**Application**

Currently the evidence base for calf housing design that is protective against bovine respiratory disease (BRD) is limited. The finding of this work will help farmers prioritize specific elements of calf housing design most associated with BRD to reduce its prevalence and therefore improve overall farm performance.

**Introduction**

Bovine respiratory disease (BRD) is detrimental to the health and welfare of dairy calves. It reduces the performance of affected dairy heifers (Buczinski et al. 2021), making its prevention a priority in dairy farming. Calf housing environment is commonly referenced as one of the major contributing factors to the prevalence of BRD on a given farm (Nordlund and Halbach, 2019). However, in a recent systematic review by Donlon et al (2023) the evidence base for the relationships between housing environment factors and BRD was found to be lacking. Given the restrictions on antimicrobial use (AMU) due to fears of antimicrobial resistance (AMR), a better understanding of the role of housing environment factors may prove useful in preventing BRD and reducing AMU and AMR. Hence, the objective of this cross sectional study was to assess the association of calf housing design, environment and management with BRD (lung consolidation and clinical signs).

**Material and methods**

In total, 83 dairy farms were each visited twice in total in autumn and in spring over three years. These farms were recruited via two methods, i). Random letters sent via the Irish cattle breeding federation, ii). Private veterinary practitioners who were asked to refer farms with known historic BRD problems. At the autumn visit, the calf housing was surveyed, data loggers (continuous monitoring of temperature and humidity) were installed inside the calf housing and a survey of calf management practices was conducted with the farmer. At the spring visit calves were examined to diagnose the presence of BRD and environmental and calf samples were collected. In total 1,640 calves (20 per farm) between 4 and 6 weeks were examined using thoracic ultrasound (TUS) and the Wisconsin clinical score (WCS). Bacterial air load was quantified (using blood agar versus VRGB agar) at three locations within the calf housing (alleyway, feeder, and middle of pen) using an impaction air sampler. Bedding samples were taken for dry matter analysis and nesting scores (scale of 1 to 3 (1 meaning a lying calves legs are fully visible and 3 meaning a lying calves not visible due to bedding)) were assigned. Two multivariable generalized linear regression models were constructed with prevalence of TUS lesions (score 3 or greater (at least a single patch of lobar consolidation)) and positive WCS (aggregate score ≥5 or two or more scores ≥2) as the outcome variables, respectively.

**Results**

The descriptive results are presented first. The calf house survey revealed that vented sheeting was the most commonly observed inlet design (17 farms), while central ridge and no outlet present were the joint most common outlet designs (29 farms each).The environmental data loggers indicated that in the week prior to calf examination in the spring the median within-calf house air temperature was 8.8oC and relative humidity 76.7%. In total 173 (10.5%) calves were classified as having complete consolidation of at least one lung lobe by TUS and 155 (9.5%) calves were considered diagnosed with BRD using the Wisconsin clinical score. The most frequently observed nesting score was 1 (on 33 farms).

Results from the generalized linear regression models showed the ratio of bacterial air (BA:VRGBA) load in the middle of the calf pen was positively associated with BRD prevalence in both models (p < 0.05). Housing temperature exceeding 20oC in the week prior to examination was also positively associated with BRD prevalence in both models (p < 0.05). In the WCS model, inlet design, feeding method (Automatic feeder vs bucket vs teat feeder), milk type (milk replacer vs whole sale able milk vs whole saleable milk & milk replacer vs other), nesting score (score 2 & 3 protective), mechanical ventilation and calf occupied area (positively associated) were all significant predictor variables for BRD (p < 0.05). In the TUS lesion model, the minimum temperature humidity index in the week prior to examination (negatively associated), number of calves in the housing (positively associated), outlet design, colostrum feeding method and colostrum source were significant predictors of BRD(p < 0.05).

**Conclusions**

This is one of the most extensive investigations of BRD epidemiology and environmental factors that has been carried out. In this work, two models were constructed investigating the associations between these variables and on-farm WCS and TUS prevalence. These models showed that housing design factors (primarily inlet and outlet design) can play an important role in the prevalence of BRD in preweaning dairy calves. Even in the spring of a temperate climate such as Ireland both heat stress and cold stress can contribute to the prevalence of BRD in dairy calves. This work demonstrated a relationship between airborne bacteria and BRD in housed calves, however this appear to be a complex one. The characteristics of the air microbiome must be investigated further to gain a better understanding of the results demonstrated in this work.

**References**

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