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Factors affecting the development of laryngeal chondritis in sheep

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SUMMARY

Historic data (from 2005 to 2011) were collected and analysed from four flocks of pedigree Texel sheep in Ceredigion, West Wales and were used to investigate a range of factors associated with death due to laryngeal chondritis (n=82) relative to all animals (n=2826) removed from the flocks, either due to death from other causes or as part of routine animal husbandry (e.g. sale of livestock to other farms, or for meat). Deaths from laryngeal chondritis were observed in both sexes, but males had a higher incidence, particularly early in life. Cases were reported throughout the year, with examples observed in all months of the year, although there was a pattern of seasonal variation associated with age/sex of affected animals. Generally males tended to be affected throughout the year, with little variation in numbers on a month-to-month basis, whilst females were more likely to be affected either later in the year around the time coinciding with puberty (in the case of ewe lambs) or in the second quarter of the year, shortly after weaning (in the case of adult ewes). Animals with laryngeal chondritis had a heavier ultrasound scanning weight at around 20 weeks, although the weight of animals at other times had no effect. It was also noted that the depth of muscle and fat depth at 20 weeks had no effect on susceptibility.

Maternal and/or nursing effects were observed. Ewes with affected lambs had a statistically higher mean pre-tupping body condition score than the others ewes in the flock, meaning that there may be some form of epigenetic role played in predisposing an animal to developing the condition later in life. The number of littermates had no effect, with no significant difference between those born as singletons, twins or triplets. However the rearing status of animals did have an effect, with animals reared as singletons having a higher incidence rate than those reared as pairs.

KEY WORDS

Environmental factors; laryngeal chondritis; sheep; texels.

INTRODUCTION

Respiratory problems in domesticated animals can pose a number of health issues including decreased productivity, or in extreme cases death. Although problems associated with the respiratory tract have been investigated and documented for a number of years (e.g. 1), there is still a general lack of knowledge concerning factors which may increase the risk of one individual developing a respiratory condition, whilst others in the flock or herd are not affected.

Respiratory problems are not just a single entity, but rather a number of different conditions which can affect the respiratory tract. Moreover, they can affect a range of species. Specifically this work deals with one example of a respiratory problem: laryngeal chondritis. This condition affects the upper respiratory tract and leads to breathing problems, with swelling and discharges in the larynx[1]. Examples having been reported in sheep[2]; horses[3]; cattle[4] and humans[5]. In the case of sheep it is seen particularly in Texel and Southdown breeds of sheep[6], an observation which has led to it often being referred to as Texel Throat. The precise cause of this condition still remains unclear[7] although these authors describe higher abundance of certain bacterial species at *post mortem* examinations, including some which had been linked to the condition previously[1]. However it appears likely that these organisms are opportunistic colonisers of mucosal lesions, rather than the original cause[7].

In addition, even within a species there can be differences in the age distribution for developing disorders. By way of illustration in sheep, it has already been suggested that males may be more likely to develop laryngeal chondritis as yearlings[2,4], or at least as younger animals[4,8,9], while ewes may be less likely to be affected[9,10] and cases in ewes may involve older animals than seen in rams[4].

The current work uses archived sheep records to investigate possible factors which may predispose animals to develop laryngeal chondritis, an upper respiratory tract disorder, throughout the recorded lifespan.

MATERIALS AND METHODS

All analyses were performed using data which was archived in Microsoft® Excel spreadsheets from Texel sheep records from four farms in the Ceredigion region of West Wales from 2005 to 2011. During this period there were over 8000 animals on the four farms and data were investigated for all animals (n=2826; 1078 males and 1748 females) which ei-

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ther died on the farms or were removed as part of routine animal husbandry (e.g. ewes affected by uterine prolapse, recurring severe foot problems, etc). For all animals the following data were recorded: sex; age at death for animals dying or being removed from the flock for health reasons; date of birth (lambs were generally born during January or February, and March at the latest); date of death; birth weight; 8-week weight; weaning weight (around 12 weeks); weight at the time of ultrasound scanning (around 20 weeks); growth rate between timepoints; fat depth at scanning; muscle depth at scanning; age of dam; pre-tupping body condition score[11] of dam, on a scale of 1 to 5; birth type (single, twin, triplet or quad); rearing type (single, pair or three); as well as the identity of the animal's sire and dam. Diagnosis of laryngeal chondritis was based on clinical signs in the animal immediately prior to death and performed either by a veterinary surgeon or in his/her absence the head shepherd on each farm, but not all cases were confirmed by a *post mortem* examination.

Statistical analyses were performed to compare parameters in animals which died from laryngeal chondritis, relative to animals which did not. Analyses were performed using either F-test supported T-tests (maternal body condition; age of dam; birth weight of lamb; weight of lamb at 8 weeks; weight of lamb at weaning; weight of lamb at ultrasound scanning date; muscle depth at ultrasound scanning; fat depth at ultrasound scanning) or Chi-Squared calculations (months or seasons of onset of laryngeal chondritis; gender; litter size; rearing status). In the case of different time points in the year, numbers of animals dying were generally too low to allow statistical analysis to be performed on a monthly basis. Instead figures were analysed as 3-monthly quarters (January to March; April to June; July to September; October to December). All calculations were performed in Microsoft® Excel.

RESULTS

In total 82 of these animals were diagnosed as having died from respiratory conditions which resembled laryngeal chondritis. Table 1 shows that a total of 42 ewes and 40 rams died from laryngeal chondritis, demonstrating that both sexes suffer from the condition although the percentage of females was actually lower (2.4% versus 3.7%), due to there being more females in the dataset. However, only 10 of the females developed the condition as lambs (i.e. during the first year of life), with 32 developing it later in life. In contrast, 21 of the males developing the condition were lambs, a statistically higher incidence ($P < 0.05$) relative to that seen in females, with 19 rams developing it later in life.

Also from Table 1, it can be seen that there was no month of the year when there was no reporting of deaths arising. However, although they were described in all months of the year, there were examples of seasonal trends based on age/sex variation. This is probably most obvious in the case of lambs. For example, the only cases in ewe lambs were in the last five months of the year (n=10), as opposed to ram lambs where just over half of the cases (11 of 21) were found in the last four months, but cases existed in nearly every month. However no statistically significant differences were detected between different quarters of the year for lambs.

In the adults a different pattern was observed with around half (15 of 32) of the cases in adult ewes being observed in the second quarter (April to June) of the year. This was significantly more frequent than for other quarters of the year (Chi-Squared calculation $P<0.001$) and coincided with a time at which there were no reports of the condition in ewe lambs. In the adult rams the condition was seen in most months, with a relatively uniform distribution between quarters.

The incidence relative to both litter size (Table 2) and the number of lambs reared by a ewe (Table 3) were both investigated. Based on a Chi-Squared calculation, there was no significant difference ($P>0.05$) between litter size for animals dying of laryngeal chondritis, compared to the rest of the flock. However, when the number of young reared by the dam was considered, it was observed that the incidence was significantly higher ($P<0.05$) in animals which were reared as a singleton, relative to those reared as one of a pair.

No difference was detected in the age of the dams of affected animals relative to the general population. However, the dams of animals which died of laryngeal chondritis had a significantly higher ($P < 0.01$) pre-tupping body condition score value relative to the general population, as can be seen in Table 4.

Data for the mean weight of the lambs at different times are shown in Table 4. Although no difference between animals dying of laryngeal chondritis and the rest of the animals was observed relative to birth weight, 8-week weight and weaning weight (around 12 weeks), a significant difference was observed at the time of scanning being performed (around 20 weeks), with animals dying from laryngeal chondritis being, on average, significantly ($P < 0.005$) heavier than the

Table 1 - The numbers of deaths from laryngeal chondritis are shown on a month-by-month basis. For the purposes of this table adult animals are defined as yearlings and older.

Sex	January	February	March	April	May	June	July	August	September	October	November	December	TOTAL
Adult Ewe	1	2	4	6	5	4	3	1	4	1		1	32
Ewe lamb								2	2	2	1	3	10
Adult Ram	2		2	2	1	3	2	2	1		4		19
Ram lamb		1	1	2	2	2	1	1	2	4	3	2	21
TOTAL	3	3	7	10	8	9	6	6	9	7	8	6	82

Table 2 - Numbers of animals dying from laryngeal chondritis relative to non-affected animals based on litter size. Note that the total number of animals does not reach the 82 and 2744 respectively as not all animals had their litter size recorded. Values were not significantly different (P>0.05).

	Single	Twin	Triplet	Quadruplets	Total
Affected	21	47	9	0	77
Non-affected	720	1672	323	12	2727

Table 3 - Numbers of animals dying from laryngeal chondritis relative to non-affected based on number of lambs reared by dam. Note that the total number of animals does not reach the 82 and 2744 respectively as not all animals had their litter size recorded. Lambs reared as singles were significantly more likely (P<0.05) to develop laryngeal chondritis.

	Single	Twin	Triplet	Artificial rearing	Total
Affected	26	48	0	0	74
Non-affected	666	2037	3	4	2710

other animals, although at the time of scanning there was no difference seen in either muscle depth or fat depth.

The pedigree of each animal developing the condition was examined. Although a number of males were identified as being sire, grand-sire, or great grand-sire of a relatively large number of affected descendants, these animals were also prolific animals in general, with a large number of offspring.

DISCUSSION

Cases of laryngeal chondritis were observed in both sexes, and while there were more females than males who died from these conditions (42 versus 40), the percentage of each sex, relative to the population under investigation, was actually lower in females (2.4% versus 3.7%), with both values being less than those seen in a study of generic respiratory disease mortality in a cohort of Suffolks[12]. In addition, the incidence in younger males was greater than in older males. It is interesting to note that these observations are in keeping with previous reports: (i) that males may have a higher predisposition towards developing laryngeal chondritis[4]; (ii) that ram lambs are more likely to be affected than ewe lambs[9]; and (iii) females dying from laryngeal chondritis tend to be mature ewes[1].

Deaths were observed throughout the year, with the current investigation identifying examples of that in every month of the year. Both adult and juvenile males appeared to be affected in a relatively uniform pattern throughout the year. Deaths in ewe lambs were only observed in the latter half of the year, coinciding with the time when ewe lambs reach sexual maturity and may be an indication that the condition is less of a problem in pre-pubescent ewes. In adult ewes almost half of the cases were observed in the second quarter of the year (April to June). Given that the ewes were tupped in August to September, and lambs were typically weaned by early/mid May, the second quarter of the year is a period which includes one of the few times when the ewe is neither carrying nor nursing a lamb and, at least in theory, might be under the least maternal stress.

For some respiratory conditions it has been hypothesized that there may be some form of maternal-influence, in that lambs reared or born as singletons, which generally grow faster than twins or multiple births, might have a higher predisposition to developing respiratory diseases[10]. This has been investigated in Suffolk lambs[12], which, like Texels, are a finisher breed renowned for quality of carcass. The data presented here suggest that this hypothesis regarding maternal influences was at least in part correct, with lambs reared as singletons being more likely to die from laryngeal chondritis, but not those born as singletons. Differences between birth type and rearing type may be due death of a littermate at, or shortly after, birth. Alternatively it may arise due to the practice of rearing orphaned lambs using a surrogate mother, or fostering of one lamb from a litter of triplets by a ewe which has lost her own lamb(s).

Although there is a general trend for single lambs to be bigger, this factor may be no more than a trend and for this reason absolute weights were also analysed. For most time points at which measurements were recorded (birthweight, 8 weeks and 12 weeks) the weight of a lamb had no impact on the probability of it developing laryngeal chondritis in the future. However, for the weights at the time of body scanning (approximately 20 weeks), it was noted that although heavier animals were more likely to die of the condition later in life, neither muscle depth nor fat depth at this time had any effect.

The other factor which appeared to have an effect on the probability of an animal dying of laryngeal chondritis was the body condition of its dam when she was assessed pre-tupping, with those having a higher score being more likely to give birth to lambs which will develop the condition later in life. This observation is particularly interesting as it raises the issue that there may be an epigenetic component associated with the development of laryngeal chondritis, in that they are heritable phenotypic effects that are not derived from a modification of the genes *per se*. This concept of linking nutrition of the mother during pregnancy with respiratory traits in the offspring is consistent with the recent observations that in humans the maternal dietary influence can

Table 4 - Body condition of the dam pre-tupping, mean weights (kg) of animals dying from laryngeal chondritis - relative to non-affected at different ages, together with muscle and fat depths (mm) at scanning. SEM values are shown in parenthesis. NS denotes not significant (P>0.05).

	Affected	Non-affected	P value
Maternal Condition Score (1 to 5)	3.25 (0.09)	2.77 (0.01)	< 0.01
Birth weight (kg)	4.94 (0.155)	4.72 (0.021)	NS
8-week weight (kg)	20.96 (0.620)	21.00 (0.094)	NS
Weaning weight (kg)	29.38 (1.936)	29.17 (0.264)	NS
Scan weight (kg)	41.14 (1.126)	38.13 (0.148)	< 0.005
Muscle depth (mm)	27.6 (0.40)	27.2 (0.06)	NS
Fat depth (mm)	1.5 (0.08)	1.6 (0.01)	NS

impact on the risk of a child developing asthma[13,14]. In conclusion, the current work is one of the largest investigations into deaths due to respiratory problems in sheep, and the largest dealing with factors involved in laryngeal chondritis. These findings are in agreement with previously identified factors, namely differences in predisposition to death from laryngeal chondritis based on age and gender. In addition, female specific seasonal factors and potential epigenetic factors related to the body condition of the affected lamb's mother at the time of conception have been identified.

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