

Article

A retrospective study of canine strychnine poisonings from 1998 to 2013 in western Canada

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Abstract — This study describes observations related to 93 cases of strychnine poisoning in dogs over a 16-year period in Saskatchewan, Alberta, and Manitoba. Epidemiological information describing age, gender, breed, and size of the dogs, geographical distribution of poisonings, and strychnine concentrations in tissue matrices were tabulated. The mortality in dogs poisoned with strychnine was 60.2%. Strychnine poisoning cases varied by year ($P = 0.0012$) and by season ($P = 0.0005$). The highest number of confirmed cases occurred in years 2000 and 2001. Poisonings occurred most frequently during the spring. There were no statistical differences related to age or gender, but older, male dogs appeared to be more commonly affected. Large dog breeds were most commonly affected. Strychnine was detected in multiple tissue matrices, including stomach contents, liver, urine, vomitus, and gastric washings. The study indicates that strychnine poisoning in the dog remains a common toxicosis in western Canada.

Résumé — Étude rétrospective des empoisonnements canins à la strychnine de 1998 à 2013 dans l'Ouest canadien. Cette étude décrit les observations se rapportant à 93 cas d'empoisonnement à la strychnine chez des chiens pendant une période de 16 ans en Saskatchewan, en Alberta et au Manitoba. Des renseignements épidémiologiques décrivant l'âge, le sexe, la race et la taille des chiens, la répartition géographique des empoisonnements et les concentrations de strychnine dans les matrices des tissus ont été compilés. La mortalité des chiens empoisonnés à la strychnine était de 60,2 %. Les cas d'empoisonnement à la strychnine variaient selon l'année ($P = 0,0012$) et selon la saison ($P = 0,0005$). Le nombre le plus élevé de cas confirmés s'est produit en 2000 et en 2001. Les empoisonnements se produisaient le plus fréquemment au printemps. Il n'y avait pas de différences statistiques reliées à l'âge ou au sexe, mais les chiens mâles âgés semblaient être le plus fréquemment touchés. Les chiens de grande race étaient le plus souvent affectés. La strychnine a été détectée dans des plusieurs matrices de tissus, notamment le contenu de l'estomac, le foie, l'urine, les vomissures et les lavages gastriques. L'étude indique que l'empoisonnement à la strychnine chez le chien demeure une toxicose commune dans l'Ouest canadien.

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Introduction

Strychnine is a highly toxic rodenticide commonly used for large-scale Richardson's ground squirrel extermination in the western Canadian provinces of Alberta, Saskatchewan, and Manitoba (1,2). The use of strychnine is restricted in these

provinces and is federally regulated by the Pest Management Regulatory Agency in Canada (1). Despite these restrictions, strychnine is associated with many non-target poisonings in dogs.

Strychnine intoxication in the dog is characterized by rapid onset of severe neurological symptoms. Its mechanism of action is to competitively inhibit glycine, the inhibitory neurotransmitter in the spinal cord, thus preventing normal neurologic control mechanisms (2). A dog develops tremors that quickly progress to intermittent, full body, tonic seizures manifested by extensor rigidity (2). Dogs poisoned with strychnine are also hyper-responsive to external stimuli. The progression of the syndrome is so rapid that dogs are often found dead or expire after multiple seizure events. Without expedient pharmacotherapeutic intervention, the prognosis of survival in the poisoned dog is low. Time is an important factor since strychnine is rapidly absorbed. Life threatening symptoms and death may occur in as little as 30 min following the consumption of poisoned bait.

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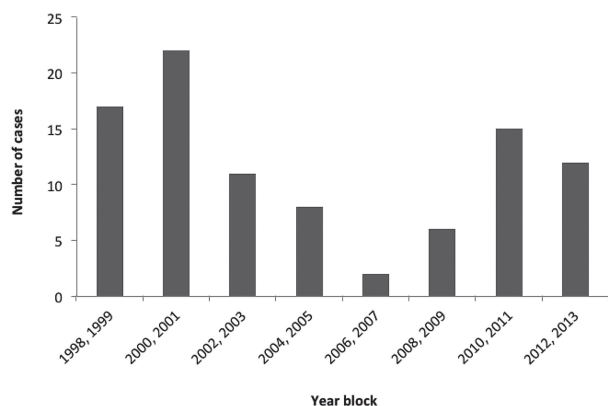


Figure 1. Number of confirmed cases of strychnine poisoning in dogs over 16 years recorded in 2-year blocks ($n = 93$) in western Canada. The probability of no year effect determined by Chi-square analysis is $P = 0.0012$.

The purpose of this report is to describe epidemiologic observations related to strychnine poisoning in dogs in western Canada from 1998 to 2013. Information presented in this study will aid in the diagnostic evaluation from suspected cases of poisoning.

Materials and methods

Diagnostic information from confirmed cases of strychnine poisoning in dogs from 1998 to 2013 was compiled from the records of Prairie Diagnostic Services (PDS), Saskatchewan's provincial diagnostic laboratory located in the Western College of Veterinary Medicine. The data include all case material investigated by the laboratory during the 16-year period. Strychnine was quantified following homogenization of tissues, extraction with chloroform, and detection of the alkaloid by UV spectrophotometry at 255 nm (3). Epidemiologic data pertaining to breed, age, gender, strychnine concentration in stomach contents, urine, liver, vomitus, and gastric washings, seasonal occurrence, and geographical distribution were tabulated and analyzed. Statistical analysis was conducted with the Chi-square goodness of fit test for case incidence by year, season, age, and gender. Statistical significance was denoted by $P < 0.05$.

Results

Diagnostic records from PDS during the years 1998 to 2013 confirmed 93 strychnine poisoning cases in dogs. Cases of strychnine poisoning seen by PDS were reported in Saskatchewan ($n = 54$), Alberta ($n = 30$), and Manitoba ($n = 9$). The mortality in dogs was 60.2% based on animals that were found dead or had died acutely from strychnine poisoning. The greatest number of poisonings occurred in the years 2000 and 2001 with a total of 22 cases ($P = 0.0012$) (Figure 1). Strychnine poisoning in the dog followed a distinct seasonal pattern ($P = 0.0005$) in which the greatest number of cases occurred in the spring (Figure 2). No difference was detected between cases in urban *versus* rural settings. Large, older (> 6 y of age), male animals tended to be the most commonly affected, though statistical significance was not evident (Figure 3; Table 1). An approximately 1.5:1 male:female ratio was observed (Table 1). Labrador

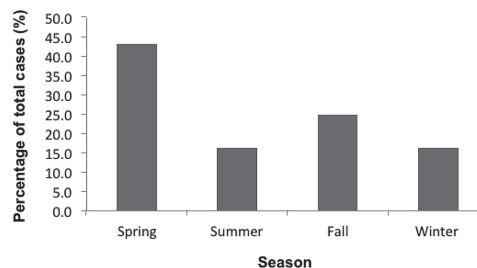


Figure 2. Seasonal distribution of confirmed cases of strychnine poisoning in dogs from 1998 to 2013 ($n = 93$) in western Canada. Spring – March, April, and May; Summer – June, July, and August; Fall – September, October, November; Winter – December, January, and February. The probability of no seasonal effect determined by Chi-square analysis is $P = 0.0005$.

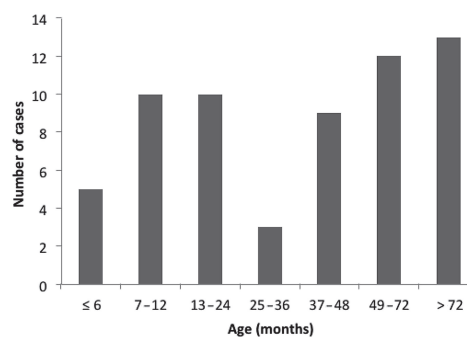


Figure 3. Age distribution of dogs poisoned with strychnine from 1998 to 2013 in western Canada. The probability of no age-related differences as determined by Chi-square analysis is $P = 0.1863$.

retriever, German shepherd, and collie breeds were most often affected, each representing 15.5% of cases in which breed was specified ($n = 71$) (Table 2). Strychnine was detected in several tissues of affected dogs, including stomach contents, urine, liver, and gastric washings. Confirmation of strychnine toxicity was most often determined by analysis of stomach contents ($n = 84$) from affected animals (Table 3).

Discussion

Strychnine poisoning in dogs occurs annually in western Canada. Poisonings may be malicious or accidental due to consumption of strychnine-laced bait. Strychnine is highly toxic, having an oral lethal dose of 0.75 mg/kg body weight in dogs (4). The likelihood of survival without medical intervention is low.

During the period of investigation, 93 cases of strychnine poisoning were observed in dogs. Strychnine poisoning is responsible for approximately 90% of case submissions in dogs seen by PDS. In a similar study in Saskatchewan from 1968 to 1982, 261 cases of strychnine poisoning were confirmed (2). In the United States, human poisoning associated with strychnine has declined in recent years (5). The decline in the United States and Canada is likely associated with more restrictive regulatory guidelines for the use of strychnine.

Prairie Diagnostic Services confirmed strychnine poisoning in dogs from the provinces of Saskatchewan, Alberta, and

Table 1. Gender distribution of strychnine poisoning in dogs between 1998 and 2013 in western Canada

Gender	Number (%)
Female	31 (33.3)
Male	45 (48.4)
Not specified	17 (18.3)
Total	93 (100)

The probability of no gender difference determined by Chi-square analysis is $P = 0.1082$.

Manitoba. The laboratory accepts submissions from all provinces for strychnine analysis, although more submissions are received from Saskatchewan. Consequently, the strychnine case data from Alberta and Manitoba are likely underestimated and do not fully reflect the impact of strychnine poisoning in these provinces.

The number of confirmed strychnine poisonings in the dog was the highest in years 2000 and 2001. The case distribution over 2-year periods showed statistically significant differences among these periods ($P = 0.0012$). During these 2 years in Saskatchewan, the 2% liquid strychnine concentrate formulation was released under emergency circumstances to control massive Richardson's ground squirrel infestations (1). The greater number of poisonings observed during these 2 years can be directly attributed to the emergency registration of strychnine at this time. Unrestricted use of strychnine is associated with increased non-target poisoning in dogs. This has regulatory and diagnostic implications. Veterinarians might anticipate poisoning cases during periods of intensive use of strychnine. A decline in strychnine cases was also observed in the years 2008 and 2009. The authors do not have an explanation for this decrease.

The number of non-target poisonings in dogs was highest in the spring months of March, April, and May. This observation reflects the use pattern of strychnine as a rodenticide. Strychnine-laced baits are typically placed in springtime to control ground squirrel infestations in Saskatchewan. A previous study also found that poisonings in dogs tended to be during the spring months, although this was not statistically significant (2). Conversely, strychnine baiting associated with its intended use pattern is not expected during the winter months. Poisoning during the winter months may be associated with malicious poisoning of dogs. In the United States, the number of cases was greater during the summer months. Distinct seasonal differences were not evident, possibly reflecting a more extensive use of strychnine throughout the year (5).

There was no difference in the gender of dogs poisoned by strychnine ($P = 0.1082$). However, another study found that males tend to be more commonly affected (1). The present study detected a 1.5:1 ratio between male and female dogs poisoned with strychnine, consistent with a previous investigation in Saskatchewan (2).

The Labrador retriever, German shepherd, and collie dog breeds were the most commonly affected by strychnine poisoning. Based on the database of top registered dog breeds maintained by the Canadian Kennel Club (6), this finding appears to reflect the breed population and does not represent breed sensitivity to strychnine. Collie breeds are the exception to this, and do not appear on the lists published by the Canadian Kennel

Table 2. Breed distribution of dogs poisoned with strychnine between 1998 and 2013 in western Canada

Breed	Number (%)
Labrador retriever	11 (15.5)
German shepherd	11 (15.5)
Collie breeds	11 (15.5)
Golden retriever	8 (11.3)
Rottweiler	6 (8.5)
Terrier breeds	5 (7.0)
Miscellaneous small breeds	6 (8.5)
Miscellaneous medium breeds	4 (5.6)
Miscellaneous large breeds	3 (4.2)
Husky breeds	2 (2.8)
Beagle breeds	2 (2.8)
Pomeranian	2 (2.8)
Total	71 (100.0)

Table 3. Mean strychnine concentration in specimens taken from poisoned dogs from 1998 to 2013 in western Canada

Sample	Strychnine concentration (nmol/g)
Stomach contents	485.1 ± 70.2 ^a ($n = 84$)
Liver	17.7 ± 6.8 ($n = 3$)
Vomitus	44.9 ± 15.3 ($n = 3$)
Urine ^b	23.2 ± 5.9 ($n = 3$)
Gastric washings	9.2 ($n = 1$)

^a Mean ± standard error of the mean (wet weight)

^b Concentration as nmol/mL

Club. This may be due to the broad classification of collies by the Club as Herding, Sporting, Working, etc. The population of dogs in western Canada is not accurately quantified and thus there is some uncertainty relating to breed sensitivity.

The highest number of poisonings was observed in dogs > 6 y of age, although this distribution was not statistically significant ($P = 0.1863$). This shift towards an increased incidence of poisoning in older dogs is in contrast to the findings of a similar study in Saskatchewan, which reported that animals < 2 y of age represented 61% of the recorded cases (2). In the present study, animals < 2 y of age made up only 40.3% of cases in which age data were available, while animals > 6 y of age comprised 21.0% of the cases. It is not clear why there is a shift towards poisoning in older dogs, although this could simply be a reflection of the age of the current dog population.

Multiple specimens can be analyzed for strychnine content, including stomach contents, liver, urine, gastric washings, blood, and kidney (2). Strychnine is most reliably detected in the stomach contents of an affected dog (2,5), as poisoning generally occurs via ingestion of strychnine-laced bait. Due to the rapid absorption of the compound from the gastrointestinal tract and extreme toxicity, detection in other tissues is often less reliable and may produce false negative results. Other factors must be considered as well, including the practical nature of collecting samples such as urine while the dog is having seizures, and that the sample may become dilute from poisoning treatment, such as intravenous fluid therapy. In cases of high dose strychnine poisoning, the animal may die before appreciable distribution or excretion of the compound can occur, thus rendering the stomach contents the only reliable indicator of exposure.

Although common to Saskatchewan, strychnine poisoning is observed in many countries (5,7). In the United States from

1992 to 2008, strychnine poisoning in dogs occurred nationwide each year, and accounted for 82% of all domestic animal strychnine poisoning (5). The United States Environmental Protection Agency has restricted the use of strychnine to < 0.5% formulations for below-ground rodent infestations since 1978 (8). The restrictions did not appear to impact the incidence of poisoning. In Spain, researchers found strychnine to be one of the most common rodenticide toxicoses in mammals between 1990 and 2005, including dogs, despite restrictions on its use (7). Strychnine was banned for use in Spain in 1994. Strychnine poisoning in mammals accounted for 17.33% of domestic poisoning cases in Spain during that time. Non-target strychnine poisoning is a global issue.

Despite restrictions on its use, strychnine poisoning in dogs continues to be a prevalent concern in western Canada and should always be considered as a differential diagnosis in dogs displaying severe neurologic signs.

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