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1 **Long-term management of horses with atopic dermatitis in**  
2 **the South East of England: owners' perceptions**

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24 Salzburg, Austria, 2014.

30 **Abstract**

31 **Background** – Allergic pruritus and urticaria in the horse are challenging for  
32 veterinarians and owners, and little is known about their long-term management.

33 **Objectives** – To summarise intradermal allergen test results (IDT), and to assess  
34 owners' perceptions of skin disease and of effects of medical treatment and  
35 management changes in their atopic horses over time.

36 **Animals** – Eighty-two horses with atopic dermatitis in the xxx referred for IDT  
37 between 2006 and 2011.

38 **Methods** – IDT results were retrospectively reviewed. Owners completed telephone  
39 questionnaires on skin changes, medication, effect of allergen-specific  
40 immunotherapy (ASIT) and management.

41 **Results-** Sixty-one owners (74.4%) could be contacted, an average of 5.9 years  
42 (range 28-88 months) after IDT; of those, three could not be enrolled. Of the 58  
43 remaining horses, eleven (19%) were deceased at time of owner interview, including  
44 four (6.9%) euthanised due to uncontrollable skin disease. The remaining 47 owners  
45 reported that signs of skin disease had not been seen for at least two years in 18  
46 horses (38.3%), including two that only flared with known triggers. Twenty-nine  
47 horses (61.7%) still required medication to control skin disease although 25 (53.2%)  
48 required less since referral. Owners reported benefit from ASIT in 9/14 horses  
49 (64.3%), from glucocorticoids in 33/35 (94.3%) and from antihistamines in 17/28  
50 (60.7%). Specific management changes were implemented for 22 horses and  
51 reported as beneficial in 9/22 (40.9%).

52 **Conclusions-** Equine atopic dermatitis may not always be chronic but severe cases  
53 appear difficult to control. IDT helps to formulate ASIT and can guide management  
54 changes.

## 55 Introduction

56 The management of pruritus and urticaria due to allergic skin disease in the horse is  
57 challenging for veterinary surgeons and owners, and little is known about the long-  
58 term treatment requirements and progression of disease over time.

59 In the horse, atopic dermatitis, as a hypersensitivity reaction to environmental  
60 allergens and food, presents with pruritus or urticaria or both.<sup>1-8</sup> It is typically  
61 described as a lifelong condition requiring ongoing treatment interventions, but signs  
62 may be seasonal or perennial, depending on the causal allergens.<sup>9</sup> Allergens  
63 commonly implicated in many reports include house dust and storage mites, insects,  
64 pollens and epithelia.<sup>6</sup> As for other veterinary species, the diagnosis of equine atopic  
65 dermatitis is a clinical diagnosis based on compatible history, clinical signs and  
66 exclusion of other differential diagnoses such as ectoparasite infestations, *Culicoides*  
67 hypersensitivity and other insect bite hypersensitivities (IBH), and if possible adverse  
68 food reactions.

69 Management strategies include allergen avoidance, topical therapy, and systemic  
70 medications such as antihistamines, glucocorticoids and tricyclic antidepressants.<sup>9</sup>  
71 Dust and moulds can be found in high concentrations in various feeds and bedding  
72 materials<sup>10</sup> and implementation of allergen reduction measures has been shown to  
73 be beneficial in some equine patients with recurrent airway disease<sup>11,12</sup> and in 18 of  
74 19 horses with non-summer seasonal and perennial pruritus with or without  
75 urticaria.<sup>13</sup> Many topical therapies are likely used but there is little published evidence  
76 regarding their use or efficacy. Hydrocortisone aceponate spray (Cortavance, Virbac  
77 Limited, Bury St Edmunds, UK) has been found to be useful anecdotally, did not  
78 seem to result in detectable levels of drug in the blood<sup>14</sup> and may only have a weak  
79 skin-thinning effect compared to other glucocorticoids.<sup>15</sup> There are few data  
80 regarding the efficacy of antihistamines in the management of equine allergic skin  
81 disease. Antihistamines used in horses include hydroxyzine and diphenhydramine,  
82 with anecdotal reports of greater benefit in urticaria than pruritus;<sup>9</sup> cetirizine was  
83 shown to be ineffective in the management of IBH.<sup>16</sup> Systemic glucocorticoids are  
84 often required in horses with atopic dermatitis to control pruritus and limit self-trauma.  
85 Injectable or oral dexamethasone and oral prednisolone are the most commonly  
86 recommended, with long-term therapy aiming at lowest necessary doses given on  
87 alternate days.<sup>9</sup>

88 For allergen-specific immunotherapy (ASIT), allergen-specific IgE can be detected by  
89 intradermal testing (IDT) and serological methods.<sup>3,7,17-21</sup> However, results from IDT,  
90 considered to be the gold standard test, and from serological tests correlated poorly  
91 or not at all in two equine studies.<sup>17,20</sup> Positive IDT reactions may occur in normal  
92 horses, but atopic horses show more numerous and stronger positive reactions.<sup>3,22</sup> A  
93 few studies have evaluated the efficacy of ASIT in equine atopic dermatitis. Most  
94 authors report a 60-71% good to excellent response to ASIT based on the results of  
95 intradermal testing,<sup>1,4,8,23</sup> but higher response rates have also been described. In one  
96 study, 13 of 15 horses with urticaria showed an excellent response to immunotherapy  
97 after one year.<sup>24</sup> In a placebo-controlled study of 28 horses with insect and  
98 environmental hypersensitivities, 64% of the horses treated with ASIT showed a 50%  
99 or greater improvement compared to 23% with placebo,<sup>25</sup> but more recently an  
100 overall response rate of 84%, as perceived by the owners, was reported in a large  
101 retrospective study.<sup>8</sup> However, of those where glucocorticoids could be discontinued,

102 59% were well controlled with ASIT as the sole treatment and 9% of the partial  
103 responders needed doxepin in addition to ASIT. In 44% of cases, ASIT was  
104 discontinued due to resolution of clinical signs, with two thirds of these reporting no  
105 recurrence of disease, but recurrence of clinical signs occurred within 1-12 years of  
106 stopping ASIT in the remaining one third.

107 The aims of this study were to investigate the progression of atopic dermatitis in  
108 horses after IDT and to summarise their IDT results. Owners' perceptions and reports  
109 on their horses' skin disease, on medical treatment utilised and on effects of  
110 management changes over time were investigated through telephone questionnaires.

## 111 **Methods**

112 The study had been approved by the Royal Veterinary College Ethics and Welfare  
113 committee (R349).

### 114 ***Study population***

115 Horses with suspected atopic dermatitis which had been referred for intradermal  
116 testing to one of two dermatology referral centres in the South East of England  
117 between 2006 and 2011 were enrolled. Patients had been diagnosed initially with  
118 allergic skin disease by their referring veterinary surgeon. At referral, allergic  
119 dermatitis was confirmed clinically based on a history and presenting signs of pruritus  
120 and/or urticaria after ectoparasite infestations and microbial infections had been ruled  
121 out. Dermatological examination was performed combined with microscopic  
122 examination of skin scrapings, coat brushings and/or with anti-ectoparasite therapy,  
123 cytological examination of lesions, and fungal or bacterial culture or antimicrobial  
124 therapy when indicated. Insect-bite hypersensitivities were ruled out by confirming  
125 non-summer seasonal or perennial disease from the medical records. Food  
126 hypersensitivity was discussed with every owner and elimination diet trials  
127 recommended but IDT was performed irrespectively, based on suspected atopic  
128 dermatitis.

129 Information on signalment (age, sex, breed or type), cutaneous signs relevant for  
130 referral for IDT (pruritus, urticaria, both, seasonality), previous therapy including  
131 response (glucocorticoids, antihistamines) and elimination diet trials was collected  
132 from electronic or paper medical histories as far as available.

### 133 ***Intradermal testing***

134 All horses were tested using procedures as previously described<sup>6</sup> against allergens  
135 considered relevant for allergic skin disease in Europe such as environmental mites,  
136 epithelia including feathers, and pollens (grasses, weeds and flowers, trees). In  
137 addition, allergen solutions of insects, fungi, grain crop pollens, house dust and grain  
138 mill dust and smut were included when available. Allergen test kits varied minimally  
139 in their composition over the six-year duration of the study due to availability of  
140 allergen solutions and between referral centres. Allergens used were recorded for  
141 each horse from the medical records. Allergen solutions had been sourced over time  
142 from one of two manufacturers (Greer Laboratories, Lenoir, North Carolina, U.S.A. or  
143 ArtuVet, Lelystad, Netherlands) with concentrations and dilutions available in the  
144 supplementary table (Supplementary table S1).

145 Reactions were considered positive if the diameter of the wheal was greater than the  
146 mean of the positive and negative controls measured at 30 minutes. Wheal sizes

147 were assessed at 30 minutes and 2-4 hours (considered immediate and late-phase  
148 IgE-mediated reactions). Additional observations were made at 12-24 hours to  
149 assess delayed reactions. ASIT was offered for all horses showing positive reactions  
150 to allergens suitable for inclusion (indoor allergens, epithelia, pollens) but not for  
151 horses only showing reactions to fungi and insects.

152 Management changes were recommended for all horses, depending on groups of  
153 allergens implicated by IDT (indoor allergens and dusts, epithelia, pollens, insects),  
154 to reduce exposure (Supplementary tables S1, S2). At Veterinary Dermatology  
155 Referrals, specific changes recommended included use of rubber matting in stables  
156 with minimal or no loose bedding, feeding of vacuum-packed, wilted grass products  
157 to replace hay and feeding of pelleted concentrate foods stored for only short periods  
158 in original packaging, frequent rug laundering and quarterly pressure cleaning of  
159 stables, removal of bird nests and use of selective weed killer, if relevant.

### 160 ***Owner recruitment***

161 Owners were telephoned between September 2013 and March 2014 and asked for  
162 their participation in a telephone questionnaire study on their horse's skin disease,  
163 medication, effect of allergen-specific immunotherapy (ASIT) and implementation of  
164 management changes since IDT. Owners were called from known telephone  
165 numbers (number not withheld by the caller) by the same investigator (DH) up to  
166 three times if there was no reply and no answering machine and up to two messages  
167 were left on answering machines before the case was excluded due to failed contact.  
168 Owners of horses who were known to be dead since IDT were not contacted. For  
169 horses reported deceased by their owner during the telephone contact, the cause of  
170 death was recorded, but they were not asked to complete the questionnaire.

### 171 ***Questionnaires***

172 Questions were divided into three broad topics. Firstly, owners were asked to assess  
173 their horse's skin problem at the time of the telephone questionnaire and at the time  
174 of IDT. They were asked to describe skin signs as pruritic, urticarial, both or other,  
175 whether changes in type or distribution of problems had been observed since IDT  
176 and whether other skin problems had been diagnosed by their veterinarian since IDT.  
177 Owners were asked to assess the severity of itching and/or urticaria on analogue  
178 scales of 0-10 (0 for normal/never and 10 for severe/present all the time).

179 Secondly, questions on medication and other treatments, specifically glucocorticoids,  
180 antihistamines, ASIT, antidepressants, nutritional supplements and washes, were  
181 asked. Sub-questions for each treatment were whether the horse had ever received  
182 it, was currently receiving it and how frequently (seasonally, throughout the year),  
183 whether the treatment was tolerated and whether the owner thought the treatment  
184 had improved skin problems.

185 Thirdly, owners were asked about their horses' current management and on  
186 implementation of management changes recommended at time of IDT  
187 (Supplementary information S2), including whether they had changed barn or  
188 paddock, where the horse spent most of its time, type of bedding used, rugging (type,  
189 time spent wearing rugs and frequency of laundering), clipping (frequency and  
190 extent) and ectoparasite and fly control measures. For each question, owners were  
191 asked whether they considered those changes beneficial to their horse's skin  
192 problem.

193 An option to answer 'unsure' or 'unknown' was included where appropriate. The  
194 questionnaire was trialled in six pilot calls and adjusted based on feedback. Each  
195 questionnaire was estimated to take 20 minutes including a short introduction  
196 outlining the study purpose, confidentiality provisions and the option to decline. At the  
197 end of the questionnaires, owners were offered contact details of investigators.

## 198 ***Data analysis***

199 Microsoft Excel (Microsoft, version 15.38, 2017) was used for data collection and  
200 analysis.

## 201 **Results**

### 202 ***Enrolled horses and owners***

203 Eighty-two horses had undergone IDT for suspected atopic dermatitis during the  
204 study period, 15 from the RVC, 67 from Veterinary Dermatology Referrals (original  
205 starting population). Ages at time of IDT ranged between one and 25 years (mean  
206 9.9 years). There were 40 mares, 40 geldings, one stallion and one horse of  
207 unknown sex. Breeds or types varied, with 23 recorded as cob or pony, mostly Welsh  
208 cob, 21 as thoroughbred including thoroughbred crosses, 7 Irish sports horses, 8  
209 warmbloods and 23 other types. Pruritus was the presenting complaint in 36 horses  
210 (43.9%), urticaria in 34 horses (41.5%) and 12 (14.6%) presented with both. In most  
211 horses (67/82, 81.7%), lesions were reported as generalised. Of the 15 horses with  
212 localised lesions, eight showed signs only on the trunk, six on the head and one on  
213 the legs. All animals suffered from skin disease during the winter months but 19  
214 (23.2%) showed seasonal flares during spring or summer.

215 Owners of 61 (74.4%) horses were contacted by telephone. For the remainder, either  
216 contact details were not available or attempts to make contact as described above  
217 had failed. One owner declined participation and two could not provide answers as  
218 the horses had been sold soon after IDT. The time between IDT and telephone  
219 questionnaire for the 58 horses ranged between 28 and 88 months (mean 71 months  
220 or 5.9 years).

221 At the time of telephone contact, eleven of the 58 (19.0%) horses were reported  
222 dead, including four (6.9%) euthanised due to uncontrollable skin disease (three with  
223 pruritus, one with urticaria). One had died a spontaneous death of unconfirmed  
224 cause, five had been euthanised for known diagnoses (brain tumour, lymphoma,  
225 colic, lameness (investigated and confirmed as non-laminitic), kissing spines) and  
226 one horse for old age-related reasons.

### 227 ***Intradermal tests***

228 The average number of allergens each horse was tested against was 54.2 (standard  
229 deviation (SD) 10) and the average number of positive reactions per horse was 13  
230 (SD 8.1). Two horses had shown no positive wheal and flare reactions to any of the  
231 allergens despite strong histamine injection reaction. The allergens tested in at least  
232 50 horses and which resulted in positive reactions in at least 25% of horses are listed  
233 in Table 1. Most (1247, 96.1%) of the 1297 positive reactions recorded in total  
234 occurred at the early readings considered compatible with immediate and late-phase  
235 hypersensitivity reactions. At the later time points, compatible with delayed reactions,  
236 122 (9.4%) positive reactions were recorded, 72 at sites of earlier readings, 50

237 (3.9%), distributed over all allergen groups, that had not been recorded at earlier time  
238 points.

### 239 ***Skin disease - owner assessment***

240 Of the 47 horses for which follow up information was available, (14 RVC, 33  
241 Veterinary Dermatology Referrals), owners considered their horse's skin disease at  
242 the time of telephone contact as resolved without medication in 18 cases (38.3%), as  
243 improved with treatment in 25 cases (53.2%) and as unchanged or worse despite  
244 medication in four cases (8.5%). Six of the 18 horses that no longer had skin  
245 problems at the time of telephone contact had been lesion-free since the time of IDT  
246 while another ten had not had skin disease for at least the previous two years. Four  
247 of these horses had had management changes implemented after IDT (see below)  
248 and two further horses only showed skin disease after known triggers (cereal-based  
249 food or treats, shavings). The remaining 29 horses were still receiving either  
250 glucocorticoids or antihistamines throughout the year or at least three times a year  
251 during flares. Six owners reported that their horses had been diagnosed with pituitary  
252 pars intermedia dysfunction since IDT and that new, different skin lesions had  
253 developed (crusting papules, urticaria in previously pruritic horses and vice versa).

254 Owners' assessment of pruritus, irrespective of medication or management used, on  
255 a 1-10 scale gave a median of 9 (range 3-10) at the time of IDT and of 1.5 (range 0-  
256 6) at the time of telephone contact. Median scores for the frequency of urticaria flares  
257 were 8 (range 2-10) at the time of IDT and 2 (range 0-7) at telephone contact.

### 258 ***Medication and immunotherapy - owner assessment***

259 Systemic glucocorticoids had been used in 35/47 horses (74.5%) to control skin  
260 disease since IDT, including seven still receiving treatment at the time of telephone  
261 contact. Good response to glucocorticoid therapy was reported in 94.3% of horses  
262 (33/35) after IDT. Adverse effects of glucocorticoid therapy were reported by owners  
263 in 7/35 (20%) including laminitis in one heavy draft horse (which according to the  
264 medical records was recorded as a foot abscess and without further mention of  
265 laminitis in the medical records during the subsequent two years), two horses with  
266 flares of pre-existing laminitis, and one each with drowsiness, weight gain, or  
267 behaviour changes.

268 Twelve owners reported using topical glucocorticoid preparations (hydrocortisone  
269 aceponate spray (Cortavance): n=6, fusidic acid/bethamethasone combination  
270 (Fuciderm, now Isaderm, Dechra Veterinary Products, Shrewsbury, UK): n=4,  
271 unknown human eczema cream: n=1), and all but one owner observed a beneficial  
272 effect when the product was applied at least daily.

273 Twenty-eight horses (59.6%) had received antihistamines (type unknown) at some  
274 stage since IDT to control their cutaneous signs and good response was reported in  
275 17 of these 28 horses (60.7%). Eight horses were still maintained on antihistamines  
276 as the sole medication at the time of telephone contact. Drowsiness was the only  
277 adverse effect reported in three horses.

278 ASIT had been ordered for 27 horses (57.5%) but its use was only reported by  
279 owners of 14/47 horses (29.8%) with nine owners of these 14 horses (64.3%)  
280 reporting a beneficial effect including eight reporting a 75-100% improvement. In only  
281 three horses was immunotherapy continued beyond the first prescribed



282 immunotherapy vial of at least nine months; in one of them antihistamines were given  
283 concurrently throughout. A further two horses were restarted on ASIT when clinical  
284 signs relapsed after immunotherapy had been discontinued following completion of  
285 injections with the initial vial. Restarting ASIT was perceived as helpful again in both  
286 cases. The remaining nine horses no longer received ASIT at the time of telephone  
287 contact. Six owners stated they thought they had finished the treatment after the  
288 initial vial (typically nine months), including three in which treatment was thought to  
289 have had no effect. Another two owners stopped ASIT before completing the initial  
290 vial due to lack of effect and one owner stated expense as the reason for stopping.  
291 Twelve owners reported administering the maintenance injections themselves  
292 (injections by the veterinarian as default administration type). No systemic adverse  
293 effects were reported, localised injection site reactions were seen by owners in 6/14  
294 horses (42.9%) on individual occasions, none persisted or required veterinary  
295 attention.

296 Fly prevention was used in 22 (46.8%) horses regularly during the spring and  
297 summer. In total, 38 horses (82.1%) were receiving or had received other agents with  
298 the aim to control their skin disease since IDT. These included systemic antimicrobial  
299 therapy (n=1), shampoo therapy used at least weekly (n=18) with seven owners  
300 using chlorhexidine-based products, and 11 using products of unknown composition  
301 but with claims of alleviating allergic skin signs (and 12/38 owners (31.6%) perceiving  
302 a beneficial effect). Skin-related, non-prescription food supplements (various,  
303 unknown) had been given by 30 owners (65.2%) without adverse effects reported.

#### 304 ***Management changes***

305 Twenty-two owners (46.8%) had implemented recommended changes to stables,  
306 bedding, feed or rugs, and nine of those (40.9%) reported a perceived subsequent  
307 improvement in their horse's skin disease, including four horses for which no  
308 additional medication had been needed since. Skin disease was reported to have  
309 improved in three horses after they had been relocated to a different yard, in another  
310 three following dietary changes (treats removed from diet), one horse improved when  
311 shavings were removed from its stable, and in the remaining two horses multiple  
312 changes had been made concurrently.

313 Almost all horses (45, 97.8%) were reported to wear rugs at some time during the  
314 year with 34 wearing the rug all day during the cooler months. Thirty-five of 47  
315 (74.5%) horses were regularly clipped.

#### 316 **Discussion**

317 This is the first study to report on the management of atopic horses over time, and a  
318 reporting interval greater than two years was available for all. While information  
319 derived from owner interviews was collected retrospectively and is inevitably  
320 associated with a high degree of subjectivity, it still provides a realistic insight into the  
321 burden of allergic skin disease on horses and their owners, and may help to stimulate  
322 future research and improvements in clinical management. In addition, questionnaire  
323 data were collected during the colder months of the year in the UK which may have  
324 biased reporting. However, in the UK, clinical signs and onset of atopic dermatitis in  
325 the horse have been reported throughout the year,<sup>2</sup> and including onset and  
326 exacerbation in autumn, suggesting that the impact of seasonality may be less  
327 relevant.

328 The data on clinical signs and IDT results collected from medical records were  
329 broadly in line with similar previously published work,<sup>8,16</sup> including one study in the  
330 South of England.<sup>6</sup> Positive reactions to house dust mites, storage mites and insects  
331 predominated, likely reflecting exposure to such allergens through a largely stabled  
332 lifestyle and management, including frequent use of house dust mite-harboured  
333 rugs,<sup>26</sup> and exposure to biting insects when at pasture.

334 Results from this study on disease outcome at least two years after referral were  
335 highly surprising, firstly with regard to the substantial proportion of horses for which  
336 owners reported that skin disease had resolved and treatment had not been required  
337 for at least two years and secondly, with regard to the number of deceased horses.

338 These findings challenge the widely accepted anecdotal belief that atopic dermatitis  
339 in the horse is chronic and requires lifelong treatment.<sup>5,7,9</sup> Unfortunately, our data do  
340 not allow conclusions to be made on duration of disease before resolution in these  
341 horses, and so predictions cannot be made on how long signs might persist in horses  
342 with potentially transient presentations. However, the results suggest that, at least in  
343 some horses, the prognosis for atopic dermatitis can be excellent and they further  
344 corroborate previous advice that it is best to perform allergen tests if the disease is  
345 recurrent or persistent for more than six to eight weeks.<sup>27</sup> Whether resolution of skin  
346 signs without medication was spontaneous or due to management changes, which  
347 were perceived to help by almost half of the owners, remains unknown. The role of  
348 allergen load rather than exposure is less clear for atopic dermatitis compared to  
349 respiratory lower airway disease in the horse.<sup>28</sup> However, in the absence of such  
350 data, the benign nature of recommendations on management changes warrant  
351 inclusion in the management plan for every atopic horse presented for IDT.

352 In contrast, the finding that 19% of horses were dead at the time of telephone  
353 interview, including 7% (four horses) where owners reported that the animals had  
354 been euthanised due to uncontrollable skin disease, is concerning. While research  
355 on the pathomechanisms and treatment options on allergic diseases has progressed  
356 substantially over the past decades, the social implications of chronic allergic  
357 diseases are only slowly starting to receive attention. Initial results of a survey on  
358 health-related quality of life in atopic dogs and on quality of life in their owners  
359 showed that the disease had a deeply negative impact on both measures but only  
360 1% of owners stated they had contemplated euthanasia.<sup>29</sup> In addition, treatment was  
361 considered a major financial burden by a third of dog owners and 40% stated that  
362 they had to limit other expenses as a consequence. The questionnaire in our study  
363 was not designed to further explore reasons for euthanasia but the results are likely  
364 to reflect some degree of welfare concerns, implications on the use of a horse with  
365 skin disease and the financial burden associated with chronic skin disease. Other  
366 horse-specific factors may also have played a role and need to be investigated  
367 further.

368 Of the 29 horses for which management of skin disease was still required after IDT,  
369 different combinations of antihistamines, glucocorticoids, ASIT and management  
370 changes were reported to achieve acceptable levels of control with tolerable adverse  
371 effects for most patients and owners. Results on drug efficacy need to be interpreted  
372 with care as these were based on owner impressions over time rather than on  
373 veterinary assessment following a defined intervention period. However, the high  
374 frequencies of beneficial effects reported for glucocorticoids (94.3%), mainly as oral

375 prednisolone, and for antihistamines (60.7%) provide some assurance on treatment  
376 effect. To date, despite their wide use, only review articles describe the use of both  
377 medications in the treatment of allergic skin disease in horses and provide some  
378 pharmacokinetic information and dose recommendations.<sup>9,23</sup> Further study is needed  
379 on which therapies or combinations help atopic horses most and if there is a  
380 difference in response to therapies between pruritic and urticarial horses which was  
381 not the focus of this study. Slightly more information is available on the use of  
382 glucocorticoids for non-infectious lower airway disease where inflammation is thought  
383 to contribute to clinical signs.<sup>28</sup> Concerns over glucocorticoid use as a risk factor in  
384 the development of laminitis are widespread, but the scientific basis for this  
385 association is sparse, at least for non-predisposed horses.<sup>30-32</sup> Results from two  
386 recent studies seem to show that such a link may have been overestimated,<sup>33,34</sup> but  
387 due to the critical consequences of laminitis, further research is still needed. In light  
388 of the relatively high number of atopic horses in this study which were euthanised  
389 due to uncontrolled disease, and none due to laminitis caused by glucocorticoid  
390 therapy, concerns over the potential risk of laminitis need to be balanced  
391 against welfare considerations due to uncontrolled atopic dermatitis. In the authors'  
392 opinion, glucocorticoids have an important role to play in the management of atopic  
393 horses, and prednisolone at low doses given on alternate days to horses not  
394 predisposed to laminitis would be a recommended strategy.<sup>9</sup>  
395 The benefit of ASIT reported in 64% of horses in this study was lower than the 84%  
396 owner-reported efficacy from a recent North American study on 41 horses receiving  
397 ASIT,<sup>8</sup> but comparable to those found by Rosenkrantz *et al.* in horses.<sup>25</sup> However,  
398 the low uptake of ASIT following IDT in this study was surprising and disappointing.  
399 Reasons for not starting or at least not pursuing therapy were not explored as these  
400 findings had been unexpected. Measures have been taken since to extend  
401 discussion with owners and strengthen recommendations towards ASIT.

402 While "much folklore still remains in respect of certain equine skin diseases" as  
403 stated in 1970 by the late L.R. Thomsett,<sup>35</sup> the results from this study on long-term  
404 management of allergic horses from an owner perspective indicate that atopic  
405 dermatitis may have a better prognosis than in other companion animals and may not  
406 always be chronic. Still of concern though, the high number of euthanised horses in  
407 this study suggests that severe cases may be difficult to control and that the burden  
408 of chronic skin disease for owners should not be underestimated. Management  
409 changes, following identification of relevant allergens by IDT, in combination with  
410 medication and sometimes ASIT, may help provide effective control of clinical signs.

411 **References**

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507 **Tables**

508 Table 1. Allergens tested in at least 50 of the 82 horses and resulting in positive  
 509 reactions in 25% or more of horses

Allergen	No. of positive reactions / horses tested	% Positive	Kit (Greer Laboratories or Artu Biologicals)
<i>Dermatophagoides farinae</i> (farina mite)	76/85	89.4	Both
<i>Dermatophagoides pteronyssinus</i> (house dust mite)	74/85	87.1	Both
Moth	55/65	84.6	Greer
<i>Aedes communis</i> (mosquito)	45/65	69.2	Greer
<i>Tyrophagus putrescentiae</i> (copra mite)	53/78	68.0	Both
Tabanid (horse fly)	43/65	66.2	Greer
<i>Lepidoglyphus destructor</i> (hay mite)	52/84	61.9	Both
<i>Acarus siro</i> (flour mite)	51/85	60.0	Both
Grain mill dust	39/65	60.0	Greer
<i>Culicoides</i> (midge)	34/64	53.1	Greer
<i>Trifolium pratense</i> (red clover)	43/84	51.2	Both
Grain mill smut	33/65	50.8	Greer
Mixed feathers (chicken, goose, duck)	42/84	50.0	Both
<i>Urtica dioica</i> (stinging nettle)	32/64	50.0	Greer
Cockroach, German	29/65	44.62	Greer
<i>Avena sativa</i> (cultivated oat)	21/55	38.18	Greer
<i>Leucanthemum vulgare</i> (daisy)	31/84	36.90	Both
<i>Rumex crispus</i> (yellow dock)	23/64	35.94	Greer
<i>Solidago virgaurea</i> (golden rod)	30/84	35.71	Both
<i>Taraxacum officinale</i> (common dandelion)	22/62	35.48	Both
Sheep epithelia	22/63	34.92	Greer
<i>Salix viminalis</i> (pussy / black willow)	22/64	34.38	Greer
<i>Aspergillus fumigatus</i>	22/64	34.38	Greer
<i>Artemisia vulgaris</i> (common mugwort)	23/84	27.38	Both
<i>Rhizopus nigricans</i>	14/55	25.45	Greer

510 Note: House dust and black ant also showed reactions in 71.5% and 70%,  
 511 respectively, but were only tested in 14 and in 30 horses, respectively.

512

513 S1: Supplementary table 1: Allergen solutions and dilutions used for intradermal  
 514 testing of horses during the study period

	Allergen	Dilutions Greer from 20.000 PNU stock solutions up to 2008	Dilutions Greer from 20.000 PNU stock solutions from 2008	Dilution Artu
Controls	Histamine phosphate	1:10000 w/v	1:10000 w/v	0.1 mg/ml
	Saline	n/a	n/a	n/a
Indoor allergens and dusts	<i>Dermatophagoides farina</i> (farina mite)	1:10	1:10	100 NU/ml
	<i>D. pteronyssinus</i> (house dust mite)	1:1000 w/v	1:1000 w/v	100 NU/ml
	<i>Acarus siro</i> (flour mite)	1:20	1:20	100 NU/ml
	<i>Tyrophagus putrescentiae</i> (copra mite)	1:20	1:20	100 NU/ml
	<i>Lepidoglyphus destructor</i> (hay mite)	1:20	1:20	100 NU/ml
	<i>Euroglyphus maynai</i>	n/i	n/i	100 NU/ml
	House dust	1:20	n/i	n/i
	Grain mill dust	1:20	1:20	n/i
	Grain mill smut	1:1000 w/v	1:1000 w/v	n/i
Epithelia	Horse dander	n/i	1:20	n/i
	Dog epithelium	n/i		100 µg/ml
	Mouse dander	n/i	1:20	
	Cat dander ( <i>Felis domesticus</i> )	1:20	1:20	100 µg/ml
	Mixed feathers (chicken, goose, duck)	1:20	1:20	
	Duck feathers ( <i>Anas platyrhynca</i> )	n/i	n/i	100 µg/ml
	Goose feathers ( <i>Anas anser</i> )	n/i	n/i	100 µg/ml
	Chicken feathers ( <i>Pullus gallinaceus</i> )	n/i	n/i	100 µg/ml
	Sheep epithelia	1:20	1:20	
	Epithelial mix 1 (guinea pig, dog, cat, hamster, rabbit)	n/i	n/i	100 µg/ml
Grass pollens	Kentucky blue (meadow) grass ( <i>Poa pratensis</i> )	1:20	1:20	1000 NU/m
	Red top (bent grass, <i>Agrotis gigantean</i> )	1:20	1:20	1000 NU/m
	Couch grass	1:20	1:20	n/i
	Orchard grass (cocksfoot, <i>Dactylis glomerata</i> )	1:20	1:20	1000 NU/m
	Sweet vernal ( <i>Anthoxanthum odoratum</i> )	1:20	1:20	1000 NU/m
	Velvet grass (Yorkshire fog, <i>Holcus lanatus</i> )	1:20	1:20	1000 NU/m
	Timothy ( <i>Pheleum pratense</i> )	1:20	1:20	1000 NU/m
	Meadow fescue ( <i>Festuca pratensis</i> )	1:20	1:20	1000 NU/m
	Perennial rye grass ( <i>Lolium perenne</i> )	1:20	1:20	1000 NU/m
	Couch grass	1:20	1:20	n/i
	Brome grass	1:20	n/i	n/i
	<i>Avena sativa</i> (cultivated oat)	n/i	n/i	1000 NU/m
	Bermuda grass ( <i>Cynodon dactylon</i> )	n/i	n/i	1000 NU/m
	Grass pollen mixture (Bermuda, orchard, sweet vernal, Timothy, velvet)	n/i	n/i	1000 NU/m
Weed pollens	Sheep sorrel ( <i>Rumex acetosella</i> )	1:20	1:20	1000 NU/m
	Ragweed ( <i>Ambrosia elatior</i> )	n/i	1:20	1000 NU/m
	Golden rod ( <i>Solidago virgaurea</i> )	n/i	1:20	1000 NU/m
	Yellow dock ( <i>Rumex crispus</i> )	1:20	1:20	n/i
	Common dandelion ( <i>Taraxacum officinale</i> )	1:20	1:20	1000 NU/m
	Red clover ( <i>Trifolium pratense</i> )	1:20	1:20	1000 NU/m
	Common mugwort ( <i>Artemisia vulgaris</i> )	1:20	1:20	1000 NU/m
	Daisy ( <i>Leucanthemum vulgare</i> )	1:20	1:20	1000 NU/m
	Stinging nettle ( <i>Urtica dioica</i> )	1:20	1:20	
English plantain ( <i>Plantago lanceolata</i> )	1:20	1:20	1000 NU/m	

	Lamb's quarter ( <i>Chenopodium album</i> )	1:20	1:20	1000 NU/m
	Weed pollen mixture 1 (mugwort and nettle)	n/i	n/i	1000 NU/m
	Weed pollen mixture 2 (mugwort, nettle, dandelion, plantain)	n/i	n/i	1000 NU/m
Tree pollens	Alder ( <i>Sambucus nigra</i> )	n/i	1:20	1000 NU/m
	American elm	n/i	1:20	n/i
	Red oak	1:20	1:20	n/i
	Black/pussy willow ( <i>Salix viminalis</i> )	n/i	1:20	n/i
	American beech ( <i>Fagus sylvatica</i> )	1:20	1:20	1000 NU/m
	Eastern sycamore ( <i>Plantanus occidentalis</i> )	1:20	1:20	1000 NU/m
	White poplar	1:20	1:20	n/i
	White ash	1:20	1:20	n/i
	American hazelnut ( <i>Corylus avellana</i> )	n/i	1:20	1000 NU/m
	White birch ( <i>Betule pendula</i> )	1:20	1:20	1000 NU/m
	Horse chestnut (Buckeye, <i>Aesculus hippocastanum</i> )	n/i	n/i	1000 NU/m
	Hawthorn ( <i>Crataegus</i> )	n/i	n/i	1000 NU/m
	Linden ( <i>Tilia cordata</i> )	n/i	n/i	1000 NU/m
	Tree pollen mix 1 (birch, alder, hazel)	n/i	n/i	1000 NU/m
	Tree pollen mix 2 (English oak, European beech, American elm)	n/i	n/i	1000 NU/m
Moulds & fungi	<i>Aspergillus fumigatus</i>	1:20	1:20	n/i
	<i>Aureobasidium pullulans</i>	1:20	1:20	n/i
	<i>Alternaria alternata</i>	1:20	1:20	n/i
	<i>Phoma beta</i>	1:20	1:20	n/i
	<i>Penicillium notatum</i>	1:20	1:20	n/i
	<i>Cladosporium herbarium</i>	1:20	1:20	n/i
	<i>Fusarium moniliforme</i>	1:20	1:20	n/i
	<i>Mucor racemosus</i>	1:20	1:20	n/i
	<i>Rhizopus nigricans</i>	1:20	1:20	n/i
	<i>Trichoderma</i> spp.	1:20	1:20	n/i
	<i>Malassezia pachydermatis</i>	1:20	1:20	n/i
	Fungus mixture 1 ( <i>Alternaria alternate</i> , <i>Aspergillus fumigatus</i> , <i>Cladosporium herbarum</i> )	n/i	n/i	100 ng/ml
	Insects	Flea ( <i>Ctenocephalides</i> spp.)	1:1000 w/v	1:10
Cockroach, German		n/i	1:20	n/i
Horse fly ( <i>Tabanus</i> spp.)		1:20	1:20	n/i
Moth		1:40	1:40	n/i
<i>Aedes communis</i> (mosquito)		1:20	1:20	n/i
<i>Culicoides</i> (midge)		1:5	1:5	n/i
<i>Culicoides</i> (midge)		1:10	1:10	n/i
House fly		1:20	n/i	n/i
Black ant		1:20	n/i	n/i

515 n/i: not included. NU: nitrogen unit

516

517



518 Supplementary table 2: Suggestions on management changes provided to horse  
 519 owners to reduce exposure to environmental mites in atopic horses. Owners were  
 520 informed that recommendations were based on anecdote rather than evidence for  
 521 efficacy and that measures should be tailored to each horse depending on practicality  
 522 and intradermal test result

Stable	Foodstuff	Rugs	Other
Replace loose bedding with rubber matting	Storage in clean, sealed containers	Avoid excessive rugging	Maintain horse at pasture for extended periods
Quarterly vacuuming and pressure hosing of stable walls, ceiling, floor	Replace hay with wilted, vacuum-packed grass products	Launder rugs frequently at high temperatures or freeze for 2-3 days after laundry	Use of broad-leaf weed-killer
Reduce exposure to birds and poultry (remove nests before eggs are laid)	Replace loose with cubed concentrate	Add human anti-allergy duvets (in polycotton cover) between skin and rugs to provide a barrier to dust mite allergens	Insect prophylaxis with frequent applications of permethrin-containing products as per data sheet or manufacturer's recommendations

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