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SHORT CONTRIBUTION

Flea (*Ctenocephalides felis*) control efficacy of topical indoxacarb on dogs subsequently bathed with a chlorhexidine–ketoconazole shampoo

RD Armstrong,[a*] JE Liebenberg,[b] K Heaney[a] and F Guerino[a]

Objective An evaluation of the effect of chlorhexidine/ketoconazole shampoo baths on the flea control efficacy of indoxacarb applied topically to dogs.

Methods and Results We randomly allocated 18 healthy mixed-breed dogs to 3 groups: shampoo only; indoxacarb treated and medicated shampoo; and indoxacarb treated but not shampooed. Indoxacarb was administered on day 0 and dogs were shampooed on days 9 and 23. Dogs were infested with 100 adult *Ctenocephalides felis* initially 2 days before treatment and then weekly from days 7 to 28. Fleas were removed and counted 48 h post-infestation.

Conclusion Medicated shampoo use did not significantly reduce indoxacarb efficacy against *C. felis*.

Keywords chlorhexidine; dogs; fleas; indoxacarb; ketoconazole; shampoo

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Flea infestations pose serious health problems to dogs and effective year-round control of fleas is a challenge for many dog owners. Topical application of indoxacarb has been shown to kill adult fleas, flea larvae, inhibit flea egg production and to significantly reduce flea infestation on pets and in households, and to provide effective flea control throughout the 1-month retreatment interval.[1,2] Dogs that are treated for flea infestation may also be bathed with a medicated shampoo, with a potential, although unknown, effect on topical flea treatment efficacy. This study was designed to evaluate the effects of using two monthly antibacterial shampoo baths on the persistent flea control efficacy of indoxacarb (Activyl®, MSD Animal Health, Madison, NJ, USA) applied topically at the label recommended dose.

Materials and methods

This was a parallel-group, randomised, single-centre, blinded, controlled efficacy study. Animals were not treated by an individual involved in performing post-treatment assessments and observations, and groups were coded to blind investigators performing the post-treatment observations and assessments. The 18 healthy mixed-breed research-colony dogs, >6 months old and weighing between 8 and 22 kg were ranked within sex in descending order of individual pre-treatment flea counts. The dogs were blocked into groups of three and then one dog from each block was randomly allocated into one of three groups: negative control – untreated with indoxacarb and shampooed on days 9 and 23; indoxacarb treated and shampooed on days 9 and 23; indoxacarb treated and not shampooed. Indoxacarb treatment was applied once topically at the label recommended dose on day 0 of the study to dogs in the treated groups following the recommended application procedure. All dogs in the shampooed groups were treated with a ketoconazole- and chlorhexidine-containing shampoo (KetoChlor®, Virbac Animal Health, Fort Worth, TX, USA). After flea counts were completed, dogs were soaked with warm tap water then the shampoo was applied according to the product directions. The bottle was shaken well then inverted to apply shampoo in a thin line from the base of the neck to the base of the tail. The shampoo was massaged into the wet hair coat to form lather and then allowed to remain on the hair coat for a minimum of 5 min before rinsing off with clean water. Dogs were blow-dried after bathing. Shampooing was done by a non-blinded person because the negative control group was shampooed before the indoxacarb-treated group. All dogs were observed hourly for 4 h after treatment and then daily throughout the study for general health and clinical signs of adverse events.

Dogs were initially infested with 100 adult fleas (*Ctenocephalides felis*) 2 days before indoxacarb treatment and then weekly from days 7 to 28 following treatment. Fleas were removed and counted 48 h post-infestation, except for the initial infestation where the flea count was 96 h post infestation. Flea counts were conducted by using several strokes of a fine-toothed comb in seven distinct locations on each the animal, each time moving in the same direction following the hair coat. Combing strokes overlapped so that no area of fur was missed and the combing procedure was repeated until no live fleas were found. The primary outcome measurement was the number of live fleas counted in the control and two treated groups on each assessment day.

Flea control efficacy was calculated for each treatment group at each assessment day according to the formula:

$$\% \text{ Efficacy} = 100 \times (\text{Mc} - \text{Mt})/\text{Mc}$$

where Mc is the geometric mean live flea count on the negative control group and Mt is arithmetic or geometric mean of live fleas on the treated group.

*Corresponding author.
[a]MSD Animal Health, Madison, New Jersey, USA; robert.armstrong@merck.com
[b]ClinVet International, Bloemfontein Republic of South Africa

Table 1. Flea control efficacy and mean flea counts (in parentheses) in dogs treated with indoxacarb, medicated shampoo or both

	Day post-treatment				
Treatment	2	9	16	23	30
Shampoo (negative control)	(52.5)	(65.2)	(68.2)	(69.8)	(68.9)
Indoxacarb	100% (0)	100% (0)	100% (0)	100% (0)	99.8% (0.1)
Indoxacarb + shampoo	100% (0)	100% (0)	100% (0)	99.1% (0.6)	95% (3.4)

Statistical analysis

Groups were compared using an ANOVA (Proc GLM procedure, SAS Version 9.3 TS Level 1 M2; SAS, Cary, NC, USA) with a treatment effect on untransformed flea data. In addition, groups were compared using an ANOVA (Proc GLM procedure in SAS) with a treatment effect after a logarithmic transformation on flea (count + 1) data. The individual dog was the experimental unit for statistical calculations with significance declared at $P \leq 0.05$ (two-sided test).

Results

Mean flea counts in the untreated control group ranged from 52.5 to 68.9 on each assessment day, indicating a consistently vigorous flea challenge. Both indoxacarb-treated groups had significantly lower ($P < 0.05$) flea counts as compared with the untreated control group on every post-treatment assessment day. Mean flea counts did not differ significantly ($P > 0.05$) between shampooed and non-shampooed treatment groups. Indoxacarb treatment was highly effective (>95%) against fleas throughout the study whether the dogs were shampooed or not (Table 1).

Discussion

Shampooing of dogs with ketoconazole–chlorhexidine shampoo every 2 weeks did not significantly reduce topical indoxacarb efficacy against *C. felis* during the month following treatment at the label recommended dose. Mean flea counts in both groups were significantly lower than in the shampoo-only group and the efficacy of indoxacarb treatment was consistently above 95% in both the shampooed and non-shampooed groups. The results of this study demonstrate that dogs being bathed with a medicated shampoo twice monthly can also receive effective flea control treatment from topical indoxacarb administration. Flea control efficacy of topical indoxacarb has not been evaluated in dogs shampooed more often than twice monthly. This study was conducted using dogs that did not exhibit flea saliva hypersensitivity, so the effect of indoxacarb treatment followed by medicated shampooing on clinical signs of hypersensitivity was not evaluated.

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