Session 2.1: Advances on monitoring welfare at group and individual level.

S02.O-03

A PREDICTIVE MODEL FOR HYPOCALCEMIA IN DAIRY COWS UTILIZING BEHAVIOURAL SENSOR DATA COMBINED WITH DEEP LEARNING

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A predictive model for hypocalcemia in dairy cows utilizing behavioural sensor data combined with deep learning

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Objectives
(Sub)clinical hypocalcemia occurs frequently in the dairy industry, and is one of the earliest symptoms of an impaired transition period. Previous studies have shown that calcium deficiency post-partum is accompanied by changes in cows' daily behavioural variables antepartum. This behaviour can be measured by sensors. The goal of this study was to construct a predictive model to identify, at the day of parturition, dairy cows at risk of developing hypocalcemia in the days after parturition, using behavioural sensor data.
Materials and methods
For this study 133 primiparous and 476 multiparous cows from 8 commercial Dutch dairy farms were equipped with neck and leg sensors measuring behavioural elements, including eating, ruminating, lying and walking behaviour of the 21 days before calving and the day of calving. From each cow, a blood sample was taken within 48 hours after calving to measure their blood calcium concentration. Cows with a blood calcium concentration ≤ 2.0 mmol/L were defined as hypocalcemic. In order to create a more context based cut-off, a second way of dividing the calcium concentrations into two categories was proposed, using a linear mixed-effects model with a k-Means clustering. Three possible binary predictive models were tested; a logistic regression model, a XgBoost model and a LSTM deep learning model. The deep learning model was expanded by adding the following static features as input variables; parity (1, 2 or 3+), calving season, day of calcium sampling relative to calving (0, 1 or 2), body condition score and locomotion score.
Results
Of the three models, the deep learning model performed best with an area under the receiver operating characteristic curve (AUC) of 0.66 and an average precision of 0.53. This final model was constructed with the addition of the static features, since they improved the model's tuning AUC with 0.07. The calcium label with the cut-off categorization method proved to be easier to predict for the deep learning model and the XgBoost model, while the logistic regression model performed better using the categorization method with the k-means clustering.
Conclusions
The behavioural patterns of the 21 days before calving contain valuable clues for the prediction of hypocalcemia after parturition, as do the static features: parity, calving season and day of measurement. This study provides a novel approach for the prediction of hypocalcemia and an ameliorated version of the deep learning model proposed in this study could serve as a tool to help monitor herd calcium status and to identify animals at risk for associated transition diseases.