Successful management of a kitten with chlorpyrifos and cypermethrin toxicosis with pralidoxime and atropine

Authors: Roy, Sawrab, Islam, Saiful, Alam, Shahrul, Ahmed, Juned, and Chowdhury, Q M Monzur Kader

Source: Journal of Feline Medicine and Surgery Open Reports, 7(2)

Published By: SAGE Publishing

URL: https://doi.org/10.1177/20551169211045647

Case Report

jfms OPEN REPORTS

Journal of Feline Medicine and Surgery Open Reports
1–5

DOI: 10.1177/20551169211045647
journals.sagepub.com/home/jfmsopenreports

This paper was handled and processed by the European Editorial Office (ISFM) for publication in *JFMS Open Reports*

SAGE

Successful management of a kitten with chlorpyrifos and cypermethrin toxicosis with pralidoxime and atropine

Sawrab Roy[1,2], Saiful Islam[2,3], Shahrul Alam[2,4], Juned Ahmed[2,5] and Q M Monzur Kader Chowdhury[2,6]

Abstract

Case summary Organophosphates and pyrethroids have been widely used as agricultural and domestic insecticides. This case report describes a 3-month-old free-roaming female kitten, weighing 930 g, that developed hypersalivation, hypothermia, dyspnoea due to increased bronchial secretion, bradycardia, miosis and neurological signs, including restlessness, ataxia, disorientation, apparent hallucination, muscle twitching and seizures within 6 h of accidental ingestion of an insecticide containing chlorpyrifos (500 g/l) and cypermethrin (50 g/l). The kitten was treated empirically with intramuscular atropine and dexamethasone, and rectal diazepam. The history of insecticide exposure was obtained after 6 h of treatment and intramuscular 2-pyridine aldoxime methochloride (pralidoxime [2-PAM]) and atropine therapy was started 2 h later. Recovery was complicated by suspected aspiration, but there were no sequelae from the insecticide exposure and by 7 days post-ingestion the kitten was normal and playful.

Relevance and novel information To the best of our knowledge, this is the first report of successful management of chlorpyrifos and cypermethrin toxicosis in a cat in Bangladesh. This case report suggests that 2-PAM followed by atropine and other supportive therapy may be an effective strategy to manage a cat poisoned by chlorpyrifos and cypermethrin; however, expanded clinical trials are needed.

Keywords: Atropine; 2-PAM; chlorpyrifos; cypermethrin

Accepted: 24 August 2021

Introduction

Organophosphates (OPs) consist of a large class of synthetic compounds that are used heavily as insecticides to control a variety of insects in an agricultural, as well as household, environment.[1,2] Overexposure to insecticides containing OPs is a major cause of OP poisoning in humans[3] and animals, particularly household cats and dogs, in some countries. The toxicity of OPs is mainly caused by inhibition of acetylcholinesterase (AChE), which causes termination of a neurotransmitter (acetylcholine) at the synapse in the autonomic nervous system, central nervous system (CNS) and neuromuscular junction (NMJ). The resultant inhibition of AChE leads to an accumulation of acetylcholine, which overstimulates muscarinic and nicotinic acetylcholine receptors.[2,4] The subsequent signs of toxicity comprise a

[1]Department of Microbiology and Immunology, Sylhet Agricultural University, Sylhet, Bangladesh
[2]Sylhet Pet Care, Sylhet, Bangladesh
[3]Department of Livestock Production and Management, Sylhet Agricultural University, Sylhet, Bangladesh
[4]Faculty of Agricultural and Nutritional Sciences, Christian Albrechts University of Kiel, Germany
[5]Department of Pathology, Sylhet Agricultural University, Sylhet, Bangladesh
[6]Department of Comparative Biomedical Sciences, College of Veterinary Medicine, Mississippi State University, MS, USA

Corresponding author:
Sawrab Roy DVM, MS, Department of Microbiology and Immunology, Sylhet Agricultural University; Sylhet Pet Care, Sylhet-3100, Bangladesh
Email: sawrab.sau@gmail.com

variety of features, including: muscarinic effects (salivation, lachrymation, urination, defecation/dyspnoea, gastrointestinal upset, emesis [also known as 'SLUDGE syndrome']; or diarrhoea/diaphoresis, urination, miosis, bradycardia/bronchospasm, emesis, lachrymation, salivation [also known as 'DUMBELS']); nicotinic effects on the sympathetic system (tachycardia, mydriasis, hypertension, sweating); nicotinic and muscarinic effects in the CNS (confusion, agitation, coma and respiratory failure); and nicotinic effects in the NMJ (muscle weakness, twitching, paralysis and fasciculations).[5,6] Generally, the safety margin of OPs is narrow owing to a steep dose–response curve.[7] After exposure to OPs, clinical signs usually manifest within a few minutes to hours, or sometimes over more than 2 days.[7] The onset of toxic signs and outcome of OP poisoning depend on the type of OP ingested, dose, route of administration, and time of exposure to the poison and start of treatment.[8] For instance, oral doses of chlorpyrifos in the range of 0.1–10 mg/kg did not induce signs of poisoning in cats; however, a dose of 40 mg/kg caused signs of toxicosis.[9] Typically, cattle and sheep manifest severe depression, whereas dogs and cats usually progress to convulsions due to CNS involvement.[7] In the acute stage of OP poisoning, the gastrointestinal, nervous, respiratory, cardiovascular and endocrine systems are all involved.[10,11] The nervous and skeletal systems are affected mainly in chronic cases.[10] OP poisoning can also cause liver damage, renal tubular damage and immunosuppression.[12–14]

Cypermethrin, a type II synthetic pyrethroid, is extensively used in veterinary practice and for agricultural purposes.[15] The main site of action of pyrethroids is on sodium and chloride channels in nerve and muscle cells. Pyrethroid alters the gating characteristics of voltage-sensitive sodium channels to delay their closures. The resultant prolonged sodium influx lowers the action potential threshold and causes repetitive nerve firing.[16–18] As a result, the most commonly reported clinical signs of pyrethroid toxicity in cats are related to the CNS, including ataxia, twitching, seizures/convulsions, muscle fasciculations/tremors, shaking/shivering and hypersalivation.[15,17] The onset of clinical signs following pyrethroid toxicity develops within a few hours – or may be delayed up to 72 h – and generally last 2–3 days.[18]

The therapeutic management of OP poisoning includes muscarinic antagonists, cholinesterase reactivators, nicotinic receptor-blocking agents, and emetics, cathartics and adsorbents to decrease further absorption.[6,7,19,20] Treatment for pyrethroid toxicosis in small animals involves control of seizures, and symptomatic and supportive care.[15,21] OP and pyrethroid poisoning have been observed in several species of animals, including dogs, cats, cattle, horses and others; however, they are poorly reported. To the best of our knowledge, this is the first documented report of the successful management of chlorpyrifos and cypermethrin poisoning in a cat in Bangladesh.

Case description

A 3-month-old female kitten weighing 930 g was admitted to Sylhet Pet Care (SPC), Sylhet, Bangladesh, for the treatment of hypersalivation and dyspnoea with neurological impairments, including restlessness, ataxia, seizures, apparent hallucination and disorientation. This impairment was not associated with any history of poisoning witnessed by the owner. The cat was known to roam outside frequently and had a habit of eating unusual, dirty foods from the street and dustbins. There was no history of vaccination or deworming. At SPC, the animal presented with muscarinic signs, including hypersalivation (foamy), miosis and dyspnoea due to increased bronchial secretions and bronchoconstriction; nicotinic signs, including muscle twitching and weakness; and CNS effects, including restlessness, apprehension, ataxia and seizures. Physical examination revealed hypothermia (98.5°F/36.9°C), bradycardia (60 beats/min [bpm]), oligopnoea (15 breaths/min), prolonged capillary refill time (>4 s), pale oral mucosa and extremities that were cold to the touch. Normal defecation and urination were observed. Muscles surrounding the shoulder and gluteal regions were twitching intermittently along with regular cyclic jerking of the head, and proprioceptive deficits were observed.

Initial therapeutic management consisting of an intramuscular (IM) injection of atropine sulfate 0.4 mg/kg body weight (Atrovet; Techno Drugs Limited) and dexamethasone 0.5 mg/kg body weight (Dexavet; Techno Drugs Limited), followed by an intravenous supply of isotonic crystalloid solution (0.9% w/v sodium chloride infusion) 30 ml/kg body weight (Normalin IV Infusion; Popular Pharmaceuticals Limited), was instituted. Later, diazepam 0.5 mg/kg body weight (Easium; Opsonin Pharma Limited) was administered rectally. After 2 h of treatment, peripheral pulse quality had improved and there was a slightly increased rectal temperature (100°F/37.8°C), heart rate (72 bpm) and respiratory rate (16 breaths/min). The kitten was then able to maintain a normal body temperature (101–102°F/38.3–38.9°C). After 6 h of treatment, the owner confirmed that the cat had accidentally ingested a liquid crop insecticide (Nitro 505 EC; Auto Crop Care Limited) by licking the discarded container. The product contains chlorpyrifos (500 g/l) coformulated with cypermethrin (50 g/l) in water. After 8 h of treatment, the cat suffered laboured, foamy salivation and restlessness, with persistent muscle twitching in the gluteal region. At that time, an IM injection of 2-pyridine aldoxime methochloride (pralidoxime chloride [2-PAM]) was instituted at a dose of 50 mg/kg (Pradox; Beacon Pharmaceuticals Limited), which was followed by an IM injection of atropine sulfate 0.4 mg/kg body weight (Atrovet; Techno Drugs Limited), rectal administration of diazepam 0.5 mg/kg body weight (Easium; Opsonin Pharma Limited) and montelukast 0.5 mg/kg body weight under the tongue (Monas; The ACME Laboratories Limited).

On the following day (9 h after the previous treatment), clinical examination revealed similar findings but fewer than seen at the time of admission, including: normothermic (101.5°F/38.6°C); bradycardia (72 bpm); laboured breathing (respiratory rate 15 breaths/min); and mild foamy salivation. Muscle twitching, nervousness and other neurological signs were diminished. Follow-up treatment consisted of half the dose of 2-PAM (20 mg/kg body weight [Pradox; Beacon Pharmaceuticals Limited]), followed by atropine sulfate (0.2 mg/kg body weight [Atrovet; Techno Drugs Limited]) and montelukast 0.5 mg/kg body weight under the tongue (Monas; The ACME Laboratories Limited). Once the kitten was stabilised, it was then managed at home and was to return to the veterinary hospital for regular check-ups and administration of medication.

After 7 h of treatment, the owner complained that the kitten had a cough, laboured breathing and a slightly elevated temperature. Further questioning of the owner revealed forced ingestion of chicken stew and oral saline, and the kitten had a pre-existing respiratory distress. Clinically, the kitten's body temperature was elevated (104°F/40°C), it was dyspnoeic (respiratory rate 10 breaths/min), was intolerant to movement and had nasal discharge with coughing, tentatively indicating aspiration. The resultant aspiration was treated immediately by nebulisation with a combination of 200 µg salbutamol and 40 µg ipratropium at 6 h intervals (nebuliser solution: Windel Plus [Incepta Pharmaceuticals Limited]) followed by cefixime (20 mg/kg body weight PO q12h [Cef-3; Square Pharmaceuticals Limited]). Nebulisation was continued for another three doses (at 6 h intervals, depending on the respiratory condition) along with the antibiotic for 7 days.

A week after the insecticide exposure the kitten was active with a normal stance and gait, with no visible abnormalities, and was also able to maintain a normal 'curled up' position while sleeping. The animal was monitored for a month for further complications; however, no similar clinical features developed.

Discussion

Several kinds of pesticides are frequently used in households to control rats, mosquitoes and other insects. Animals are therefore easily exposed to discarded products, sometimes from licking empty bags or containers carelessly disposed of in accessible areas.[22] Owners may identify some insecticides by noting the colour and odour, but may not necessarily deter animals from ingesting them. Young animals have immature hydrolysing enzyme systems and are therefore more likely to be poisoned, even at lower doses.[22] Like acetylcholine, OP insecticides are structurally compatible with acetylcholinesterase. The physiology of acetylcholinesterase is to catabolise acetylcholine to acetic acid and choline. The resultant overaccumulation of acetylcholine causes overstimulation of the end organs.[22] With that notion, one might have anticipated that body temperature could be elevated owing to musculoskeletal activity and neurological stimulation. However, there have been several human and animal studies of thermoregulation in OP poisoning, with inconsistent results. Initial hypothermia and later fever have been reported in OP poisoning in humans.[23] Similarly, hypothermia and delayed fever have been observed in the case of chlorpyrifos poisoning in the rat.[24] OP-induced intermediate syndrome (IMS) has been seen in human and animals acutely poisoned with a massive dose of an OP insecticide.[7] Clinical signs associated with IMS include acute paralysis and weakness in the areas of several cranial motor nerves and neck flexors, as well as facial, extraocular, palatal, nuchal, proximal limb and respiratory muscles after 24–36 h of poisoning.[7] IMS is a separate clinical entity from OP-induced delayed neurotoxicity (OPIDN).[7] Clinically, OPIDN is characterised by muscle weakness and ataxia that progresses to flaccid paralysis,[7] and signs usually present 8–21 days after administration of the drug.

Cats are highly sensitive to the effects of pyrethroids, even at a small dose, and this increased sensitivity may be due to deficiency of hepatic glucuronosyltransferase.[17,18] Additionally, because of the larger body surface-to-weight ratio, overdosing of small pets is easier than in large ones.[15,25] Type II cypermethrin pyrethroid is 17-fold more toxic in an 8-day-old rat than in an adult rat owing to the fact that younger animals likely have incomplete development of liver enzymes that catalyse the metabolism of pyrethroid.[15,26] The mechanisms by which pyrethroids alone are toxic are complex and become more complicated when they are coformulated as an organophosphorus insecticide.[15,16] Coadministration of pyrethroids with an organophosphorus insecticide increases insecticidal efficacy and toxicity; this is likely because of the inhibition of pyrethroid metabolism by the organophosphorus insecticides.[15,16] In experimental conditions, beta (β)-cypermethrin and chlorpyrifos in mixtures have been verified to act together in a synergistic manner.[27]

Generally, the existing therapeutic recommendations for chlorpyrifos and cypermethrin intoxication include symptomatic and supportive treatment.[7,16] Atropine acts as a muscarinic receptor blocking agent and physiological antidote to OP poisoning.[8] Initially, in our kitten, atropine sulfate was given IM (0.4 mg/kg body weight) and repeated as often as the muscarinic signs appeared. Atropinisation was deemed sufficient when the cat became more alert, its pupils were dilated and salivation ceased. Although atropine is highly effective in antagonising muscarinic receptors, it fails at nicotinic receptors.[28] In addition to atropine, diazepam was administered rectally at 0.5 mg/kg body weight to alleviate the nicotinic cholinergic effects such as muscle fasciculations. Moreover, reactivating oximes can act as specific antidotes. Oxime reactivates cholinesterase that is inhibited by organophosphorus.[6,28] In the mid-1950s, the efficacy

of 2-PAM iodide as a reactivator of phosphorylated cholinesterase was discovered independently by Wilson and Ginsburg[29] in the USA and by Childs et al[30] in the UK. Some studies have also reported a dramatic and successful recovery in cases of OP poisoning treated with pralidoxime and atropine.[9,31] In the present case, the dose of 2-PAM was 50 mg/kg, repeated at half the initial dose as needed. The product is not available locally for veterinary purposes. For this reason, pralidoxime chloride for use in humans was used in this case, and the dosage was followed in accordance with the MSD Veterinary Manual.[7]

Decontamination was not attempted after hospitalisation as the exposure to insecticide was not confirmed at that point. However, after 6 h, the owner confirmed that the cat had accidentally ingested a liquid crop insecticide by licking the discarded container. Induction of emesis is not recommended after 2 h of ingestion of a toxin.[7] Furthermore, considering the risk of aspiration and the clinical condition of the kitten, gut decontamination was not performed.[7,32] The kitten was suffering from breathing difficulties. Considering the respiratory condition of the kitten, montelukast was administered to facilitate breathing as it acts as a bronchodilator and has bronchoprotective effects.[33] In this case, a corticosteroid (dexamethasone) was used because of its potential role in increasing the blood glucose level and reducing the inflammatory response in aspiration pneumonia[34] by inhibiting activation of inflammatory cells, microvascular leakage and mucous formation.[35] Inhaled salbutamol in combination with ipratropium bromide was used to ameliorate the asthmatic condition that had developed in the cat. Salbutamol acts as a β_2 inferior agonist and ipratropium as an anticholinergic (additive bronchodilator with β_2 agonists).[36] Inhaled salbutamol and ipratropium bromide are more useful than salbutamol or ipratropium alone in preventing bronchoconstriction in cats.[37] Owing to fact that the kitten was pre-compromised with respiratory distress and suspected aspiration was noted, a third-generation cephalosporin was instituted to control possible secondary bacterial coinfection. After 7 days, the kitten was completely healthy and playful.

Conclusions

We have reported the safe and successful management of a kitten with severe clinical signs after exposure to chlorpyrifos and cypermethrin using locally available drugs, including atropine and pralidoxime. Despite the complication of suspected aspiration, the lack of an initial diagnosis and gut decontamination, and the small body size of the animal in this case, the kitten recovered fully with no adverse effects from therapy or sequelae from the pesticides.

Conflict of interest The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding The authors received no financial support for the research, authorship, and/or publication of this article.

Ethical approval The work described in this manuscript involved the use of non-experimental (owned or unowned) animals. Established internationally recognised high standards ('best practice') of veterinary clinical care for the individual patient were always followed and/or this work involved the use of cadavers. Ethical approval from a committee was therefore not specifically required for publication in *JFMS Open Reports*. Although not required, where ethical approval was still obtained, it is stated in the manuscript.

Informed consent Informed consent (verbal or written) was obtained from the owner or legal custodian of all animal(s) described in this work (experimental or non-experimental animals, including cadavers) for all procedure(s) undertaken (prospective or retrospective studies). No animals or people are identifiable within this publication, and therefore additional informed consent for publication was not required.

ORCID iD Sawrab Roy https://orcid.org/0000-0002-4646-3401
Juned Ahmed https://orcid.org/0000-0003-3904-9381

References

1 Colovic MB, Krstic DZ, Lazarevic-Pasti TD, et al. **Acetylcholinesterase inhibitors: pharmacology and toxicology.** *Curr Neuropharmacol* 2013; 11: 315–335.
2 Gupta RC, Miller Mukherjee IR, Doss RB, et al. **Organophosphates and carbamates.** In: Gupta RC (ed). Reproductive and developmental toxicology. Oxford: Academic Press, 2017, pp 609–631.
3 Karalliedde L, Baker D and Marrs TC. **Organophosphate-induced intermediate syndrome.** *Toxicol Rev* 2006; 25: 1–14.
4 Lotti M. Clinical toxicology of anticholinesterase agents in humans. In: Krieger R (ed). Hayes' handbook of pesticide toxicology. Oxford: Academic Press, 2010, pp 1543–1589.
5 Clark RF. **Insecticides: organic phosphorus compounds and carbamates.** In: Goldfrank L, Flomenbaum N, Lewin N, et al (eds). Goldfrank's toxicologic emergencies. New York: McGraw-Hill Professional, 2002, pp 1346–1360.
6 Eddleston M, Buckley NA, Eyer P, et al. **Management of acute organophosphorus pesticide poisoning.** *Lancet* 2008; 371: 597–607.
7 Gupta RC. **Organophosphates (toxicity).** MSD veterinary manual. https://www.msdvetmanual.com/toxicology/insecticide-and-acaricide-organic-toxicity/organophosphates-toxicity (2014, accessed July 25, 2021).
8 Pandit V, Seshadri S, Rao SN, et al. **A case of organophosphate poisoning presenting with seizure and unavailable history of parenteral suicide attempt.** *J Emerg Trauma Shock* 2011; 4: 132–134.

9 Hooser SB, Beasley VR, Sundberg JP, et al. **Toxicologic evaluation of chlorpyrifos in cats.** *Am J Vet Res* 1988; 49: 1371–1375.
10 Perry J, Cotton J, Rahman M, et al. **Organophosphate exposure and the chronic effects on farmers: a narrative review.** *Rural Remote Health* 2020; 20: 4508–4508.
11 Robb EL and Baker MB. **Organophosphate toxicity.** http://europepmc.org/books/NBK470430 (2017, accessed July 26, 2021).
12 Rajak P, Ganguly A, Sarkar S, et al. **Immunotoxic role of organophosphates: an unseen risk escalating SARS-CoV-2 pathogenicity.** *Food Chem Toxicol* 2021; 149: 112007. DOI: 10.1016/j.fct.2021.112007.
13 Yurumez Y, Ikizceli I, Sozuer EM, et al. **Effect of interleukin-10 on tissue damage caused by organophosphate poisoning.** *Basic Clin Pharmacol Toxicol* 2007; 100: 323–327.
14 Peter JV, Sudarsan TI and Moran JL. **Clinical features of organophosphate poisoning: a review of different classification systems and approaches.** *Indian J Crit Care Med* 2014; 18: 735–745.
15 Anadón A, Martínez-Larrañaga M and Martínez M. **Use and abuse of pyrethrins and synthetic pyrethroids in veterinary medicine.** *Vet J* 2009; 182: 7–20.
16 Bradberry SM, Cage SA, Proudfoot AT, et al. **Poisoning due to pyrethroids.** *Toxicol Rev* 2005 2005; 24: 93–106.
17 Boland LA and Angles JM. **Feline permethrin toxicity: retrospective study of 42 cases.** *J Feline Med Surg* 2010; 12: 61–71.
18 Richardson JA. **Permethrin spot-on toxicoses in cats.** *J Vet Emerg Crit Care* 2000; 10: 103–106.
19 Eddleston M, Singh S and Buckley N. **Organophosphorus poisoning (acute).** *BMJ Clin Evid* 2007; 2007: 2102.
20 Worek F, Thiermann H and Wille T. **Organophosphorus compounds and oximes: a critical review.** *Arch Toxicol* 2020; 94: 2275–2292.
21 Gupta RC. **Insecticides derived from plants (toxicity).** MSD veterinary manual. https://www.msdvetmanual.com/toxicology/insecticide-and-acaricide-organic-toxicity/insecticides-derived-from-plants-toxicity (2014, accessed July 26, 2021).
22 Plumlee K. **Insecticides and molluscicides.** In: Plumlee K (ed). Clinical veterinary toxicology. St Louis, MO: Mosby, 2004, pp 177–192.
23 Moffatt A, Mohammed F, Eddleston M, et al. **Hypothermia and fever after organophosphorus poisoning in humans–a prospective case series.** *J Med Toxicol* 2010; 6: 379.
24 Gordon CJ, Grantham TA and Yang Y. **Hypothermia and delayed fever in the male and female rat exposed to chlorpyrifos.** *Toxicology* 1997; 118: 149–158.
25 Gfeller R and Messonnier S. **Handbook of small animal toxicology and poisonings.** 2nd ed. St Louis, MO: Mosby, 2004.
26 Cantalamessa F. **Acute toxicity of two pyrethroids, permethrin, and cypermethrin in neonatal and adult rats.** *Arch Toxicol* 1993; 67: 510–513.
27 Zhang J, Liu L, Ren L, et al. **The single and joint toxicity effects of chlorpyrifos and beta-cypermethrin in zebrafish (*Danio rerio*) early life stages.** *J Hazard Mater* 2017; 334: 121–131.
28 Eyer P. **The role of oximes in the management of organophosphorus pesticide poisoning.** *Toxicol Rev* 2003; 22: 165–190.
29 Wilson IB and Ginsburg S. **A powerful reactivator of alkylphosphate-inhibited acetylcholinesterase.** *Biochim Biophys Acta* 1955; 18: 168–170.
30 Childs AF, Davies DR, Green AL, et al. **The reactivation by oximes and hydroxamic acids of cholinesterase inhibited by organo-phosphorus compounds.** *Br J Pharmacol Chemother* 1955; 10: 462–465.
31 Jaggy A and Oliver JE. **Chlorpyrifos toxicosis in two cats.** *J Vet Intern Med* 1990; 4: 135–139.
32 Luiz JA and Heseltine J. **Five common toxins ingested by dogs and cats.** *Compend Contin Educ Vet* 2008; 30: 578–587.
33 Diamant Z, Mantzouranis E and Bjermer L. **Montelukast in the treatment of asthma and beyond.** *Expert Rev Clin Immunol* 2009; 5: 639–658.
34 Sibila O, Luna CM, Agustí C, et al. **Effects of glucocorticoids in ventilated piglets with severe pneumonia.** *Eur Respir J* 2008; 32: 1037–1046.
35 Saqib M, Abbas G and Mughal MN. **Successful management of ivermectin induced blindness in an African lion (*Panthera leo*) by intravenous administration of a lipid emulsion.** *BMC Vet Res* 2015; 11: 1–7.
36 Padrid P. **Feline asthma: diagnosis and treatment.** *Vet Clin North Am Small Anim Pract* 2000; 30: 1279–1293.
37 Kirschvink N, Leemans J, Delvaux F, et al. **Bronchodilators in bronchoscopy-induced airflow limitation in allergen-sensitized cats.** *J Vet Intern Med* 2005; 19: 161–167.