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Comparison of the use of sodium carbonate (washing soda crystals) and apomorphine for inducing emesis in dogs

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Abstract

Objective

To describe the use of sodium carbonate and apomorphine in a historical cohort of dogs, compare the occurrence of emesis and report any adverse effects recorded.

Methods

This historical, observational study included information from medical records of dogs that received an emetic agent. The occurrence of emesis with apomorphine or sodium carbonate was calculated and the association between emesis and agent was explored, with the odds ratio and 95% confidence interval (CI) reported. A non-inferiority analysis of the occurrence of emesis for sodium carbonate was performed against an equivalence range of ±7% of the estimated occurrence of emesis with apomorphine. Owners were emailed a short survey about their dog's health after their visit to the hospital for induced emesis.

Results

Records for 787 dogs seen from January 2007 to December 2013 were included. For apomorphine, 382/392 dogs showed emesis (97%, 95% CI 95–100%). For sodium carbonate, 320/395 dogs showed

emesis (81%, 95% CI 77–85%), which fell below the equivalence range for apomorphine ($97 \pm 7\%$, 90–100%) and was considered inferior. The odds ratio of emesis with apomorphine to sodium carbonate was 9.0 (95% CI 4.6–17.6). Of 18 responses to the survey, 5 reported abnormalities after emesis (3 with sodium carbonate, 2 with apomorphine).

Conclusion

The occurrence of emesis with sodium carbonate was high but inferior to apomorphine. However, the advantages of sodium carbonate, including less expense and ease of accession compared with apomorphine, make it a viable choice in emergency medicine.

Keywords: dogs; emetic agents; gastrointestinal decontamination; poisoning; toxins

Abbreviation

CI

confidence interval

Ingestion of a harmful substance is a frequent reason for dogs to be presented as an emergency. Induction of emesis is performed in certain cases to limit exposure to ingested toxins or to remove foreign material that may cause harm.[1-3] Apomorphine and sodium carbonate, the latter also known as washing soda crystals, are reported for use as emetic agents in dogs.[1, 3-9] Apomorphine is a non-selective dopamine agonist that activates D_2 receptors in the chemoreceptor trigger zone to produce emesis.[10-14] Apomorphine can be administered in the conjunctiva and via a number of parenteral routes to induce emesis but has been associated with adverse effects, such as ocular irritation, sedation, prolonged vomiting and persistent nausea.[1, 4, 12, 15]

Compared with apomorphine, sodium carbonate is administered orally. The mechanisms for producing emesis are unknown but are thought to be related to its alkaline nature when dissolved in aqueous solution,[16] thereby causing oesophageal and gastrointestinal irritation. Conclusive evidence of its safety in dogs is lacking and there are no objective studies of its effectiveness or adverse effects when used as an emetic agent.

The purpose of this study was to describe the use of sodium carbonate and apomorphine in a historical cohort of dogs, to compare the occurrence of emesis and to describe any adverse effects reported for each emetic agent. We hypothesised that the occurrence of emesis with sodium carbonate would be at least 70% and be at least as frequent as that with apomorphine.

Materials and methods

Case selection

Dogs that were given an emetic agent at the authors' institution met the inclusion criteria of the study. The hospital's database was searched for the key phrase, 'emesis and monitoring' to identify the relevant medical records, which were collected by working backwards from December 2013 until 1000 records were reached. Dogs that had incomplete medical records or were vomiting prior to presentation were excluded. Dogs that were given an emetic agent or anti-emetic agent before presentation and dogs that received both sodium carbonate (Lectric soda crystals, Brands RMJ Pty Ltd, VIC, Aust) and apomorphine (apomorphine hydrochloride 10 mg/mL, Hospira Australia Pty Ltd, VIC, Aust), but had no record of which drug was given first, were also excluded.

Data collection

The following information was retrieved from medical records, where available: signalment, body weight, indication for emesis, estimated time between ingestion of toxin and presentation, estimated quantity of toxin ingested, clinical signs of intoxication displayed, current medications and record of previous illness. The emetic agents administered were recorded for the order of emetic agent given

and any report of emesis afterwards, including the contents of the vomitus. Only the response to the first emetic agent was used to calculate emesis occurrence. The use of other drugs, including anti-emetic agents administered after induction of emesis, any further emesis noted during hospitalisation and the outcome of the visit (hospitalised vs discharged) was also recorded.

The second part of the study was conducted in accordance with human ethics approval granted by the institution's Human Research Ethics Committee (2014/029). Owners of dogs that were included in the study were invited by email to answer a short survey about their dog's health after their visit to the hospital for induced emesis. Survey questions included any change to the dog's health in general, any gastrointestinal signs such as vomiting, dry retching, diarrhoea, reduced appetite, lethargy, haematemesis, haematochezia or melaena noticed within 1 month of induced emesis.

Statistical analysis

The age and weight of the cohort were summarised as mean and standard deviation (SD), based on verifying a normal distribution of the data by failure to reject the null hypothesis of normality using the Shapiro-Wilk statistic. The occurrence of each category within the cohort was summarised as a percentage. The estimate of occurrence of emesis was reported as a percentage with a 95% confidence interval (CI), based on estimation of a binomial proportion. The odds ratio for emesis was calculated and reported with a 95% CI. The odds ratio was considered significant if the 95% CI excluded 1.0.

A non-inferiority analysis of the estimated occurrence of emesis for sodium carbonate was performed based on an equivalence range of ±7% of the estimated occurrence of emesis with apomorphine. The equivalence range was chosen based on what was thought to be clinically relevant equivalence. When the estimated occurrence of emesis for sodium carbonate fell below this range, inferiority was declared, and within this range, equivalency was declared. All statistical analysis was performed with SAS 9.4 (SAS Institute, Cary, NC, USA).

Results

Of 1000 records from January 2007 to December 2013 that met the inclusion criteria, 213 records were excluded and 787 records were included in the study. Reasons for exclusion included vomiting before presentation (n = 99), apomorphine and sodium carbonate administered with no record of which drug was given first (n = 50), incomplete records (n = 46), emetic agent given prior to presentation (16) and an anti-emetic agent given prior to presentation (n = 2).

Age ranged from 0.5 to 17.0 years with a mean (SD) of 5.0 (3.8) years. Weight ranged from 1.6 to 75.0 kg with a mean (SD) of 17.0 (11.8). Of the 787 dogs, most frequent breeds included Labrador Retriever (74; 9%), Maltese Terrier-cross (54; 7%), Staffordshire Bull Terrier (35; 4%), Poodle-cross (28; 4%), Staffordshire Bull Terrier-cross (27; 3%), Jack Russell Terrier (27; 3%), Golden Retriever (26; 3%), Kelpie-cross (25; 3%), Beagle (24; 3%) and Border Collie (21; 3%). There were 398 female (259 spayed) and 389 male (273 neutered) dogs.

The most frequent indications for emesis included ingestion of anticoagulant rodenticide (194; 25%), chocolate (137; 17%), foreign material (96; 12%), puffer fish (73; 9%), unknown (63; 8%), molluscicide (58; 7%), non-steroidal anti-inflammatory drugs (NSAIDs) (32; 4%), sultanas or grapes (23; 3%) and excessive amount of food (food engorgement) (6; 1%).

For apomorphine, 382/392 dogs showed emesis, with an estimated occurrence of 97% (95% CI 95–100%). Route of administration was recorded in 365 dogs and included intravenous (n = 284), subcutaneous (n = 63), intramuscular (n = 15), conjunctival (n = 1) and combined intravenous and subcutaneous (n = 2). The dose was recorded in 333 dogs and ranged from 0.015 to 0.8 mg/kg. For sodium carbonate, 320/395 dogs showed emesis, with an estimated occurrence of emesis of 81% (95% CI 77–85%). The odds ratio comparing emesis with apomorphine to sodium carbonate was 9.0 (95% CI 4.6–17.6). An equivalence range for emesis occurrence of 97 ± 7% was established, with a lower limit of 90% to an upper limit of 100%. The estimated occurrence of emesis with sodium carbonate fell below the equivalence range and was considered inferior.

Concurrent illnesses and medications varied (Table 1). Drugs with central nervous system effects included fluoxetine, chlorphenamine, loratadine, cetirizine, diazepam, phenobarbital and levetiracetam. Drugs with cardiovascular effects included pimobendan, furosemide and benazepril.

Of the 112 dogs admitted to hospital after emesis was induced, the most frequent toxins ingested by these dogs were unknown (36; 32%), chocolate (16; 14%), methiocarb (15; 13%) and metaldehyde (6; 5%). Of the 411 dogs given an anti-emetic agent after emesis was induced, the most frequent anti-emetic was metoclopramide (403; 98%), acepromazine (4; 1%), maropitant (3; 0.7%) and dolasetron (1; 0.3%).

Four dogs had gastrointestinal signs noted post emesis (2 with sodium carbonate, 1 with apomorphine and 1 with both emetic agents). None of these dogs had any record of previous illness or concurrent medications. The first dog ingested carprofen and was administered sodium carbonate, activated charcoal, metoclopramide, intravenous fluid therapy and gastrointestinal protectants. This dog had regurgitation for the next 2 days and developed aspiration pneumonia, which was treated with nebulisation and antimicrobial therapy. The dog was hospitalised for 4 days and then discharged. The second dog ingested meat from a 1-week-old rotten bone and was administered sodium carbonate and activated charcoal and discharged. This dog presented 6 h later for protracted vomiting and was administered maropitant and tramadol and discharged with omeprazole and oral electrolyte sachets. The third dog ingested metaldehyde and was administered sodium carbonate initially, then apomorphine and underwent gastric lavage under general anaesthesia because of worsening tremors. This dog regurgitated under general anaesthesia and during subsequent hospitalisation was treated with methocarbamol, mannitol, propofol, intravenous fluid therapy and metoclopramide and was discharged the next day. The fourth dog ingested anticoagulant rodenticide and was administered apomorphine and discharged without any further sign of vomiting. This dog returned 5 h later for acute vomiting and nausea, which was suspected to be secondary to an unrelated type 1 hypersensitivity reaction, because of a history of previous similar episodes. This dog was treated with chlorphenamine and maropitant as an outpatient.

A total of 18 owners answered the survey. The range of time from their dog's visit to the hospital for induced emesis to owners answering the survey ranged from 1 to 8 years. Of the 18 dogs, 5 were noted to have abnormalities after emesis was induced, including lethargy, decreased appetite, dry retching and vomiting, coughing and mild tremors. The indications for emesis for these dogs were ingestion of fruitcake, mouldy cream cheese, carprofen tablets, methiocarb and difenacoum. Three dogs were administered sodium carbonate and two dogs were administered apomorphine. Three of the five dogs had a history of previous illness (cardiac disease, separation anxiety and inflammatory bowel disorder).

Discussion

This is the first study to report on the use of sodium carbonate as an emetic agent in a large cohort of dogs. The occurrence of emesis with sodium carbonate was >70%, as hypothesised, but was inferior to apomorphine. Apomorphine was 9-fold more likely to produce emesis than sodium carbonate.

The occurrence of emesis with sodium carbonate may have been affected by individual variability in gastrointestinal irritation or failure to administer an effective dose; for example, inadvertent loss of sodium carbonate crystals during oral administration, deactivation of sodium carbonate crystals by light, interference of gastric contents thereby preventing contact of sodium carbonate crystals with gastric mucosa, and sodium carbonate crystals lodged in the oesophagus and not reaching the stomach. The recommended oral dose for sodium carbonate at the authors' institution based on anecdotal data is 1 cm^3 per 20 kg and it is likely that most dogs in this study received this amount.

The occurrence of emesis with apomorphine in this study was similar to that in previous studies reporting 94%[4] and 90.6%[1] in dogs. Small variations in the occurrence of emesis may be explained by the varying routes of administration, as one study reported that subcutaneous administration appeared more effective than intramuscular administration.[12] A range of doses was administered in the present study, but all were within the recommended dosing range.[17] It was not

possible to investigate the association of different routes and doses of administration with the occurrence of emesis in this study, as that information was not always recorded.

To date, there has only been one published case report documenting adverse effects of chronic oral sodium carbonate intoxication on a chinchilla farm.[18] Documented necropsy findings of a population of affected chinchillas included lesions in the gastrointestinal mucosa, liver, kidneys, adrenal glands, lungs, skin and reproductive tract, which ultimately led to mass abortions and death. The inhalation of aerosols containing sodium carbonate resulted in pathological lesions in the respiratory tract of mice, rats and guinea pigs[19] and ocular application of sodium carbonate powder caused ocular inflammation in rabbits from the alkaline nature of sodium carbonate powder.[16] There is one unpublished case report by the Veterinary Poisons Information Service documenting tongue ulceration and pyrexia in a dog after administration of sodium carbonate for inducing emesis (pers. comm.). Dogs in the current study received sodium carbonate as a single administration, so it is unlikely that any clinically relevant adverse effects would be sustained and there were none reported in the medical records.

No major complications of apomorphine administration were reported in this study, despite some dogs receiving concurrent medications, including those with central nervous system and cardiovascular effects. Apomorphine is contraindicated in dogs receiving central nervous depressants, because of the potential cumulative effects on mu receptors. Apomorphine should also be avoided in dogs receiving antidopaminergic drugs, because of the inhibition of its dopamine effects.[17] Dose-dependent cardiovascular depression associated with the use of apomorphine in healthy dogs has been documented.[20] However, cardiovascular effects documented in a previous experimental study occurred with higher doses than the dose used for emesis. In the present study, two dogs with cardiac disease that were receiving pimobendan and frusemide were administered apomorphine. No adverse cardiovascular effects were recorded for these dogs.

Study limitations

The main limitations of this study are based on its historical, observational design, which relied on accurate record keeping and appropriate search keywords, and suffers from a lack of randomisation of emetic agents administered. Clinicians chose anti-emetic agents based on preference and may have avoided using sodium carbonate in cases where gastric mucosal contact was less likely, for example, in large-volume ingestion, creating bias. The dose and route of apomorphine and dose of sodium carbonate administered were not assessed for any effect on the occurrence of emesis. The occurrence of emesis was defined by the observation of a productive vomit, but did not take into account the quantity of vomitus or whether emesis was successful at eliminating the toxin. Some toxins ingested could have had emetic or anti-emetic properties, which may have confounded the results. Clinicians may not have given the first emetic agent adequate time to produce emesis and given a second emetic agent prematurely, biasing the results towards the first emetic agent failing to produce emesis. Also, the study design made it difficult to accurately assess adverse effects related to the lack of prospective design and lack of further data, such as laboratory work. The historical nature of the study relied on clinicians recording particular clinical signs that may be an adverse effect, and owners being observant and having accurate memory of those events. There was a low rate of owner participation in gathering follow-up information and a serious adverse effect could have been unreported by owners. However, this was considered less likely as owners were more likely to respond if a negative memory surrounding the event persisted.

It was not possible in this study to determine causal association between administration of these emetic agents and adverse gastrointestinal effects, because of the study's design and confounding effects of some of the toxins ingested. To adequately assess adverse effects, a prospective design with a focused observation period would need to be undertaken. However, given the results of this study, these adverse effects are unlikely to be clinically important.

Conclusion

Sodium carbonate and apomorphine are both used to induce emesis in dogs that require emergency gastrointestinal decontamination. The occurrence of emesis with sodium carbonate was high but inferior to apomorphine in this study. Despite this, the advantages of sodium carbonate being less expensive and more readily available than apomorphine are relevant to the choice of emetic agent. Therefore, although sodium carbonate is less consistent for inducing emesis, it still has a place as a viable and safe emetic agent when administered under the guidance of a veterinary surgeon.

Acknowledgement

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Table 1. Dogs administered emetic agents apomorphine or sodium carbonate with concurrent illness and medications

		Emetic agent administered	
	No. of dogs (%)	**Apomorphine**	**Sodium carbonate**
Concurrent illness	217 (28)	100	117
Concurrent medications	51 (6)	26	25
Drugs with CNS effects	11 (1)	8	3
Drugs with CVS effects	7 (0.9)	2	5

CNS, central nervous system; CVS, cardiovascular system.