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SHORT CONTRIBUTION

Marking to weaning production aspects of lambs provided with NSAID analgesia compared with lambs receiving no analgesia at the time of elastrator ring marking

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The provision of analgesia at the time of marking has been adopted by the Australian sheep industry, but data on production benefits are lacking. In the current study, alternate lambs were provided with either meloxicam (non-steroidal anti-inflammatory drug [NSAID], n = 781) or no analgesia (NONE, n = 822) at the time of ring castration and tail docking. Six distinct management groups of lambs were studied. Lambs were weighed immediately before marking and then again at weaning. There was no significant effect of treatment on average daily gain between marking and weaning in cross-bred lambs. In Merino lambs, average daily gain was 5 g/day lower ($P < 0.005$) in lambs receiving NSAID, but this may not be biologically significant. Lamb losses were significantly ($P < 0.05$) lower in the NSAID group (1.1%) than in the NONE group (2.7%). This observation is worth validating in larger studies, particularly considering that lamb mortality is a significant cost to production and welfare concern.

Keywords ADG; castration; mortality; pain; sheep; tail docking

Abbreviations ADG, average daily gain; GLM, generalized linear modelling; NSAIDs, non-steroidal anti-inflammatory drugs

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The use of non-steroidal anti-inflammatory drugs (NSAIDs) to mitigate pain at the time of lamb marking (castration and tail docking) is being adopted by the Australian industry following registration of meloxicam formulations for sheep.[1] Although evidence of analgesic efficacy of meloxicam in sheep is available,[2-6] data on the potential production benefits of the provision of analgesia at the time of marking are limited. The aim of this study was to assess the impact of the provision of meloxicam at the time of ring marking on lamb survival and growth between marking and weaning. The hypotheses tested were as follows:

1 Lambs provided with an NSAID at the time of marking will show increased growth (average daily gain) between marking and weaning than lambs that did not receive analgesia;
2 The survival of lambs provided with an NSAID at the time of marking will be greater between marking and weaning than that of lambs that did not receive analgesia.

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Materials and methods

The protocol and conduct of the study were approved by the CSIRO McMaster Laboratory Animal Ethics Committee with approval number ARA 16/24, under the New South Wales Animal Research Act 1985.

The study was carried out at the CSIRO McMaster Research Station, Chiswick, New England, Northern NSW, between September and April 2016. A total of 1603 lambs from six distinct contemporary groups of lambs were enrolled in the study (Table 1). Four contemporary groups (A–D) were of pure-bred Merino lambs, and two were second-cross lambs from first-cross Merino ewes (Merino x Border Leicester, White Suffolk or Dorset) joined with either Border Leicester or Dorset rams. The contemporary groupings were predetermined by the research station farm, with lambing periods staggered over a 6-month period in order to maintain a continuous supply of lambs for other research purposes over the season. Marking and weaning were scheduled to fit with other farm activities. Thus, groups differed in terms of lamb age at marking, lamb body weight at marking, month of marking and marking-to-weaning interval, allowing benefits of pain relief at marking to be assessed in a range of industry-relevant scenarios. Ewes had been naturally mated in their contemporary groups for a 5-week joining period, resulting in a spread of lamb ages within each group at the time of marking. Date of birth was not recorded for individual lambs in all contemporary groups; therefore, Age at Marking was defined as the number of weeks after the mid-point of the lambing period. Actual birth dates were known for Groups B and C as those groups had undergone supervised lambing for parentage and pedigree data collection as part of other studies.

At marking, the lambs were drafted from the ewes, identified with an individual radion frequency identification device (RFID) ear tag, weighed and marked. Marking involved each lamb being individually caught and lifted into a carousel marking cradle. All lambs were vaccinated (Glanvac 6 B12, Zoetis Australia Pty Ltd, Rhodes, NSW, Australia) and treated with the combination anthelmintic Triguard (Boehringer Ingelheim Animal Health Australia Pty Ltd, Macquarie Park, NSW, Australia) prior to marking. The NSAID meloxicam (Ilium Buccalgesic OTM, Troy Laboratories Pty, Ltd, Glendenning, NSW, Australia) was administered to every second lamb as they were caught and placed in the marking cradle, thus randomising the NSAID group across gender and body weight and providing two treatment groups (NSAID, n = 781 and NONE, n = 822). The

Table 1. Summary of lambs enrolled in the study

Group	Breed	Mean age at marking (weeks)	Month of marking	Marking to weaning interval (days)	Treatment	Gender	Mean (± standard deviation) weight at marking (kg)	Mean (± standard deviation) weight at weaning (kg)	Number marked	Number weaned
A	Merino	5 (range 3–7)	October	75	NSAID	Male	12.66 (± 3.07)	24.22 (± 3.53)	66	65
						Female	12.27 (± 2.89)	22.78 (± 3.22)	82	81
					NONE	Male	12.62 (± 2.88)	24.93 (± 3.53)	74	73
						Female	12.29 (± 2.90)	22.76 (± 3.60)	88	87
B	Merino	6 (range 4–8)	September	77	NSAID	Male	14.78 (± 3.49)	27.11 (± 3.25)	69	67
						Female	13.02 (± 2.13)	25.00 (± 3.41)	26	26
					NONE	Male	14.26 (± 3.11)	27.45 (± 3.43)	74	71
						Female	12.22 (± 2.44)	24.35 (± 3.43)	28	26
C	Merino	4 (range 2–6)	October	78	NSAID	Male	10.57 (± 2.71)	22.28 (± 3.89)	104	103
						Female	10.23 (± 2.07)	21.47 (± 3.53)	107	106
					NONE	Male	13.71 (± 2.61)	26.15 (± 3.29)	114	111
						Female	12.97 (± 2.18)	25.18 (± 3.06)	106	105
D	Merino	5 (range 3–7)	November	71	NSAID	Male	13.44 (± 2.75)	21.43 (± 3.73)	30	30
						Female	12.54 (± 1.89)	20.21 (± 2.36)	36	36
					NONE	Male	13.75 (± 2.68)	21.18 (± 3.24)	31	31
						Female	12.08 (± 3.06)	19.82 (± 4.05)	37	37
E	Cross	6 (range 4–8)	October	99	NSAID	Male	15.51 (± 3.81)	32.82 (± 5.04)	72	71
						Female	14.87 (± 2.58)	33.35 (± 4.19)	75	74
					NONE	Male	15.99 (± 3.78)	33.96 (± 5.73)	75	74
						Female	14.21 (± 2.18)	32.06 (± 3.06)	77	74
F	Cross	4 (range 2–6)	December	92	NSAID	Male	17.19 (± 3.19)	31.99 (± 4.13)	52	52
						Female	16.11 (± 3.70)	30.06 (± 4.98)	62	62
					NONE	Male	16.81 (± 4.14)	31.62 (± 4.96)	60	57
						Female	16.02 (± 3.83)	29.87 (± 4.38)	58	58

NONE group contained more lambs than the NSAID group due to limitations in NSAID supply in some contemporary groups, leading to the final lambs being marked in each contemporary group not receiving NSAID. Thus, in group A, there was 148 NSAID and 168 NONE; in group B, 95 NSAID and 102 NONE; in group C, 211 NSAID and 220 NONE; in group D, 66 NSAID and 68 NONE; in group E, 147 NSAID and 152 NONE; and in group F, 114 NSAID and 118 NONE at the time of marking. Marking was carried out by an experienced operator, applying a rubber ring (Elastrator brand, Heiniger Pty Ltd, Bibra Lake, WA, Australia) to the tail at the level of the third palpable joint and to the scrotal neck above the testes, according to industry guidelines.[7] Following marking, the insect growth regulator dicyclanil (CLiK Spray-On Sheep Blowfly Treatment, Elanco Australasia Pty Ltd, West Ryde, NSW, Australia) was applied, and the lamb was released into the holding pen to reunite with its mother. Dose rates and administration of all pharmaceutical agents were according to the manufacturers' instructions.

Ewes and lambs grazed in a mixed native and ryegrass pasture post-marking, where they remained until weaning. Supplementary feeding was not provided. Internal parasite burden was monitored using scheduled faecal egg counts, and the group was treated with anthelmintic if required, according to routine farm management procedures. At weaning, lambs were re-weighed to provide the weaning weight, and any lamb losses were identified.

Body weight data were converted into average daily gain (ADG) for analysis in order to account for the variation in the marking-to-weaning interval. Statistical analyses were carried out in R.[8] Initially, a mixed model was explored to test the null hypothesis 'ADG in lambs receiving NSAID at marking does not differ from ADG in lambs receiving no NSAID'. The experimental unit was an individual lamb. The initial full model included Treatment (NSAID vs NONE); Gender (Male v Female); Contemporary Group (six levels, A–F); Breed (Merino v Crossbred); Age at Marking; and the covariate Weight at Marking and interactions. Residuals from the model could not be transformed to satisfy a normal distribution, so generalized linear modelling (GLM) fitting a binomial distribution was used to test the effects of Treatment, Gender, Breed and Group on ADG. There was a significant Breed*Treatment*Gender interaction, so data were subsequently reanalysed within Breed using GLM.

The variables Age at Marking, Mark-to-Wean interval (six levels, associated with Contemporary Group) and Weight at Marking are

confounded by the Contemporary Group but provide continuous data as opposed to categorical data. Hence, to explore the effect of these on ADG, one-way analysis of variance was performed on each of these variables individually.

For lamb losses, the experimental unit was the subset of lambs in each Gender–Treatment Group combination (column titled 'number marked' in Table 1). The GLM procedure fitting a Poisson distribution and log link was used to test the null hypothesis 'lamb losses in the NSAID group does not differ from lamb losses in the NONE group', including Treatment, Gender, Breed, Group and interactions. P values of <0.05 were considered significant, and P 0.1 > 0.05 was considered to be a tendency towards significance. All values reported are back-transformed estimates.

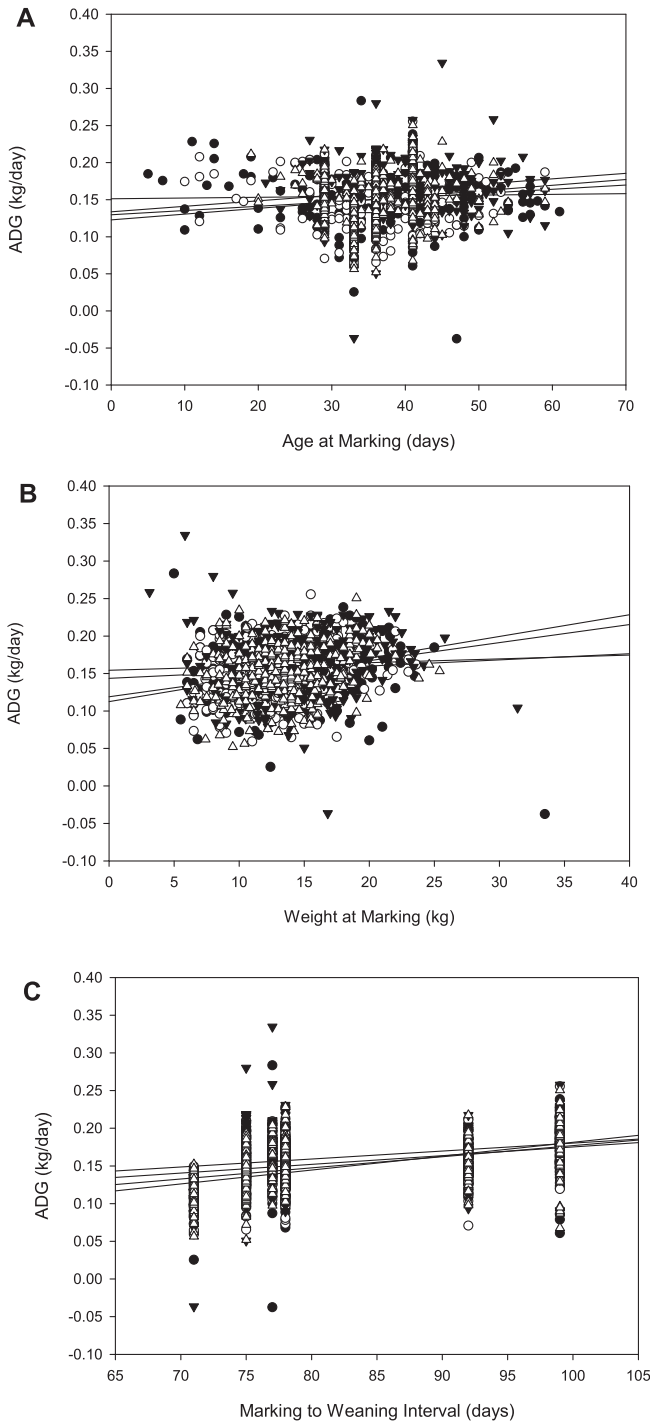

Figure 1. Correlations of (A) age at marking, (B) weight at marking and (C) marking to weaning interval with average daily gain (ADG). ●, NSAID male; ○, NSAID female; ▼, NONE male; Δ, NONE female.

Results

There was a tendency (0.1 > P > 0.05) for Age at Marking, Weight at Marking and Mark-to-Wean interval to influence ADG. ADG was poorly correlated with each of these variables (Figure 1).

In contemporary groups containing crossbred lambs (E and F), gender and treatment had no significant effect on ADG. The interaction of Treatment*Gender was also not significant. There were significant effects of the Contemporary Group (SE 0.016, P < 0.001) and Weight at Marking (SE 0.002, P < 0.001) on ADG. The ADG for group E (156 g/day) was greater than group F (133 g/day). In the contemporary groups containing Merino lambs (A, B, C and D), there were significant effects of Group (SE 0.016, P < 0.01), Weight at Marking (SE 0.002, P < 0.05), Gender (SE 0.012, P < 0.000) and Treatment (SE 0.012, P < 0.005). There were no significant interactions. Lambs in group B gained 143 g/day, those in group C gained 137 g/day, those in group A gained 134 g/day, and those in Group D gained 99 g/day. Male lambs gained 9 g/day greater than female lambs; lambs in the NSAID group gained 5 g/day less than lambs in the NONE group.

There was no significant effect of Group, Breed or Gender on lamb losses and no significant interactions, but there was a significant effect of Treatment (SE 0.422, P < 0.05). The proportion of lambs lost in the NSAID group were estimated to be 0.011, compared with 0.027 in the NONE group.

Discussion and conclusions

In the current study, there was no significant effect of treatment on growth rates (ADG) in crossbred lambs, which concurs with many published studies on the effect of the provision of analgesia for painful husbandry procedures on growth. In many studies, a reduction in feeding behaviour and growth rate in the first few days post-procedure is reported, but a compensatory increase in feeding behaviour and growth leads to no significant differences in growth being observed between treatments after 2–3 weeks.[2,5,6,9-12] Interestingly, it appeared that, in Merinos, use of an NSAID reduced ADG during marking to weaning. The growth of livestock is impacted by a wide range of factors, including but not limited to genetics, feed availability, feed quality, parasitism and weather/climate. In the current study, although all mobs were maintained on the same 1500 ha property, they were genetically different; managed separately, so feed availability and quality would have differed; they were lambed and marked at different times of the year and at different ages; and marking to weaning intervals varied considerably, with cross-bred lambs having a greater marking-to-weaning interval than Merinos in the current study. Furthermore, ADG assumes even growth rates during the marking-to-weaning period, and it is likely that this is not the

case as lambs are transitioning from pre-ruminant to ruminant status during this period. Indeed, the correlations between ADG and age at marking, weight at marking or marking-to-weaning interval all differ between mobs, indicating that multiple factors are at play. Body weight and ADG may be coarse measures of production parameters, and there may be effects on, for example, feed conversion efficiency, longer-term growth, immune competence and resilience to challenge that could result in morbidity or mortality; any study aiming to identify such effects must be on a very large scale and should be extremely well controlled. However, it is important to note that the industry-level benefits of pain relief in terms of improved welfare, consumer confidence in livestock products, social license to operate and market access are likely to far outweigh any short-term on-farm productivity effects.

In terms of survival, there appeared to be an effect of treatment, 1.1% of NSAID lambs being lost between marking and weaning, compared to 2.7% in the NONE treatment. Overall lamb losses were low, and reasons for mortality were not recorded, so it is difficult to draw a firm conclusion with regard to cause and effect from the data generated. However, the difference in lamb survival to weaning was statistically significant ($P < 0.05$), and this observation is worth validating in larger studies, particularly considering that lamb mortality is a significant cost to production and welfare concern.[13]

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Conflicts of interest and sources of funding

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