Preventive Veterinary Medicine 125 (2016) 89–98

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

A cross-sectional study of 329 farms in England to identify risk factors for ovine clinical mastitis

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ARTICLE INFO

Article history:
Received 15 November 2015
Received in revised form 2 January 2016
Accepted 12 January 2016

Keywords:
Ovine mastitis
Poisson regression
Incidence rate
Risk factor

ABSTRACT

The aims of this study were to estimate the incidence rate of clinical mastitis (IRCM) and identify risk factors for clinical mastitis in suckler ewes to generate hypotheses for future study. A postal questionnaire was sent to 999 randomly selected English sheep farmers in 2010 to gather data on farmer reported IRCM and flock management practices for the calendar year 2009, of which 329 provided usable information. The mean IRCM per flock was 1.2/100 ewes/year (CI:1.10:1.35). The IRCM was 2.0, 0.9 and 1.3/100 ewes/year for flocks that lambed indoors, outdoors and a combination of both, respectively.

Farmers ran a variety of managements before, during and after lambing that were not comparable within one model, therefore six mixed effects over-dispersed Poisson regression models were developed.

Factors significantly associated with increased IRCM were increasing percentage of the flock with poor udder conformation, increasing mean number of lambs reared/ewe and when some or all ewes lambed in barns compared with outdoors (Model 1).

For ewes housed in barns before lambing (Model 2), concrete, earth and other materials were associated with an increase in IRCM compared with hardcore floors (an aggregate of broken bricks and stones). For ewes in barns during lambing (Model 3), an increase in IRCM was associated with concrete compared with hardcore flooring and where bedding was stored covered outdoors or in a building compared with bedding stored outdoors uncovered. For ewes in barns after lambing (Model 4), increased IRCM was associated with earth compared with hardcore floors, and when fresh bedding was added once per week compared with at a frequency of ≤2 days or twice/week.

The IRCM was lower for flocks where some or all ewes remained in the same fields before, during and after lambing compared with flocks that did not (Model 5). Where ewes and lambs were turned outdoors after lambing (Model 6), the IRCM increased as the age of the oldest lambs at turnout increased.

We conclude that the reported IRCM is low but highly variable and that the complexity of management of sheep around lambing limits the insight into generating hypotheses at flock level for risks for clinical mastitis across the whole industry. Whilst indoor production was generally associated with an increased IRCM, for ewes with large litter size indoor lambing was protective, we hypothesise that this is possibly because of better nutrition or reduced exposure to poor weather and factors associated with hygiene.

1. Introduction

Mastitis is an inflammation of the mammary gland typically caused by bacterial infection (Khan and Khan, 2006). In suckler ewes (ewes rearing lambs for meat), clinical mastitis may be acute, with signs of local or systemic disease such as a hot or cold mammary gland, change in gait, not eating supplementary food; or chronic, when intramammary masses are detected by palpation during routine checks e.g. at weaning or before mating.

Clinical and sub-clinical mastitis result in direct and indirect economic losses for the suckler sheep industry. Costs arise from ewe and lamb deaths, culling chronically diseased ewes (Conington et al., 2008), ewe replacements and decreased live-weight gain in lambs reared by affected ewes (Fthenakis and Jones, 1990; Keisler et al., 1992; Saratsis et al., 1998; Huntley et al., 2012). An accurate estimate for the cost of mastitis to the UK sheep industry across all breeds is not available, however, a model in Texel flocks indicated

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http://dx.doi.org/10.1016/j.prevetmed.2016.01.012

that reducing the risk of mastitis by 10% would save £8.40 per ewe (Conington et al., 2008).

An estimate of the incidence rate of clinical mastitis (IRCM) depends on a farmer's ability to detect (frequency and attentiveness of observations) and record clinical cases of mastitis. There are no estimates of the IRCM of suckler ewes in the UK. The only available estimate outside the UK is from Canada, where it was estimated to be 1.2% p.a. (0–6.6%) (Arsenault et al., 2008).

In suckler sheep, clinical cases of mastitis have been reported to peak in the first week post-partum. A second peak has been reported at 3–4 weeks of lactation in Norway (Mørk et al., 2007) and at 4–7 weeks of lactation in Ireland (Onnasch, 2000).

In dairy cows, the peak IRCM is also in the first week of lactation (Olde Riekerink et al., 2008; Waller et al., 2009). One explanation for this is that there is a pre-existing bacterial infection in the mammary gland that develops into clinical disease after the onset of lactation (Bradley and Green, 2000). Sheep also have bacteria present in the mammary gland without signs of disease (Huntley et al., 2012). As a consequence, risks for infection might not be closely related temporally to disease events, however, risks that trigger disease might be temporally close to the disease event, for example a change in ewe physiology such as the onset of lactation (Oliver and Sordillo, 1988; Kehrli et al., 1989) or the environment, such as housing. Alternatively, new bacterial infections might occur in the first week of lactation due to the opening of the teat orifice and contamination from the environment or from lambs sucking and cross-sucking, transmitting bacteria from udder skin or between ewes into the gland.

Several studies outside the UK have identified risk factors associated with mastitis in suckler ewes. Risks included litter size, breed, udder conformation, pasture type, lamb growth rate, assistance at lambing, whether the ewe had mastitis in a previous lactation, ewe age, geographical region and ewe body condition (Gross et al., 1978; Watkins et al., 1991; Larsgard and Vaabenoe, 1993; Lafi et al., 1998; Arsenault et al., 2008; Waage and Vatn, 2008). In the UK, poor udder conformation and age have been associated with high somatic cell count in individual ewes (Huntley et al., 2012).

The aims of the current study were to estimate the incidence rate of clinical mastitis and generate hypotheses for potential flock management risk factors associated with clinical mastitis, using a retrospective cross-sectional postal study of a random sample of English sheep farmers.

2. Materials and methods

2.1. Study population

The number of sheep holdings in England in the 2003 census was 45,801 (DEFRA, 2003). Based on this, a sample size of 315 flocks was required, assuming 75% of flocks had at least one case of clinical mastitis, with 95% confidence and 80% power (Win-Episcope-2, 2010). Assuming a response rate of 30% (Kaler and Green, 2008), 999 farmers whose details were provided by AHDB Beef & Lamb (formerly EBLEX), the levy body for English sheep and beef farmers, were contacted in January 2010.

2.2. Design of the questionnaire

Published literature and veterinary expertise on risk factors for mastitis in sheep and cattle were used to design a postal questionnaire. Questions were based on the farm, flock, ewes, management regimes, mammary gland health, nutrition and housing. There were a total of 114 questions. The majority of questions were closed or semi-closed, however, there were some open questions. These included whether farmers thought certain fields were a risk for mastitis, whether the farmer had changed farm management between 2008 and 2009 and farmer opinions on the causes of mastitis and preventive actions.

2.3. Pilot study

The pilot questionnaire was sent to 12 convenience selected farmers with between 50 and 1000 ewes in the north of England that included commercial and pedigree flocks situated in lowland, hill and upland areas. As a result of the feedback from the pilot study several additional questions were added to the questionnaire, and questions that had poor response rates or were answered incorrectly were re-designed.

2.4. Data collection & storage

The final questionnaire was sent out on 8th January 2010. A reminder was sent to non-respondents on 10th February 2010 and a second reminder and a second copy of the questionnaire were sent to non-respondents on 21st April 2010.

A database was designed in Microsoft Access 2007. Data were entered using multiple-choice drop down boxes. The postcodes from the 999 farmers were transformed into X and Y co-ordinates and inputted into ArcView with the worldwide shapefile from the Economic and Social Research Institute (ESRI) to create a map of respondents and non-respondents (Fig. 1).

2.5. Data analysis

Measures of dispersion and central tendency were used to investigate the data (R Core Team, 2013). Normality was tested using Shapiro–Wilks test and the arithmetic or geometric mean was calculated for variables in *R*. Obvious errors were corrected, and categories within variables with <5 responses were merged where logical. Queries were used to select and link data from related databases in Microsoft Access for statistical analysis. Respondents with ≤20 ewes in their flock were removed from the analysis ($n = 4$). Analysis of variance (ANOVA) was used to test the differences between group means in *R*.

The incidence rate of clinical mastitis (IRCM) per flock was calculated. The variance was greater than the mean and so over-dispersed Poisson regression models, offset by flock size, were used to investigate factors associated with IRCM. A total of 144 variables were used to investigate management from 8 weeks before lambing, during lambing and during lactation. Farmers managed sheep either wholly indoors or outdoors or a combination of both, as a consequence 6 separate models were necessary. Model 1 included all respondents and covered general information about the farm, flock, lambing, mastitis, health management and nutrition. Model 2 included flocks housed in barns from up to 8 weeks before lambing to lambing. Model 3 included flocks housed during lambing, and Model 4 included flocks housed after lambing. Model 5 included flocks outdoors during lambing, and Model 6 included flocks outdoors after lambing. The percentage of flock with poor udder conformation was forced into Models 2–6. A forward stepwise approach was used and significance was determined using Wald's test such that variables where 95% confidence intervals did not include unity were significant ($p < 0.05$).

Outliers were assessed to determine their impact on the coefficients.

The models took the following general form:

$$g(E(Y)) = \beta_0 + \sum B_m x_m - \log(O_i)$$