Efficacy of ivermectin jetting fluid against strike by some primary and secondary blowflies of sheep

D RUGG*, DR THOMPSON*, PG SCOTT*, LG CRAMER† and RA BARRICK‡

SUMMARY: Merino sheep, which were hand jetted with ivermectin jetting fluid, and untreated sheep were challenged with larval implants of Lucilla cuprina, Lucilia sericata, Calliphora noclva and Chrysomya rufifacies at intervals of about 2 weeks from 6 to 16 weeks after treatment. Both Lucilla species produced strike rates of about 90% in untreated sheep; the respective rates were lower for Chrusomya rufifacies (58%) and C noclva (60%). Strike rates for the treated group were about 17, 11, and 9% for L cuprina, L sericata, and Chr rufifacies, respectively. Only 1 implant site in the treated group was struck by C noclva. Treated sheep had significantly (P < 0.01) longer time to first strike than did untreated ones for each species of fly. L sericata, Chr rufifacies, and C noclva larvae implanted on treated animals had significantly (P < 0.05) longer time to first strike than did L cuprina larvae.

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Introduction

Blowfly strike is one of the most significant causes of wool loss and death of sheep in the Australian sheep industry. While Lucilla cuprina initiates 80 to 90% of all strikes, a number of other calliphorid blowflies contribute significantly to primary and secondary strikes (Arundel and Sutherland 1988).

Avermectins are broad-spectrum compounds with activity against a wide range of nematodes and arthropods (Campbell et al 1983). Avermectins were shown to have larvicidal activity against L cuprina in both in-vitro (Hughes and Levot 1990) and in-vivo (James et al 1980) evaluations. Ivermectin has been found to be a highly effective prophylactic and therapeutic treatment for flystrike in sheep (PG Scott et al, unpublished).

We report investigations of the efficacy of ivermectin against some primary and secondary strike flies, using the larval implant method to compare these species with L cuprina.

Materials and Methods

Merino sheep, 18-months-old, with about 7 months wool growth, were used. All sheep were individually identified with numbered ear tags. During challenges the sheep were held in pens. At other times the sheep were grazed on pasture. The treatment groups were run separately for the duration of the trial.

Sheep were randomly assigned to 3 groups of 20 animals: untreated, untreated 'reserves', and a group treated with ivermectin concentrate diluted with water to 0.03 mg/mL.

The diluted product was applied by hand jetting to ensure that the wool and skin along the full width of the sheep's back was saturated. The poll and breech were treated according to normal jetting procedures. Pump output was calibrated, and the application to each sheep was measured as the time needed to saturate the fleece. Sheep were treated with about 4.8 L per animal.

First instar larvae of the following blowfly species were implanted: Lucrina, a 'Q' (organophosphate-resistant) strain maintained at Merck Sharp and Dohme (MSD), Ingleburn, Lucilia sericata, cultured from adults collected near Bulli, NSW, on May 21, 1990, Calliphora noclva, a pooled culture derived from adults collected at Gingin, WA, and Fowler's Gap Research Station via Broken Hill, NSW, in April 1990, Chrysomya rufifacies, a pooled culture derived from larvae collected from a carcass near Cooma, NSW, on February 28, 1990 and from sheep at MSD, Ingleburn, in April 1990.

Five implant sites were identified on both sides of each sheep.
and the side used for the initial challenge was randomly allocated for each sheep. Subsequent challenges were alternated between sides. Each fly species was randomly assigned to one of the 5 possible implant sites on each sheep before challenge.

Treated and untreated sheep were scheduled for challenge at intervals of 2 weeks starting 6 weeks after treatment. If any species failed to produce sufficient larvae for implants on all sheep, this challenge was conducted in the following week. L cuprina were implanted at each challenge as a reference species. If a control sheep became unsuitable for challenge (because of strike wounding) it was replaced by a 'reserve' animal in subsequent challenges.

The implant procedure was as follows: The wool in the selected area was parted, the skin lightly abraded, and the wool in the vicinity moistened with tepid water. About 50 first instar larvae were applied to a 4 cm cotton dental roll moistened with tepid water. This was placed against the abraded skin and a clip was placed on the wool to hold the implant in place.

Sheep were inspected 24 h after the implant was applied. Implants were recorded as 'strike' (larvae feeding on the skin and growing) or 'no strike' (larvae dead, or alive but failing to actively feed and grow). Strikes were then cleaned and treated with boric acid powder.

TABLE 1

<table>
<thead>
<tr>
<th>Blwfly species</th>
<th>Week of challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 8 9 10 12 13 14 15 16</td>
</tr>
<tr>
<td>Un-treated</td>
<td></td>
</tr>
<tr>
<td>Lucilla cuprina</td>
<td>15 19 12 20 18 18 19 17</td>
</tr>
<tr>
<td>Lucilla sericata</td>
<td>18 20 17 19 19 17 17 17</td>
</tr>
<tr>
<td>Chrysomya rufifacies</td>
<td>6 12 10 17 8 13 13 13 13</td>
</tr>
<tr>
<td>Calliphora nicina</td>
<td>13 13 17 13 8 8 8 8 8</td>
</tr>
<tr>
<td>Treated</td>
<td></td>
</tr>
<tr>
<td>Lucilla cuprina</td>
<td>7 6 3 0 2 0 4 6 2</td>
</tr>
<tr>
<td>Lucilla sericata</td>
<td>3 1 2 0 0 0 4 3 3</td>
</tr>
<tr>
<td>Chrysomya rufifacies</td>
<td>2 0 2 1 1 1 1 1 1 5</td>
</tr>
<tr>
<td>Calliphora nicina</td>
<td>0 0 0 0 0 0 0 0 0 1</td>
</tr>
</tbody>
</table>

TABLE 2

### Mean strike rate (% of implant sites struck) and mean relative strike rate (% strikes in treated group/untreated strikes) for untreated sheep and sheep treated by hand jetting with ivermectin, challenged with implants of larvae of four blowfly species from 6 to 16 weeks after treatment.

<table>
<thead>
<tr>
<th>Blwfly species</th>
<th>Number of implants/ treatment</th>
<th>Un-treated Mean strike rate (%)</th>
<th>Treated Mean strike rate (%)</th>
<th>Mean relative strike rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lucilla cuprina</td>
<td>180</td>
<td>87.8</td>
<td>16.7</td>
<td>19.0</td>
</tr>
<tr>
<td>Lucilla sericata</td>
<td>120</td>
<td>91.7</td>
<td>10.8</td>
<td>11.8</td>
</tr>
<tr>
<td>Chrysomya rufifacies</td>
<td>120</td>
<td>55.0</td>
<td>9.2</td>
<td>16.7</td>
</tr>
<tr>
<td>Calliphora nicina</td>
<td>120</td>
<td>60.0</td>
<td>0.8</td>
<td>1.4</td>
</tr>
</tbody>
</table>

TABLE 3

The median time in weeks to first strike by fly species on sheep treated with ivermectin jetting fluid and untreated sheep.

<table>
<thead>
<tr>
<th>Blwfly species</th>
<th>Treatment group</th>
<th>Comparison of untreated vs treated sheep</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Un-treated</td>
<td>Ivermectin 0.03 mg/mL ( \chi^2 ) statistic^2</td>
</tr>
<tr>
<td>Lucilla cuprina</td>
<td>&lt;= 6*</td>
<td>8</td>
</tr>
<tr>
<td>Lucilla sericata</td>
<td>&lt;= 6*</td>
<td>&gt;16</td>
</tr>
<tr>
<td>Chrysomya rufifacies</td>
<td>8</td>
<td>&gt;16</td>
</tr>
<tr>
<td>Calliphora nicina</td>
<td>&lt;= 6*</td>
<td>&gt;16</td>
</tr>
</tbody>
</table>

* Based on a log-rank test for comparison of times to strike with censored data assuming a proportional hazards model
† Statistical with one degree-of-freedom
‡ Larval implants began six weeks after treatment.

For each species of blowfly, the time to first strike on untreated animals was compared with that on treated animals using a log-rank test with censored data assuming a proportional hazards model. Censored observations are those for which no strikes occurred on a given animal after any challenge with a given species. To compare the sensitivity of other blowfly species to ivermectin versus the sensitivity of L cuprina to ivermectin, the Prentice-Wilcoxon Test for censored paired data (O'Brien and Fleming 1987) was used. For each blowfly species other than L cuprina, the time to first strike was compared with that by L cuprina among treated animals. Times to first strike for the two species being compared were paired by animal to calculate the test statistic.

### Results

Treated sheep were rarely struck by more than one species at a single challenge, and strikes by the same fly species on consecutive challenges were relatively uncommon. The numbers of implant sites struck for each species at each challenge are given in Table 1. The mean strike rates (% of implants struck) and mean relative strike rate (% strikes in treated group/control strikes) for each fly species over the entire challenge period are shown in Table 2. Both Lucilla species produced strike rates of about 90% in untreated sheep, the respective rates were lower for Chrysomya rufifacies (55%) and Calliphora nicina (60%). Strike rates on the treated sheep were about 17, 11, and 9% for L cuprina, L sericata and Chrysomya rufifacies, respectively. Only 1 implant site in the treated group was struck by C nicina. Mean relative strike rates for the four species were 19.0, 11.8, 16.7 and 1.4%, respectively.

The median time to first strike was summarised by fly species and treatment group in Table 3. There was a significantly longer time to first strike (\( P < 0.01 \)) on treated sheep than on untreated sheep.
L. sericata, Chr. nificaes, and C. nociva than for L. cuprina (Table 4).

Discussion
Larval implantation is a convenient, though relatively artificial method of assessing insecticides for the prevention of flystrike. Under field or fly cage conditions there is a complex interaction between the microclimate and bacterial flora of the fleece and skin to produce a site that will attract a gravid female, induce oviposition, support egg hatch and permit larval survival. The placement of hatched larvae onto abraded, moistened skin circumvents many of these natural processes. In addition, variability of the insecticide concentration and in the severity of skin abrasion creates a different and largely uncontrollable micro-environment at each implant site.

The above factors were probably responsible for the irregular distribution of strikes in both untreated and treated sheep. Treated sheep were irregularly struck throughout the experiment; they were rarely struck by more than one species at a single challenge or by the same fly species in consecutive challenges. We surmise that the implant methodology, which includes wounding of the sheep’s skin, may have resulted in larvae occasionally being placed on sites where the insecticide could either be avoided or was sufficiently diluted by serum so that strikes resulted. While L. sericata is regarded as an important parasite of sheep in the UK and Europe and to a lesser extent in New Zealand, it is generally regarded as of minor importance in Australia (Watts et al. 1976; Arundel and Sutherland 1988). However, when larvae are implanted as described in this experiment, this species had equivalent strike rates in untreated sheep to L. cuprina.

Some researchers regard C. nociva as the second most important primary blowfly in Australia. This fly lays sheathed maggots, which immediately create a wound, and thus it may initiate strikes before L. cuprina larvae invade the site (Arundel and Sutherland 1988). However, in this experiment only 60% of C. nociva implants on untreated sheep produced strikes, suggesting that this species may not be as well adapted as the two Lucilia species for the exploitation of living sheep.

The strike rate for C. ruficrus was considerably lower than those of the Lucilia spp. This may reflect its status as a secondary blowfly, which in the field is primarily attracted to wounds caused by the strike of a primary blowfly species.

Despite the differences in strike rates between the species, the larval implant method demonstrated that ivermectin jetting fluid provided satisfactory protection against strikes by L. cuprina and even better protection against strikes by L. sericata, C. ruficrus, and C. nociva. Thus, it could be expected that treatment with ivermectin jetting fluid would provide protection against flystrike by these species in the field.

Acknowledgments
We thank Renate Winter, John Sewell and Steve Wilson for their expert technical assistance.

References
Campbell WC, Fisher MI, Stapley EO, Albers-Schoenberg G and Jacob TA (1983) Science 221:823
(Accepted for publication 1 December 1992)

The Veterinary Board of Victoria
Veterinary Surgeons Act 1958 – (as amended)

The Veterinary Board of Victoria (the Board) conducted an Inquiry on 3 March 1993 into the conduct of Dr Paul Leslie Miller, a registered veterinary surgeon of 49 Alness Street, Applecross in the State of Western Australia, to ascertain:

(a) whether in or about the month of July 1992 he did careless and inadequately certify in writing that during the period 4 to 10 July 1992 a total of 71 400 head of sheep for export were inoculated against anthrax,
(b) whether on the 7th and 10th day of July 1992 he permitted a person not registered in the State of Victoria as a veterinary surgeon to administer anthrax vaccination contrary to Regulation 26 (1) (b) of the Stock Diseases Regulations 1988,
(c) whether he careless and inadequately certified that on the 4th and 5th days of July 1992, a total of 16 150 sheep assembled for export at Peddigree Cape Nelson and Kobo feedlot, identified by yellow ear tags, were inter alia sprayed for external parasites.

The Board found Dr Miller guilty on all three counts and inflicted the following penalties:

Charge (a) Reprimand Suspension of registration in the State of Victoria for a period of three months from the date of notification.
Fine of $300 plus costs of $853 being costs of and incidental to the Inquiry.

Charge (b) Reprimand Fine of $300 plus costs of $853 being costs of and incidental to the Inquiry.

Charge (c) Reprimand Fine of $300 plus costs of $853 being costs of and incidental to the Inquiry.

A stay of 3 months for payment of fine and costs was granted.

Margaret B Wilson
Registrar

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