CASE REPORT

Fluoroacetate poisoning in seven domestic dogs

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Sodium monofluoroacetate, also known as compound 1080, is used in Australia for control of feral and pest species. Poisoning of non-target species by sodium monofluoroacetate can be difficult to diagnose if there is no history of exposure because clinical signs are non-specific.

This communication describes the poisoning by sodium monofluoroacetate of seven dogs from one property over a period of 3 days. Poisoning by sodium monofluoroacetate was confirmed by toxicological analysis of stomach contents, gastric lavage fluid and vomitus from three of the dogs, but the source of the toxin was not found. Six of the seven dogs were Maremmas, and livestock guard animals may be at particular risk of exposure to pest control baiting programs.
Aust Vet J 2004;82:754-756

SMFA is a highly regulated poison used in the control of pest species such as rabbits, foxes, wild dogs and pigs. Because inadvertent ingestion by non-target species can occur, the distribution and use of SMFA must follow strict regulations.[1] Clinical signs of SMFA poisoning vary between species with dogs showing predominantly neurological signs, while horses, ruminants and chickens show mainly cardiac signs.[2] Humans,[3] pigs and cats show a combination of clinical signs.[2] Dogs are particularly sensitive to exposure to SMFA and exhibit an extremely low LD_{50} when compared to other species (LD_{50} 0.066mg/kg orally as opposed to 0.3 mg/kg for rabbits, cats and monkeys).[4]

Little information is available on successful treatment of SMFA poisoning in animals. Glyceryl mono-acetate has been used in an attempt to supply acetate ions to the TCA cycle, which is poisoned by SMFA.[2,3,5] The effectiveness of this treatment has been inconsistent[2] and furthermore, glyceryl monoacetate is not readily available to most veterinary practices.

The following reports an episode of multiple deaths, of dogs from one property, attributed to ingestion of SMFA. SMFA poisoning was confirmed by toxicological analysis, although the source of SMFA was never found, and the property was more than 25km away from the closest known baiting program.

Case reports

Sequence of events

Day 1

A mature female Maremma bitch (Dog 1) was presented to a neighbouring practice after dying suddenly with signs of seizures and excessive salivation. There was no history of access to toxins.

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At necropsy examination there were no external signs of trauma, no mucosal or subcutaneous haemorrhages, and no gross abnormalities of the heart, liver or kidney. There was no urine in the bladder and the stomach contained only a small volume of fluid. Blood in the heart and major vessels had not clotted. A tentative diagnosis of snake envenomation was made. A mature male Maremma (Dog 2) was found dead on the same property 6 hours later. No necropsy was performed.

Day 2

A 3-year-old female Springer Spaniel (Dog 3), from the property was presented 2 hours after acute onset of excessive salivation and lethargy. On physical examination she was depressed and unresponsive, and seemed unaware of her surroundings. Her heart rate was 100 beats per minute with a regular rhythm and her rectal temperature was 37.5° C. Both pupils were midrange in size and had normal pupillary light responses. The dog sat quietly for blood collection. Blood collected into a silica earth clotting tube did not clot. Haematological parameters were within normal limits.

Following blood collection the dog began to seizure, with strong extensor contractions that were not associated with any sound stimuli. The dog's pupils became dilated and unresponsive to light. The dog was sedated with diazepam, intubated and given 100% oxygen. An 18-gauge catheter was placed in a cephalic vein and Hartmann's fluid was administered at 10 mL/kg/h. Sodium pentabarbitone was administered to effect to control seizures and to anaesthetise the dog for gastric lavage. Gastric lavage only retrieved lavage solution, which was retained for later analysis.

The differential diagnoses considered included ingestion of exogenous toxins such as organochlorines, metaldehyde, lead and SMFA, and snake envenomation. Organophosphate poisoning seemed unlikely given the initially normally responsive pupils. The season (midwinter) did not support snake envenomation and the absence of hyperaesthesia made strychnine poisoning unlikely. Although there was no history of exposure, the clinical signs suggested SMFA poisoning as the most probable diagnosis.

Because the practice did not have access to glyceryl monoacetate, 100 mL of 5% acetic acid solution was administered via the stomach tube and a further 2 mL of 5% acetic acid was added to the intravenous fluids. Amoxycillin suspension was administered at 11 mg/kg subcutaneously. Over the next 8 hours seizures continued and were controlled to varying degrees and for varying

LD	Lethal dose
SMFA	Sodium monofluoroacetate
TCA	Tricarboxylic acid

periods with diazepam, sodium pentabarbitone, and guaifenesin, the latter given in an attempt to minimise muscle activity. Intravenous fluids were continued at a flow rate of 10 mL/kg/h with 0.9% sodium chloride and 5% dextrose, with 3 mL of 5% acetic acid added to each litre. Re-intubation was necessary to ensure a patent airway. The dog died but permission for a necropsy was not given.

On the same day a pregnant Maremma bitch (Dog 4) from the same property was presented dead. The dog appeared normal 2 hours previously. A sample of vomitus from the bitch was also presented. It contained what appeared to be hairless dried skin or hide.

Necropsy examination revealed no external signs of injury. Fresh blood in the mouth appeared to originate from a tongue laceration. No mucosal or subcutaneous haemorrhages were found. The lungs showed dependant consolidation. The uterus contained eight near-term foetuses. The gastro-intestinal tract was very pale and blood in the major vessels and heart had not clotted. The heart appeared otherwise normal. The liver was more friable than normal and had an obvious acinar pattern. The stomach and urinary bladder were empty. The spleen and kidneys appeared grossly normal. Samples of liver, lung, kidney, spleen, heart and jejunum were fixed in 10% formol saline. Fresh samples of liver, kidney, jejunum, heart blood and intestinal contents were also collected and frozen.

Day 3

Three more Maremma pups died on the farm in the following 24 hours. These dogs were not necropsied. Another three Maremma pups, a mature Maremma bitch and two mature Cattle Dogs were not affected.

Laboratory analyses

The following samples were sent to Dr John Gibson at the Department of Primary Industries, Veterinary Laboratory, Toowoomba and were forwarded for toxicological testing to Alan Fletcher Research Station:

- Dog 1 - fresh frozen samples of kidney, liver, blood, stomach contents and small intestine
- Dog 3 - small volume of EDTA preserved blood and stomach lavage sample
- Dog 4 - fresh frozen samples of liver, jejunum, kidney, small intestinal contents and heart blood; fixed samples of lung, heart, liver, kidneys, jejunum, pancreas, stomach and spleen; and vomitus sample.

Histological examination showed congestion and haemorrhage of the kidney and pancreas and congestion and fatty change to the liver of Dog 4. No abnormalities were seen in sections of stomach, spleen or intestine. Toxicological testing did not detect significant levels of arsenic, lead, strychnine, organochlorines or organophosphates in tissue samples or gut contents. SMFA was identified in the stomach contents of Dog 1 (0.44 mg/kg), the gastric lavage fluid from Dog 3 (0.03 mg/kg) and the vomitus sample from Dog 4 (1.52 mg/kg) using gas chromatograph mass spectrometry (Agilent 5973 Gas Chromatograph – Mass Spectrometry System).

Discussion

Chemical evidence of intoxication is indispensable in the positive diagnosis of poisoning,[6] particularly when no known exposure has occurred, however broad screening for a range of toxins is rarely economically feasible. Pre-mortem diagnosis of SMFA poisoning in dogs relies on history of exposure or possible exposure to the poison. There is some evidence that increased serum citrate concentrations may be indicative of SMFA poisoning,[7] but this test was not available for these cases. The suspicion of SMFA poisoning in these cases was based largely on similarity of the clinical signs in these dogs to previous cases with known exposure.

Relative hypocalcaemia occurs in SMFA poisoning as a result of binding of calcium by citrate, [8] which is increased due to interference with the TCA cycle. Hypocalcaemia is responsible for cardiac irregularities seen with SMFA poisoning in humans and herbivores. The failure of the blood to clot, whether collected pre- or post-mortem in these animals, may have been a result of this relative hypocalcaemia. The use of prolonged clotting time as a diagnostic aid may however lead to confusion with brown snake envenomation (*Pseudonaja* sp). No attempt to measure serum calcium or to treat hypocalcaemia was made.

Glycerol monoacetate has been used to protect monkeys from SMFA poisoning.[3] Its mechanism of action is thought to be competitive antagonism of fluoroacetate by provision of large amounts of acetate ions.[3] This compound was not available at the time of presentation and an attempt was made to supply acetate to the treated dog using common acetic acid on an empirical basis, but this was not successful. Experimental work using calcium gluconate along with sodium succinate has been reported as a potential treatment in SMFA intoxication in mice.[8] Whether this may be of use in treating SMFA intoxicated dogs is unknown and questionable, because the predominating clinical signs in the dog are neurological rather than heart-related.

Regulations governing the use and distribution of SMFA in Queensland are given in the Health (Drugs and Poisons) Regulation 1996.[1] In summary, these require that baits be used only for destruction of wild dogs, rabbits, foxes and feral pigs; all baits are to be distributed only on land described by the permit; baits are not to be laid within 2 km of any habitation (other than the property owner's), 5 km of a town area (unless approved by the Land Protection Officer), 5 m of a fenced property boundary or 50 m of a declared road; at least 3 days notice of intention to lay baits must be served to landholders of adjoining properties and warning signs must be displayed by the landholder at every entry point to the property and all adjoining public thoroughfares and left in place for a minimum of 1 month.[9]

In the cases reported here, there were no registered SMFA baiting programs reported for any adjoining properties. The nearest one was more than 25 km away. Dogs generally begin to show clinical signs within 2 hours of ingestion,[5] so it is unlikely that a baited animal could travel 25 km on foot. It is possible that a large bird may have transported part of a carcase or dying animal this distance. The owners of the property had moved there only recently and were unaware of any history of baiting on the property. An extensive search of the property failed to find the poison source. There was no reason to suspect malicious baiting, although this cannot be ruled out.

Given the distance of these animals from the nearest registered area of SMFA baiting, it is surmised that one source was responsible for the deaths of multiple dogs. Because dogs are extremely sensitive to SMFA compared to other animals it is possible that a single source could contain enough SMFA to kill several dogs. Baits used for wild dog control routinely contain 6 mg/kg of SMFA (P Hinchcliffe, Queensland Department of Natural

Resources and Mines, personal communication). One 250 g bait would therefore contain 22 times the LD_{50} and could theoretically kill a number of dogs. Dogs are reported to vomit after ingestion of SMFA,[5] supporting the suggestion that a number of dogs could be affected by one bait.

In the current incident, while no definite source was identified, the vomitus from Dog 4 appeared to contain hairless skin or hide, and it is possible that the source of SMFA was an animal previously exposed to a baiting program. SMFA has been shown to persist in the carcases of rabbits poisoned with SMFA[10] and in desiccated tissues.[11] Livestock guard dogs such as Maremmas, which live paddocks with livestock, maybe at particular risk of exposure to poisons set for pest species due to their close proximity to baits and their in-paddock feeding habits. SMFA poisoning should be an early consideration for such dogs presented with acute clinical signs involving the nervous system.

Acknowledgments

I would like to thank R Pascoe, T King and T Wismer; J Gibson from Queensland Department of Primary Industries Veterinary Laboratory, Toowoomba and B Parker from Alan Fletcher Research Station, Yeerongpilly, for processing of samples.

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(Accepted for publication 20 April 2004)

BOOK REVIEW

Canine and Feline Endocrinology and Reproduction, *3rd edn. Feldman EC, Nelson RW. Saunders, St Louis, 2004, 1089 pages. Price $209.00ISBN 0 7216 9315 6*

The third edition of Canine and Feline Endocrinology and Reproduction has been long awaited, it being 8 years since publication of the second edition in this rapidly evolving area of small animal medicine. The presentation of the third edition is stylish and modern and although not quite as robust as the previous cloth-bound edition, it is sturdy enough for most clinic bookshelves and regular use. The revamped appearance of the book appropriately reflects the thorough revision and updating of its content, and at 1089 pages it is 300 pages longer than the previous edition.

The book is divided into nine sections: the pituitary gland; the thyroid gland; the adrenal gland; the endocrine pancreas; parathyroid gland; renal hormones and atrial natriuretic hormone; canine female reproduction; canine male reproduction; and feline reproduction. Each section is then subdivided into chapters on the relevant disease syndromes for the endocrine organ(s), and reproductive topics for the reproduction sections. This format remains unchanged from the second edition.

The material is presented in a very readable format that is well set out to facilitate either in-depth reading or quick skimming for required information. Common units of measurement are mostly used in the book, but tables on the inside cover enable Australian readers to convert common to SI units. While this text provides an extremely useful reference for veterinary students, post-graduate students and internists, it is particularly targeted at the general practitioner. Appropriate emphasis is placed on the importance of the historical, physical and clinical signs in diagnosing endocrine and reproductive disease and diagnostic and treatment protocols are well explained in a step-by-step manner. The approach of the authors is practical and recommendations readily applicable.

Of particular note and relevance to small animal practitioners is the extensive updating of information on canine hyperadrenocorticism, canine hypothyroidism, and the addition of new chapters on feline hyperadrenocorticism and feline diabetes mellitus. This is a necessary recognition of the large amount new information on these topics.

Like previous editions this stands out as the most comprehensive textbook on the subject of endocrine disease in small animals, and is unrivalled in its completeness and depth of coverage. To the authors' credit, a great deal of the material presented and discussed is supported by their own original research and clinical experience. This is augmented by well-researched and current references in each chapter that include studies and reports published internationally. But like many North American textbooks the Australasian literature coverage is patchy, neglecting to include some important studies that provide answers to questions raised in the text. It is pleasing to see acknowledgement of recent Australian studies on medical management of canine hyperadrenocorticism. Inevitably the vast experience of the authors in this subject also gives the writing some bias in particular areas, and this is openly stated in the preface. Although this bias is reasonably obvious to a reader familiar with the subject and the literature, it may be less apparent to general practitioners and students who have not perused the opening pages. Furthermore, in some places it is declared that the authors do not recommend a certain treatment but the justification for this is not clear, nor are the alternative treatment practices consistently referenced. Minor flaws in the new edition are sporadic incorrect page references in the index, and occasional editing oversights in the text that do not have clinically important implications. One slight criticism of the current edition would be its references back to the second edition for full discussion of some topics, presuming the reader has both editions at hand. This is likely necessitated by constraints on the size of this already expanded edition.

Overall, this textbook has to be recommended as an essential reference book for every small animal practitioner. It makes an excellent companion to the popular medical textbooks and includes information and protocols that are not readily accessible elsewhere. The third edition unquestionably supersedes the second, however the latter is still a useful reference for some material not as comprehensively covered in the later edition.

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