Monitoring of activity and feeding behaviour for early detection of respiratory disease in pre-weaned calves

Bowen, J M; Miller, G A; Mason, CS; Bell, DJ; Haskell, MJ; Duthie, C-A

Print publication: 09/04/2019

Document Version
Peer reviewed version

Monitoring of activity and feeding behaviour for early detection of respiratory disease in pre-weaned calves

Application This analysis shows the potential of close monitoring of feeding and activity behaviours for early detection of ill health, which will allow early intervention and optimised treatment.

Introduction Calf health problems throughout early life are not only a major source of calf and financial losses, but also impact heavily on calf survival and subsequent lifetime performance. In some treatment scenarios, when a few animals have been diagnosed with disease, a blanket treatment of antimicrobials is administered (metaphylaxis). This includes treatments of calves which have not contracted the disease, a practice that increases the probability of antibiotic resistance arising. Changes in feed intake and behaviour often precede clinical symptoms of disease; these can therefore be used as a means of identifying the early onset of disease. Early detection of disease can allow for targeted treatment of animals, therefore reducing the use of antimicrobials. The aim of this study was to develop and assess prediction models for the early detection of respiratory disease in pre-weaned dairy bred calves.

Material and methods Feeding behaviour and activity data was collected from 100 pre-weaned pure bred Holstein-Friesian bull calves from ~8 to 42 days of age. Calves were group housed and provided with starter diet (ForFarmers Vitastart), straw bedding, *ad libitum* water and *ad libitum* access to milk replacer (ForFarmers Omega Gold: 15% concentration) through computerised calf feeders (Holm and Laue). Activity behaviour was captured through an accelerometer (Axivity®) mounted to the hind-leg. The health status of individual calves was assessed daily using an adapted version of the Wisconsin Scoring System, which is best practice technique to identify respiratory disease in calves. This involved recording rectal temperature alongside coughing, nasal and ocular discharge. Continuous diseased days were classed as a single disease event, 4 healthy days had to be present between disease days for them to be classed as separate events. Health was independently monitored by farm staff and treated as per normal farm practice. Two prediction models were developed to predict disease; (i) deviation from the normal using rolling averages (RA) based on daily lying time and (ii) random forest (RF), a machine learning based technique, which used both feeding behaviour and activity variables. Within the RA model, lying time was predicted based on previous behaviour and the expected value for the current day (based on calf age). If the actual lying time increased by >9% of the predicted lying time, a disease day was predicted. Note that the RA model was not split into training and test datasets. Both feeding behaviour and activity variables were included within the RF model. Data was split into training (70% of the data) and test (30% of the data) datasets based on disease events, e.g. consecutive disease days were classified as one disease event and kept together. The RF model was built on the training dataset, and tested against the test dataset using the RandomForest package in RStudio. Outcomes from RA and RF prediction models were combined to give a third prediction model (COMB), based on the test dataset used in the RF model. To assess the accuracy of the RA, RF and COMB models, an adapted version of sensitivity and specificity was performed. If a positive disease prediction was in agreement with an actual disease event within a 3 day rolling window it was classified as a true positive. Note that disease events were used in this sensitivity specificity analysis rather than individual disease days.

Results In total, 88 respiratory disease events were identified (based on individual calves). Eighty events were used in the RA model (due to missing activity data around the time of a disease event), whilst 28 events were used in the RF and COMB models (due to data being split into training and test datasets). Sensitivity (the rate of how often the model correctly provided a disease prediction) and specificity (the rate of how often the model correctly provided a healthy prediction) were 0.41 and 0.97, and 0.48 and 0.98 for RA and RF models respectively. The COMB model had a sensitivity of 0.64 and specificity of 0.95 – see Table 1 for summary.

Table 1. Sensitivity and specificity analysis on three prediction models.

	Sensitivity	Specificity	Disease events used in model
RA	0.41	0.97	80
RF	0.48	0.98	28
COMB	0.64	0.95	28

RA – Rolling Average model; **RF** – Random Forest model, **COMB** – Combination of models.

Conclusion Close monitoring of feeding behaviour and activity can allow for early detection of respiratory disease in pre-weaned dairy bred calves, with moderate sensitivity (the ability of the model to correctly predict a disease event) and high specificity (the ability of the model to correctly identify healthy days) observed in the COMB model.

Acknowledgements Authors gratefully acknowledge funding from AHDB Beef & Lamb and the Scottish Government.