A STUDY OF THE USE OF CYCLOPHOSPHAMIDE IN MERINO EWES AS A MEANS OF FLEECE REMOVAL

E. M. ROBERTS* and P. R. McMAHON*

Summary

Seventy-five full-woolled Merino ewes of mixed age were treated orally with 20, 25 or 30 mg/kg liveweight of an aqueous solution of cyclophosphamide. Five ewes in each dose group were covered with plastic sheep coats to retain spontaneously shed wool.

At the time of manual defleecing 3 weeks after treatment, many treated ewes had already spontaneously shed much of their wool, resulting in considerable loss, the proportions retained in the uncovered group ranging from 26 per cent to 46 per cent, and from 57 per cent to 73 per cent in the covered sheep. As a result, no difficulty was experienced in defleecing the sheep. At the time of defleecing it was seen that wool regrowth had been negligible, and approximately 2 days later 19 ewes died, probably as a result of exposure to minimum temperatures of 8°C (47°F).

I. INTRODUCTION

It has been found (Simister 1966) that in the course of administration of anti-tumour agents to humans, loss of hair frequently follows. Hair cells of animals with continuous wool or hair growth are sensitive to cytotoxic drugs (Homan et al. 1969) because they are usually in an active state of growth and the matrix cells of the follicle bulb show great mitotic activity; in this respect they are similar to tumour cells, and thus it is common for anti-tumour drugs to have an effect on hair growth. Hair loss is not usually permanent and new growth replaces that lost. Of these anti-tumour drugs, cyclophosphamide, a member of the nitrogen mustard series of cystostatic agents, seems one of the most active in regard to depilation.

The possibility of using such a drug to effect fleece removal in commercial sheep becomes more attractive when the present costs of shearing are considered.

The only reported studies of cyclophosphamides as a means of wool removal in the healthy sheep have been in the United States (Dolnick et al. 1969; Terrill 1969).

The present study was conducted to investigate the practicability of using the chemical agent cyclophosphamide to achieve removal of wool from the sheep by manual means.

II. MATERIALS AND METHODS

Seventy-five adult full-woolled Merino ewes were run with a flock of untreated sheep at the Field Station of The University of New South Wales, Hay, New South Wales, (Jackson and Roberts 1970). The pasture was that of a typical dry late

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*School of Wool and Pastoral Sciences, The University of New South Wales, Kensington, New South Wales, 2033.
Fig. 1. — Examples of percentage wool retention.

(a) 5% retention  
(b) 30% retention  
(c) 90% retention
spring, but did not contain plants of a height which would cause wool to be mechanically detached from the sheep. The ewes were randomly allocated to one of three groups of 25 for the different doses of cyclophosphamide. To control spontaneous loss of wool within each group five ewes were covered with plastic sheep coats developed by the CSIRO Division of Textile Industry (Lipson et al. 1970). The sheep were weighed after a night in yards, and the cyclophosphamide* in aqueous solution was administered orally according to individual live-weights. The doses of cyclophosphamide used, of 20, 25 or 30 mg/kg liveweight, were selected following the study by Dolnick et al. (1969) in which doses of 10 mg to 30 mg/kg liveweight produced fleece shedding with little signs of toxicity or other ill effects. The cyclophosphamide solution was administered on October 14, 1969, and the sheep were defleeced 21 days later on November 4, 1969, to coincide with the Station's general shearing. The percentage of fleece remaining on the animal at this time was estimated subjectively in accordance with grades illustrated in Figure 1. When the fleeces were removed manually in the shearing shed, the appearance of the skin and the degree of regrowth of wool were also assessed. The coats were not put back on the previously covered sheep.

III. RESULTS

(a) Loss of wool

The estimated proportion of wool remaining on each group of ewes at time of defleecing is shown in Table 1.

<table>
<thead>
<tr>
<th>Dose of cyclophosphamide (mg/kg liveweight)</th>
<th>Mean percentage retention of wool ± standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not covered</td>
</tr>
<tr>
<td>20</td>
<td>38 ± 7</td>
</tr>
<tr>
<td>25</td>
<td>46 ± 9</td>
</tr>
<tr>
<td>30</td>
<td>26 ± 8</td>
</tr>
</tbody>
</table>

*There was no significant difference in wool retention between the three levels of cyclophosphamide (P > 0.05) in both the uncovered and covered groups. However, the covered sheep retained a significantly greater proportion of fleece than the uncovered group (P < 0.01).

It is of interest to note that the operator conducting the manual defleecing, although not a trained shearer, would have preferred a conventional shearing handpiece to separate the wool from the sheep. In essence he found a handpiece for untreated sheep less arduous than hands for a treated animal.

(b) Regrowth of wool

It was expected from previous preliminary trials (Roberts and Terrill 1969

*Cyclophosphamide was supplied by Mead Johnson Pty. Ltd. P.O. Box 46, Carringbah, 2229, Australia.
unpublished) that in the 3 weeks between treating the sheep and defleecing, some regrowth of wool would have occurred, sufficient to protect the sheep from cold, heat, sunburn and fly irritation. Of the 75 ewes, however, only three could be graded as showing slight regrowth and the remainder were classed as nil regrowth. All the ewes displayed a pink, tender-looking skin after defleecing (Figure 2).

![Image of sheep after defleecing](image)

**Fig. 2.** Skin appearance of ewes after defleecing. Ewes immediately after manual defleecing showing nil wool regrowth 3 weeks after treatment with cyclophosphamide.

(c) Mortality

A total of 19 ewes died within about 2 days of defleecing. The mortality and the mean percentage of wool retention of the ewes that died in each group is shown in Table 2.

| TABLE 2 |
|------------------|------------------|------------------|
| **Mortality of cyclophosphamide treated sheep** |
| **Dose of cyclophosphamide (mg/kg liveweight)** | **Deaths 2 days after defleecing** | **Mean wool retention prior to defleecing of dead ewes (%)** |
| | **Not covered** | **Covered** | |
| 20 | 4 | 1 | 68 |
| 25 | 5 | 1 | 53 |
| 30 | 5 | 1 | 60 |

*Ewes were only covered prior to defleecing.*

The climatic conditions prevailing at the time of defleecing and during the subsequent 4 days are given in Table 3.
TABLE 3

Climatic record during and following defleecing

<table>
<thead>
<tr>
<th>DATE</th>
<th>Nov. 4 (day of defleecing)</th>
<th>Nov. 5</th>
<th>Nov. 6</th>
<th>Nov. 7</th>
<th>Nov. 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum temperature (°C)</td>
<td>36</td>
<td>29</td>
<td>20</td>
<td>24</td>
<td>27</td>
</tr>
<tr>
<td>Minimum temperature (°C)</td>
<td>19</td>
<td>21</td>
<td>8</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Rain (mm)</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>1.6</td>
</tr>
</tbody>
</table>

While there was a trend towards higher mortality with increasing doses of cyclophosphamide, this could not be shown to be statistically significant. The mean wool retention of the ewes that died, however, was greater than the mean of each dose group, which suggests that the sudden exposure to low environment temperature was conducive to death.

IV. DISCUSSION

The use of drugs to effect wool or hair removal in animals is a very recent field of study, and little comparative work is available. Homan et al. (1969) induced complete wool loss after 3 weeks in two Suffolk sheep after intravenous doses of 30 mg cyclophosphamide/kg liveweight. Following upon this experiment, Dolnick et al. (1969) treated 24 sheep with doses ranging from 5 to 90 mg/kg liveweight, the drug being administered either orally or intravenously. The sheep receiving the largest dose of 90 mg/kg liveweight all died; those receiving 60 mg/kg liveweight refused their feed for 7 to 18 days but otherwise showed no ill effects. After doses of 10 to 30 mg/kg liveweight, the fleeces could be removed manually 7 to 10 days after treatment; however, to allow some regrowth to take place, it was recommended that a 3 week interval be allowed between administration of the drug and removal of the wool.

Homan et al. (1969) examined skin biopsy specimens following a dose of 40 mg/kg liveweight of cyclophosphamide. Intracellular damage to the germinal matrix of the hair follicles was evident after 4 hours, but gross manifestation was not apparent for several days. Although there was histological evidence of retarded growth of hair, neither complete follicular necrosis nor cessation of hair growth was seen, and functional recovery of the follicles was apparently complete. Dolnick et al. (1969) reported that constriction in the wool fibre is evident above the bulb about 48 hours after dosing, and at the skin surface about 7 days after dosing.

The present experiment allows conjecture on the part that chemical treatment of sheep might play in the development of cheaper system of wool removal.
Improvement would be necessary firstly in the regrowth of wool after defleecing, since too high or low temperature, and insect irritation would be stressful to sheep. In addition, the possible interaction with below average nutrition, as was experienced in the trial, needs to be clarified and controlled. Moreover, the “cold-shock” which is presumed to have caused the present mortality, would be a major problem if shorn stock need to be housed or rugged after defleecing.

The potential advantages of “Chemical Shearing” are the elimination of second cuts, negligible skin damage, and the use of unskilled labour or purely mechanical means. However, on the other side, there is the need for an additional yarding of the sheep to administer the drug; some spontaneous loss of wool can occur before the manual defleecing; the same dose may differ in its effects between animals, and the sheep is exposed to the environments more than with conventional shearing.

Theoretically, the use of a drug to effect wool removal seems quite possible, but further studies should be initiated to determine the mode of action of the drug, interactions with level of nutrition, degree of residue remaining in the carcass, the effect of the drug on future reproductive performance, and other possible side effects, before any economic evaluation of its use is possible.

Finally, it is worth noting that the manual removal of wool is more arduous than the use of traditional shearing equipment. Mechanised defleecing of chemically treated sheep would, however, offer an alternative procedure with possible cost savings.

V. REFERENCES


