals must be encouraged to bring in samples of the ingested botanical. As with any poisoning we are only as effective as our phone staff allows us to be.

Conclusion

Veterinarians treating companion animals are frequently faced with both accidental and intentional poisoning cases. Such cases can be challenging exercises but small animal clinicians must realize that the intoxicated animal has to be approached in a systematic fashion no different than any other critically ill animal. The patient must be stabilized, life-threatening conditions identified and corrected, a tentative diagnosis is arrived at, differential diagnoses can be ruled out through history, physical examination and laboratory results, and appropriate therapy must be initiated as swiftly as possible. Certainly we must both "treat the patient not the poison" and "treat the patient not the laboratory." Critically ill animals must never be denied vital supportive therapy while awaiting confirmatory laboratory tests or positive toxin levels. To maximize successful outcomes when handling real or suspected poisoning cases veterinarians and their staff must have protocols in place for dealing with possible intoxications.

To help guarantee favorable prognoses for poisonings the whole staff must be brought up to speed. Initial telephone contact is critical. Operators and receptionists must be educated in managing potential poison calls. In-house seminars, protocol sheets, and recently published resources (articles, textbooks, etc) can all help staff to recognize the true emergency poisoning and differentiate it from the nontoxic exposure. Generally, local toxicologists are happy to help veterinary hospitals and can be enticed to talk to assembled staffs. The benefits of adequately training our crews and helping to equip them in handling toxicological emergencies are staggering. Local or regional poison control centers, regional veterinary schools, and local toxicology groups are all tremendous resources. National animal poison hotlines: The Animal Poison Control Centers (1-888-426-4435) or the Pet Poison Helpline (1-800-213-6680) are also additional services that can provide valuable information. Clinicians must learn to not only recognize specific poisons but also how to identify the most appropriate resources available that will provide the most relevant and current information: local hospital, the Internet, manufacturers of the poison, local experts, and so forth. We must come to use whatever means necessary to obtain a favorable resolution of animal poisonings.

Staff must be adequately educated and worked with. Telephone staff must realize that for most critically ill animals swift initiation of treatment can make all the difference. They must be taught that animals ingesting caustic substances (acids, alkalis, etc) must not be made to vomit at home just as animals that are unconscious should not be given emetics. If telephone staffers make mistakes we are at fault for not providing them with the right training and access to the appropriate information.

Once at the veterinary hospital, technicians and staff must understand the various protocols for different poisonings and how to swiftly initiate such therapy. Our emergency rooms must be equipped with the proper equipment: fluids, endotracheal tubes, oxygen, blood pressure equipment, laboratory access, appropriate antidotes, and emergency drugs commonly used to counter life-threatening conditions.

Veterinary hospitals are faced with an ever-expanding, often overwhelming number of potential poisons. However, through a set regimen of toxicological protocols, through continuing education, through constant reinvestment in equipment and in the training of our staffs, we can level the playing field and manage poisonings with the same sound, thorough approach designed for any critically ill animal. By setting a solid foundation for the management of poisoning cases, veterinarians can optimize their chances at establishing a definitive diagnosis and selecting an appropriate and successful treatment plan. In this way we are most able to provide the best, most effective care to the patients and clients we serve.

Acknowledgment

We would like to thank Dr. Robert A. Taylor and the entire staff of Alameda East Veterinary Hospital for providing such

a wonderful environment in which to treat poisoned animals. Also, we would like to thank Dr. Alvin C. Bronstein for his unselfish help with animal poisonings and our friends at the Rocky Mountain Poison Center celebrating 50 years of helping poisoned pets and people.

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