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PARACLINICAL DIAGNOSIS AND THERAPEUTIC APPROACH IN ETHYLEN GLICOL POISONING IN DOGS

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Abstract

One of the most affected species by various toxic substances is, undoubtedly, the canides. Among them, ethylene glycol is one of the most possible causes, its use as an antifreeze solution making it a frequently encountered substance. Because of its sweet taste, it is eaten with pleasure by dogs and not only. The aim of the study was to optimize the diagnostic and treatment methods in ethylene glycol poisoning in dogs. In this study were included 8 clinical cases of dogs (2 males and 6 females), aging from 4 months to 13 years, that were isostenuric after 3 hours after ingestion. Also, calcium oxalate crystalluria becomes detectable after 3-6 hours after consumption. After the onset of renal impairment, the value of blood urea nitrogen and creatinine increased, which resulted in glomerular filtration damage. The present study highlights the effectiveness of the treatment in the first 8 hours after ingestion, being very important to slow down the oxidation metabolism of ethylene glycol by alcohol dehydrogenase. The administration of ethyl alcohol or fomepizole (4-methylpyrazole) to dogs presented to the veterinary clinic following exposure to ethylene glycol increase their chances of survival.

Key words*: diagnosis, treatment, ethylene glycol, dogs.*

INTRODUCTION

One of the most affected species by various toxic substances is undoubtedly the canine species. Along with other glycols, ethylene glycol is one of the most possible causes of dog poisoning, its use as an antifreeze solution making it an almost domestic agent (Davis et al., 1997; Dobre, 2019).

Because of its sweet taste, it is eaten with pleasure by dogs and other species. After hepatic metabolism by alcohol dehydrogenase, the metabolites formed produce CNS depression and nephrotoxicity, which can lead to acute renal failure (Gupta, 2018).

The mortality rate in dogs, due to this type of intoxication, varies between 50% and 70%, most cases being accidental (Barton and Oehme, 1981; Rowland, 1987).

According to data provided by some poison control centers, antifreeze poisoning is the second most common cause of fatal animal poisoning (Hornfeldt and Murphy, 1998). In addition, ethylene glycol is not toxic by itself, but by toxic products resulting from hepatic metabolism under the action of alcohol dehydrogenase (ADH) - glycolic, glycoxalic and oxalic acids.

Interestingly, this intoxication is somewhat seasonal, with the highest incidence occurring in late autumn and early spring, with the change in antifreeze solution.

The aim of the study was to optimize the diagnostic and treatment methods in ethylene glycol poisoning in dogs.

MATERIALS AND METHODS

In this study were included 8 clinical cases of dogs that were registered between September 1, 2020 - March 31, 2021 at a veterinary medical clinic near Bucharest.

Data about the animals included in the study are presented in Table 1.

Table 1. Data about dogs examined following ethylene glycol exposure

Dog ID	Breed	Sex	Age
D1	Belgian shepherd	Male	1 year
D2	German shepherd	Female	4 months
D3	Half breed	Female	2 years
D4	Bichon	Female	13 years
D5	Half breed	Male	1 year
D6	Half breed	Female	6 years
D7	Half breed	Female	10 years
D8	Half breed	Female	10 years

All animals were clinically examined, the anamnesis was collected. Thereafter, blood samples were taken for paraclinical examination (hematological and biochemical) and treatment was instituted.
Blood samples were analyzed using a 5-Diff haematological analyzer and a biochemistry analyzer, respectively.
After evaluating the anamnesis and the hematological and biochemical results, antidote treatment and rehydration treatment were administered to the patients.
Taking into account that we didn't have Fomepizole (4-methylpyrazole) in our clinic, we used 40% ethyl alcohol, which was brought to a concentration of 20% by 1:1 dilution with saline, at a dose of 5.5 ml/kg, IV (Mathews, 2006).
For rehydration a therapy with saline and glucose solutions was administered, and for the correction of acidosis 8.4% sodium hydrogen carbonate was used.

RESULTS AND DISCUSSIONS

The anamnesis tried to establish the time elapsed from ingestion to the time of presentation to the clinic. Hematological examination quantified the values of lymphocytes, granulocytes, hemoglobin and hematocrit in all cases studied (Table 2). Broadly, lymphocytes and granulocytes were above the maximum values of the reference values, possibly due to the stressful situation experienced by the patients and, respectively, the overlapping infections over this situation. Hematocrit was also increased due to dehydration of the examined animals.

Table 2. The results of the hematological parameters determined in the 8 dogs exposed to ethylene glycol

Parameter	D1	D2	D3	D4	D5	D6	D7	D8
WBC x10^9/L	23 ↑	40.2↑	21↑	22.6↑	20.7↑	21.5↑	32.2↑	22.1↑
GRAN x10^9/L	19.8↑	36.7↑	10.8	12.4	16.9↑	19.8↑	25.4↑	14.8↑
HGB g/dL	19.8↑	18.9	21.3↑	20.6↑	18.5	17.8	18.6	19
HCT %	58.2↑	37.9	65↑	42.4	50.1	47.2	43.5	55.4

The biochemical examination showed an increase in azotemia values in 7 of the 8 cases studied, while the creatinine value showed a significant and constant increase in all cases. Increased levels of azotemia and creatinine indicate impaired renal function in animals in this condition. Also, in 50% of cases the serum glucose showed increases that can be interpreted by the stress conditions that the subjects had to face (Table 3).

Table 3. The values of the biochemical parameters determined in the 8 dogs exposed to ethylene glycol

Parameter	D1	D2	D3	D4	D5	D6	D7	D8
GLU mg/dl	107	**448**	112	**158**	127	**237**	116	**156**
BUN mg/dl	21.2	**94.7**	**42.2**	**143**	**105.8**	**82**	**53**	**159**
CRE mg/dl	**1.84**	**7.63**	**2.89**	**6.87**	**11.82**	**7.9**	**5.3**	**16.4**

The therapeutic protocol used included antidote and supportive treatment. We used 20% ethanol to competitively inhibit alcohol dehydrogenase and prevent the metabolic conversion of ethylene glycol. The dose used was 5.5 ml / kg every 8 hours on the first day (3 times a day) and every 12 hours on the next two days (twice a day), so that the animal was kept for 72 hours in a drunken state (Table 4). We used 40% ethyl alcohol which was diluted with saline in a ratio of 1: 1, the amount being administered slowly intravenously. When determining the administration interval, we also took into account the disadvantages of ethyl alcohol, such as the ability to depress the CNS, to form acetaldehyde, which in turn affects carbohydrate metabolism and the fact that it is irritating to the brain (Money et al., 1989).
In the body's supportive therapy, we aimed to antagonize the acidity with sodium bicarbonate infusion solution 8.4% (1000 mEq / L) at a dose of 6.2 mEq / kg every 8 hours and to combat dehydration with 5% glucose infusion solution. 10% calcium gluconate was used to control hypocalcemic attacks (0.25 ml / kg / day). We used supportive therapy for 7 days to support the regeneration of the renal tubules and the resumption of renal function in optimal conditions.

Table 4. Treatment schedule administered to the dogs exposed to ethylene glycol (drugs and doses are provided)

Patient ID	Weight (kg)	Etanol 20%/ admin	NaHCO3/ admin	Gluconat de Ca/admin
D1	18	99 ml	112 mEq	4.5 ml
D2	10	55 ml	62 mEq	2.5 ml
D3	13	71.5 ml	81 mEq	3.25 ml
D4	3	16.5 ml	18.6 mEq	0.75 ml
D5	9	49.5 ml	56 mEq	2.25 ml
D6	12	66 ml	74 mEq	3 ml
D7	20	110 ml	124 mEq	5 ml
D8	13	71.5 ml	81 mEq	3.25 ml

During the course of the therapy, we noticed the reluctance of the owners towards the duration of such a treatment in the conditions of the reserved vital prognosis. The unpromising clinical course of some of them eventually led them to request euthanasia. Also, some of the owners did not return to our clinic to continue the treatment.

It is worth noting the importance of early initiation of antidote therapy with ethanol, which was confirmed by the clinical study. Remarkably, ethanol dosing recommendations vary from author to author, with some preferring continuous infusion at a constant rate (CRI). In this case, it is recommended to use a concentration of 5% at a rate of 5.5 ml / kg / h which can avoid the concentration of ethanol in the blood, which can exacerbate the clinical effects (Mathews, 2006).

The cases presented more recently after exposure have evolved towards healing, while the cases that arrived at the clinic late went to the exitus. As it can be seen in Figure 1, 25% of patients recovered, compared with 37% who succumbed. It is interesting to note that the latter showed increased values of azotemia and impaired renal function upon arrival.

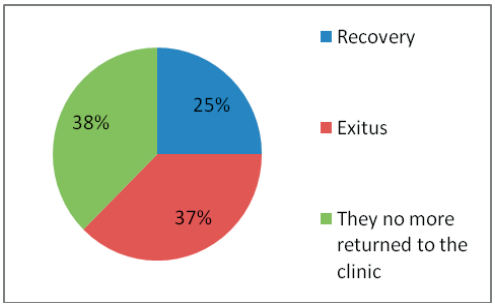

Figure 1. The evolution of the studied cases

In this way, we notice how important the therapeutic intervention is before the increase of azotemia and the disorder of the renal function.

It can be seen that in 38% of the cases, the owners did not return to the clinic, which means that either the animals in their possession died or, on the contrary, the animals recovered, so the owners considered unnecessary the return to the clinic. From this perspective, it may be useful, a centralized system for recording and monitoring poisoning, following the model practiced in other states, knowing that dogs are especially victims of poisoning.

Regarding the distribution by age groups in our study, we observed a higher frequncy in adults (63%) compared to young animals (37%), which supports the opinion that ethylene glycol tastes good for dogs in general, and that experience does not prevent adults from avoiding the harmful substance (Figure 2).

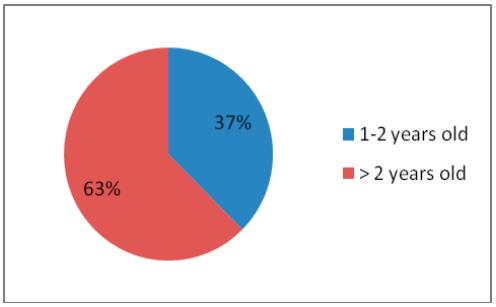

Figure 2. Distribution of age-related intoxication (youth and adults)

CONCLUSIONS

In this study, we had a large number of cases in a short period of time, thus indicating an increased incidence of ethylene glycol poisoning cases. Particularly important is the evaluation of the patient based on the hematological and biochemical examination as well as the evaluation of the time elapsed since the exposure.

20% ethanol treatment should be instituted as soon as possible in order to prevent metabolic transformation of ethylene glycol and the occurrence of renal failure.

The adverse effects of ethanol must also be taken into account in determining the antidote therapy protocol. It is very important to perform a long-term supportive therapy that allows the resumption of renal function in good conditions.

Despite the prompt application of the therapeutic protocol, the survival rate remains low, which supports the importance of preventing animals from accessing this type of substance.

REFERENCES

Barton, J., Oehme, F. J. (1981), The incidence and characteristic of animal poisonings seen at Kansas State University from 1975 to 1980. *Vet. Hum.Toxicol.* 23, 101-102.

Dalefield, R. (2004), Ethylen glycol In: Plumlee, K.H. (Ed.) Clinical Veterinary Toxicology, Mosby, St. Louis, MO, pp. 150-154

Davis, D. P., Bramwell, K. J., Hamilton, R. S., et al., (1997). Ethylene glycol poisoning: case report of a record high level and a review. *J. Emerg. Med.* 15, 653–657.

Dobre, I.R. (2019). Toxicologie veterinară. București, Editura Printech, 262-268.

Gupta, R. (2018). Veterinary toxicology. Basic and clinical principles. Academic Press, 647–651.

Hornfeldt, C. A., Murphy M. J. (1998). American Association of Poison Control Centers report on poisonings of animals, 1993-1994 *J. Am. Med. Vet. Assoc.* 212, 358–361.

Mathews, K. A. (2006). Veterinary Emergency and Critical Care Manual, Lifelearn Inc., Guelph, 630-640.

Money, S.R., Petroianu, A., Kimura, K. et al. (1989), Acute hypocalcemic effect of ethanol in dogs: alcoholism. *Clin. Exp. Res.* 13, 453-456.

Rowland, J. (1987), Incidence of ethylene glycol intoxication in dogs and cats seen at Colorado State University Veterinary Teaching Hospital. *Vet. Hum. Toxicol.* 29, 41-44.

Stice, Sz., Thrall, M., Hamar, D. (2018). Alcohols and glycols In: Gupta, R. (Ed.) *Veterinary Toxicology*, Academic Press, 651-655.