



TOXICOLOGY BRIEF

Ethylene Glycol Testing

Wendy Hull, BS, CVT

The ASPCA® National Animal Poison Control Center is hosting a **free online toxicology CE course** on the Veterinary Support Personnel Network on May 22 and 29 from 9:30 PM to 11:30 PM (ET). Register at <http://www.vspn.org>.



ethylene glycol (EG), an ingredient commonly used in antifreeze, is one of the most hazardous poisons to animals. Even relatively small amounts can cause toxicologic syndromes. Cats are more sensitive than dogs to this chemical. As little as 15 ml of 50% diluted antifreeze can be lethal to a 10-lb cat, whereas 65 ml would affect a similarly sized dog.¹

Commercial antifreeze preparations usually contain 95% to 97% EG.² These products are often diluted 50:50 with water for automotive coolant use. EG does not significantly degrade over time when used in coolant systems.² Most animal exposures to antifreeze are a result of product spills, engine flushing, or engine leaks (Figure 1).³ Less commonly, animals may drink water treated for winterizing (e.g., toilet water at cabins or camping facilities in northern climates).

Historically, EG antifreeze exposures were considered a seasonal problem occurring in colder months. However, a recent study conducted by the ASPCA® National Animal Poison Control Center showed that with the exception of a slight increase of incidents reported in early spring, most cases are reported consistently throughout the year.³ This may be due to the fact that antifreeze is used year-round for automotive purposes.

Toxicokinetics

The EG molecule does not directly

cause toxic effects. Rather, the potentially lethal effects are caused by the metabolites produced by the biotransformation of the EG molecule in the liver.

Once ingested, EG is measurable in the blood within 30 minutes.² Peak concentrations in cats and dogs occur approximately 1 and 3 to 6 hours after ingestion, respectively.⁴ Approximately 50% of the compound is excreted in the urine unchanged.⁴

Effects induced by the parent molecule (e.g., central nervous system depression, ataxia, vomiting, polyuria, polydipsia) can be seen as soon as 30 minutes and can persist up to 12 hours after ingestion. Animals often appear to recover as the EG is metabolized. However, as mentioned, the main deleterious effects (i.e., renal failure and acidosis) are produced by the metabolites of EG. As levels of these harmful metabolites build, blood pH is decreased and kidney damage occurs. The resulting compromise in renal function lessens the kidneys' ability to filter the toxic metabolites, thus creat-

ing a vicious cycle.

The liver enzyme alcohol dehydrogenase converts EG into glycolaldehyde. Since glycolaldehyde is metabolized rapidly to glycolic acid, it does not accumulate at high levels and is not considered one of the more hazardous metabolites. Glycolic acid is the primary metabolite associated with the metabolic acidosis and renal epithelial damage caused by EG toxicoses (Figure 2). This is primarily due to its slow conversion to glyoxylic acid. Oxalic acid is excreted through the urine, either in its original form or in combination with serum calcium as calcium oxalate crystals.

Diagnostic Testing

Early laboratory analysis is crucial in assisting diagnosis and successful management of EG exposure. This is especially true in cases in which a history of exposure is absent or incomplete. It is often necessary to rule out EG exposure because animals with other conditions or those exposed to other toxins can present initially with similar clinical signs.



Figure 1—Antifreeze, which contains ethylene glycol, is extremely dangerous for dogs and cats. Exposure often results from spills or leaks from coolant systems. Animals are attracted to the substance because of its sweet taste (Courtesy of Tom Schaeffges, Sidney, Illinois).

cal signs. Delaying treatment until there is evidence of renal insult (i.e., increased blood urea nitrogen and creatinine values) will place patients at increased risk, resulting in a poorer prognosis.

Qualitative Screening

Qualitative screening can be accomplished using a commercial test kit (Allelic Biosystems Ethylene Glycol Test™ Kit, distributed by PRN Pharmacal, Pensacola, FL; 800-874-9764) available for veterinary use. This test can be conducted in-house quickly and easily. It requires a serum or plasma sample and yields results in 30 minutes.⁵ Optimally, testing for EG should be done in 30 minutes to 12 hours after exposure.⁵ After 12 hours, most of the EG may be metabolized or excreted. The amount of serum EG that remains in the body 12 hours after exposure may not be enough to generate a positive test result because it will likely fall below the sensitivity of the test.⁵

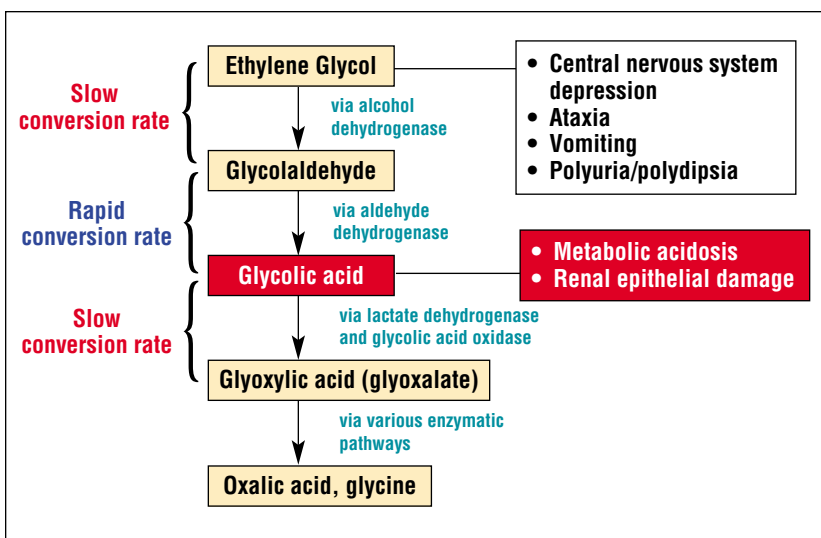


Figure 2—Metabolic pathway of ethylene glycol.

The kit can be used for cat and dog samples, but there are limitations in its diagnostic ability for feline patients because the kit detection limit and control levels are based on canine parameters. Because cats are known to be more sensitive to EG, the test may yield false-negative results if EG levels are below the test detection limit. Thus negative results should not rule out EG toxicosis in cats. Positive results suggest a toxic level in cats.

Ingestion or administration of products containing propylene glycol or glycerol will elicit false-positive results.⁵ Propylene glycol is a common vehicle for various injectable medications and some older activated charcoal preparations and is an ingredient of “nontoxic” or “safe” antifreeze preparations. Glycerol is commonly found in suppositories and laxatives, cough syrup, hairball remedies, capsulated medications and vitamins, candy, topical skin creams and ointments, shampoos, liqueurs, and some activated charcoal suspensions. Ingestion or administration of these substances can elicit false-positive results. Blood for the Ethylene Glycol Test™ Kit must be drawn before any medications containing propylene glycol or glycerol are administered. Another agent that may interfere with test results is metaldehyde, a common slug and snail poison. Exposure to metaldehyde may yield false-positive results.⁵ Ethanol, a common treatment for EG toxicosis, does not interfere with test results.

Quantitative Analysis

Quantitative testing methods may be valuable in medicolegal cases (e.g., malicious poisonings) and should be considered in addition to in-house qualitative testing. Blood or urine samples for quantitative analysis can be sent to nearby human hospitals or veterinary laboratories. A local human diagnostic laboratory can be used to conduct quantitative analysis. Sample collection and mailing guidelines should be strictly followed. Regardless of where samples are submitted, the turnaround time for results must be quick to be of diagnostic benefit.

Diagnostic laboratories can also test for other potential toxins (e.g., methanol, ethanol, illicit drugs) to help rule out these substances as the possible cause of illness.

Conclusion

It should be emphasized that EG testing should be used in addition to other diagnostics (blood chemistries, urinalysis, anion and/or osmolal gaps) and a complete patient history. The collection of detailed data will help confirm exposure, severity of intoxication, appropriate action, and expected prognosis. With comprehensive adjunct laboratory analysis, an effective management plan to care for patients can be developed early. It is important for veterinary professionals to remember to treat their patients and not the poison.

(continues on page 216)

Toxicology Brief (continued from page 202)

Acknowledgment

The author thanks Michael W. Knight, DVM, of the ASPCA® National Animal Poison Control Center, Urbana, Illinois, for his contributions and review of the column.

About the Author

When this column was submitted for publication, Ms. Hull was affiliated with the ASPCA® National Animal Poison Control Center, Urbana, Illinois, and the Animal Emergency Clinic of Champaign County. She is now associated with the Arkansas Livestock and Poultry Commission, Little Rock, Arkansas. She resides in Little Rock with her two cats, Homey and Melrose, and two rats, Molson and Dewey.

References

1. Beasley VR: Diagnosis and management of ethylene glycol (antifreeze) poisoning. *Feline Pract* 15(1):41-46, 1985.
2. Knight MW: Management of small animal toxicosis: Ethylene glycol. *Proc Illinois State Vet Med Assoc*, Chicago, pp 26-32, 1993.
3. Khan SA, Schell MM, Trammel HL, et al: Ethylene glycol exposures managed by the ASPCA® National Animal Poison Control Center from July 1995 to December 1997. *Vet Hum Toxicol* 41(6):403-406, 1999.
4. Thrall MA, Grauer GF, Dial SM: Antifreeze poisoning, in Kirk RW (ed): *Kirk's Current Veterinary Therapy XII: Small Animal Practice*. Philadelphia, WB Saunders Co, 1995, pp 232-237.
5. Product information: Allelic Biosystems Ethylene Glycol Test™ Kit. Distributed by PRN Pharmacal, Pensacola, FL; 800-874-9764. □