BRIEF COMMUNICATION: Development of a visual scoring system for ovine pneumonia at the processing plant

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Introduction

Pneumonia in sheep is a consequence of multiple infectious agents compromising the host's immune system, often with the aid of environmental factors. Chronic non-progressive pneumonia (CNP) and acute fibrinous pneumonia (AP) are the main concerns to the New Zealand sheep industry. AP occurs in sheep of all ages and is more common in older lambs during the late summer early autumn period. CNP is often seen in lambs aged between five and ten months of age. Clinical diagnosis is difficult with affected lambs showing few, if any, clinical signs of illness as reviewed by (Alley 2002). Accurate diagnosis requires examination of the lung.

The economic cost of pneumonia to the New Zealand sheep industry is high. A recent study by Goodwin-Ray et al. (2008a) estimated the economic cost of pneumonia where more than 10% of the lung surface was affected, to be NZD$28.1 million/year and from pleurisy to be NZD$25.1 million/year. Pneumonia has a significant effect on lamb growth rate (Alley 1987; Goodwin et al. 2004). It also affects the quality of the carcass where extensive pleural lesions can result in downgrading and condemnation of carcasses. Large lesions are probably the result of individuals surviving outbreaks of acute pneumonia. The smaller lesions that require trimming and stripping at slaughter are usually associated with recovery from CNP.

Vaccination is the ideal preventative measure, however creating a vaccine has met with limited success due to the range of pathogens capable of causing pneumonia (Goodwin-Ray et al. 2008b). The failure to find a suitable vaccine leaves on farm practices and management as the sole preventative measure currently available to the farmer.

To date studies into the prevention of pneumonia have focused on farm management practises and vaccine development. The aim of this study was to investigate visual scoring systems of lungs for pneumonic lesions in lambs that can be implemented at the processing plant, allowing fast and accurate data collection for genetic studies.

Materials and methods

A total of 1,253 individually identified ram lambs from a pedigree recorded flock reported to have shown indications of pneumonia within the lamb flock in previous years, were selected for scoring. Data collection was carried out in March over three consecutive years for lambs born in 2008, 2009 and 2010. All ram lambs from the flock were slaughtered in one group with the exception of the top 50 animals based on breeding values for parasite resistance which were retained for breeding purposes. After slaughter the lungs were collected off the slaughter chain and visually scored at the plant ensuring the lungs were fresh. 'Pneumonia incidence' (PI) was recorded as a 'Yes/No' trait as to whether the lamb's lungs possessed any pneumonic lesions.The extent of the pneumonic lesions within the lungs was determined by assessing each of the five lobes giving them a score of 0 to 5 indicating the percentage of surface area that was affected where 0 = No lesions present; 1 = Small lesions; 2 = Approximately 25% of the lobe affected; 3 = Approximately 50% of the lobe affected; 4 = Approximately 75% of the lobe affected and; 5 = 100% of the lobe affected. Lesions are hard consolidated areas of the lung that are dark purplish – red in appearance. The sum of the individual lobe scores was calculated and recorded as a 'total lesion' (TL) score'.

To investigate if a refined version of the TL score system is a feasible option at chain speed, the lesion scores for each lung were consolidated into three categories termed a 'consolidated pneumonia' (CP) score with a range of 0, 1, or 2 where 0 = No lesions present; 1 = Individual lobes with a score of 1 to 3; and 2 = Individual lobes with a score of 4 to 5. Carcass measurements were obtained from the processing plant and all other data were obtained from Sheep Improvement Limited (SIL) records. A sire model using SAS analysis software version 9.1 (SAS 2009), was used to calculate preliminary heritability estimates. The mixed model procedure was used to determine the significance of several production parameters on the incidence of pneumonia and its effect on lamb growth rate, carcass weight and the depth of tissue 110 mm off the mid-line in the region of the 12th rib at the GR site. In order to normalise the data TL score was $\log_{10}$ transformed for analysis. The significant fixed effects used for the pneumonia classifications were year of birth with significant covariates of lamb birth weight and growth rate between weaning and slaughter at six months of age. Year of birth was a significant fixed effect for the growth and meat characteristics with PI and CP score being significant for growth rate from weaning to slaughter at six months of age and carcass weight. Covariates of day of birth and birth weight

Table 1 Incidence of pneumonia recorded from the lungs of lambs born in one flock slaughtered over three consecutive years. Some rams were used for more than one year.

Year born	Number of lambs slaughtered	Number of infected lungs	Proportion infected (%)	Number of rams used
2008	485	87	18	19
2009	371	141	38	18
2010	397	206	52	16
Total	1,253	434	35	53

Table 2 Mean ± standard error for growth rate from birth to weaning (Growth rate 1), growth rate from weaning to six months of age (Growth rate 2), depth of tissue 110 mm off the mid line in the region of the 12th rib (GR) and carcass weight of lambs at slaughter when scored for prevalence of pneumonia lesions using the CP scoring system. CP 0 = No lesions present, CP 1 = One or more lobes with up to 50% of the surface area affected, CP 2 = One or more lobes with greater than 50% of the surface area affected. P values in bold indicate significance at ($P < 0.05$). P values in italics indicate approaching significance with a P value between 0.05 and 0.10.

CP score	Growth rate 1 (g/day)	Growth rate 2 (g/day)	GR (mm)	Carcass weight (kg)
0	280 ± 2	130 ± 1[a]	4.3 ± 0.2	18.4 ± 0.1
1	280 ± 3	128 ± 1[a]	4.3 ± 0.2	18.3 ± 0.1
2	285 ± 4	124 ± 2[b]	4.1 ± 0.2	18.2 ± 0.2
P value	0.48	**0.02**	0.46	*0.09*

Table 3 Heritability estimate for three indices of the prevalence of pneumonia in 1,253 lambs from one flock slaughtered over three consecutive years.

Trait	Heritability ± standard error
Pneumonia incidence	0.08 ± 0.05
Total lesion score	0.10 ± 0.05
Consolidated pneumonia score	0.12 ± 0.06

were used for the growth rate, and carcass weight and GR tissue depth data with the two growth rate measurements added for the carcass weight and GR tissue depth data. Growth rate from birth to weaning and from weaning to six months of age are referred to as Growth rate 1 and Growth rate 2 respectively in this paper.

Results

The incidence of pneumonic lesions present was recorded for each year. A total of 1,253 lungs from ram lambs were examined. The incidence of lungs with pneumonic lesions from all trial years was 35% (Table 1) and the average for lambs that had pneumonic lesions was 4.89 ± 0.14 (standard error).

Pneumonia had a significant impact on Growth rate 2 irrespective of the scoring system with PI ($P < 0.05$) and $\log_{10}$TL score ($P < 0.001$) showing a loss of 2.9 ± 1.4 and 11.8 ± 2.8 g/day respectively. The least square means ± standard error for Growth rate 1, Growth rate 2, GR tissue depth and carcass weight in each CP score group are shown in Table 2. Carcass weight was also affected by pneumonia when analysed with PI ($P < 0.05$) or $\log_{10}$TL score ($P < 0.05$) showing the carcass to be 0.15 ± 0.07 and 0.35 ± 0.16 kg lighter, respectively, than an individual without pneumonic lesions. Analysis of carcass weight and the CP scoring system showed a progressive decrease in carcass weight as the CP score increased with the overall effect approaching significance ($P = 0.09$) (Table 2). There was no significant difference in the relationship between lambs with pneumonic lesions and Growth rate 1 or GR tissue depth, irrespective of the scoring system used.

The preliminary heritability estimates for pneumonia recorded as either PI, TL score or CP score are shown in Table 3.

Discussion

Pneumonia is recognised to be a high cost within the New Zealand sheep industry. Using genetic selection to improve resistance to pneumonia has not previously been explored. To investigate the underlying genetic relationships requires the collection of data on the prevalence of the condition from a large number of pedigree recorded flocks.

The pneumonia scoring system developed in this study was based on the visual scoring system of Goodwin et al. (2004), but did not take into account the weight of each lobe that was scored for the presence of pneumonic lesions. Although the Goodwin et al. (2004) system was developed for use on a processing chain, it was moving at a speed that allowed 16 seconds per lamb for scoring. Now with most processing plants having almost doubled their chain speed, there is only approximately eight seconds available to score each set of lungs for the extent of pneumonic lesions.

Currently the only way that pneumonic lesions in individual lobes can be scored and recorded is through the removal of the lungs from the chain. This creates an extra step requiring staff situated away from the chain. The alternative developed was a consolidated three-step score (CP score) of just 0, 1, and 2 that is fast, and can be undertaken repeatabily at modern chain speed thereby allowing for increased sample numbers to be collected without compromising data quality.

Lambs with pneumonia have been reported to have a slower growth rate (Alley 1987; Goodwin et al. 2004). We found that the presence of pneumonia

at slaughter, graded according to each of the scoring systems, had no effect on lamb growth between birth and weaning (Growth rate 1) but had a significant negative effect on growth between weaning and six months of age (Growth rate 2), albeit a smaller loss than that observed in the other studies. This present study found that lambs with pneumonia (CP score = 2) had 124 ± 2 g/day growth between weaning and six months of age compared to 130 ± 1 g/day for lambs without pneumonia. Goodwin et al. (2004) found that in cases of pneumonia where more than 20% of the lung surface area was affected, the rate of weight gain was halved from an average daily gain 136 g/day in healthy lambs to 65 g/day in affected lambs. However, if less than 5% of the lung surface was affected no effect on weight gain was reported. An earlier study by Alley (1987) found that differences in carcass weight depended on the level of nutrition but that lambs with significant pneumonic lesions were on average 1.5 kg lighter than uninfected control animals over a two-month period. Possible reasons for the differences in the size of the effect on growth rate between this and other studies include different types and levels of exposure to the pneumonia causing infectious agents as in natural infection versus inoculation, the exact scoring system used, the timing of slaughter and when live-weight measurements to estimate growth rate were made (Alley 1987; Goodwin et al. 2004; Goodwin-Ray et al. 2008c).

The presence of the effect on Growth rate 2 in the present study suggests that lambs are potentially not infected with the organisms causing pneumonia until after weaning with live weight not being a factor in their susceptibility to becoming infected. Both fast and slow growing lambs were infected equally. As all the lambs were slaughtered late in the season it is possible that other management factors associated with pasture quality may have contributed to an overall slower growth rate after six months of age until slaughter than between weaning and six months of age.

This study found that the preliminary heritability estimates for pneumonia remained similar irrespective of the scoring system used in the analysis. Hence, use of the CP scoring system will allow additional pneumonia data to be collected at 'chain speed' on a larger number of lambs as required for heritability studies, without loss of accuracy. The estimated heritability using a CP score was 0.12 ± 0.06.

Additional CP scoring data are currently being collected from the flock used in this analysis and from other industry progeny test flocks. A larger data set will permit a more in-depth analysis allowing further investigation into the underlying genetic relationships and associations between the presence of pneumonia as assessed by CP scoring, and production traits.

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