# Automated detection of lameness in dairy cows using measurement of weight distribution and activity

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## The problem

Lameness is a costly and widespread health and welfare problem in intensive dairy production. The increasing size of dairy farms makes lameness detection by visual observation difficult, showing the need for automated detection methods. Lameness is painful but the effects of analgesics have not been adequately studied.

## The objective

The objective of the study was to assess whether measures of activity and how cows distribute their weight among their legs when standing can detect lameness and the effects of analgesics.

## Conclusion

Measures of weight shifting between legs while cows are standing and measures of activity show great potential as automated methods of detecting lameness. These methods may also provide a tool for future evaluation of lameness therapies. Ketoprofen reduced the effects of lameness on weight shifting but had no other effects.

## Methodology

From 57 lactating cows, we measure:

- **Activity measures**: number of lying bouts and their duration, daily lying time and number of steps during two consecutive days

(Ice Tag TM , Icerobotics Inc. Edinburgh, Scotland)

- **Weight distribution measures** when standing on force plate scales:

  -**Variability (SD) over time of the weight** applied to each pair of legs, as a measure of weight shifting between contralateral legs

  -**Leg weight ratio** between the lighter and the heavier leg of each pair of legs, as a measure of symmetry between contralateral legs. A ratio of 1 means that equal weight is applied to the two legs.

- **Gait score** using a 1-to-5 scale (Frances and Weary, 2006). Using a gait score of 3.5 as the cut-off point, cows were classified as clinically lame or non-lame.

Cows were injected on 2 consecutive days with **Ketoprofen** (Anafen, Merial Canada Inc;3.0 mg/kg im) or the same volume of saline, and the same measures were taken on the injection days and the day after.

## Results

**Table 1.** Lame cows shifted weight between contralateral legs more often (shown by the weight variability) and also presented a greater asymmetry in the weight applied to the rear pair of legs. Lame cows had longer lying bouts and as a result, tended to spend more time lying down per day. Lame cows also walked more slowly. Consequently, some of the weight distribution and activity measures were good predictors of the risk of being lame.

| Variable | Non-lame | Lame | OR[1] | CI $_{95}$ [2] |
|---|---|---|---|---|
| Rear legs weight variability (SD,kg) | 24.1 ± 2.0 | 32.6 ± 2.2 * | 1.39 [3] | 1.08 – 1.81 |
| Front legs weight variability (SD,kg) | 16.5 ± 1.5 | 22.6 ± 1.7 ** | 1.58 [3] | 1.08 – 2.34 |
| Rear legs weight ratio | 0.88 ± 0.02 | 0.77 ± 0.02 ** | 0.67 [4] | 0.50 – 0.91 |
| Daily lying time (min) | 720.1 ± 23.2 | 787.6 ± 27.1 † | 1.14 [5] | 0.99 – 1.3 |
| Lying bout duration (min) | 73.9 ± 3.9 | 89.7 ± 4.6 * | 1.46 [5] | 1.05 – 2.02 |
| Walking speed (m/s) | 1.5 ± 0.4 | 1.3 ± 0.4 ** | 0.69 [6] | 0.54 – 0.89 |

([1] Odds Ratio; [2] 95% Confidence Interval;[3] OR adjusted to a 5-kg increase; [4] OR adjusted to a 5% increase; [5] OR adjusted to a 30-min increase; [6] OR adjusted to a 0.1 m/s increase)

**Figure 1.** The variability over time of the weight applied to the rear legs (SD) seemed to be the most accurate predictor among the weight distribution measures, expressed as area under the receiver operating characteristics curve (AUC = 0.71) . Accuracy increased by adding the duration of the lying bout to the model (AUC = 0.76 ) and the walking speed (AUC = 0.83).

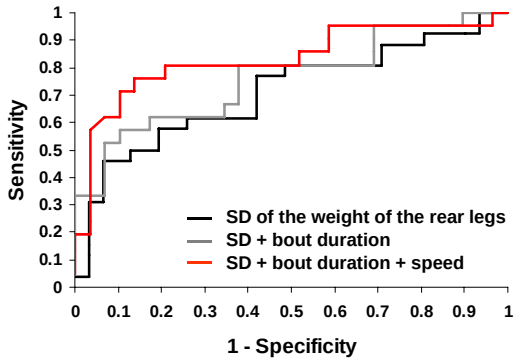
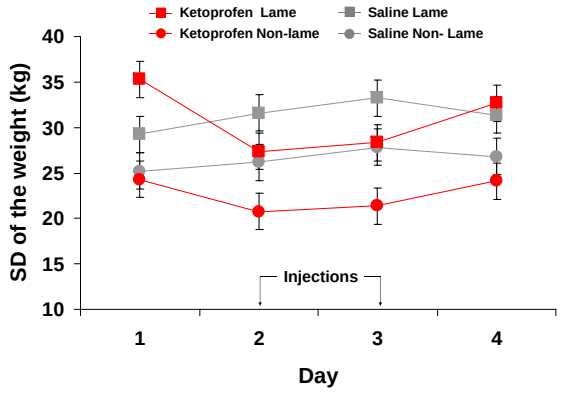



**Figure 2.** The SD of the weight applied to the rear legs significantly improved after the ketoprofen injections, but not after the saline injections.The SD of the rear legs decreased on the days when the ketoprofen injections were applied, compared to the day before and after (18% and 12% decrease for lame and non-lame cows, respectively; $P > 0.001$). Ketoprofen did not affect any other measure of weight distribution or activity ($P > 0.10$)

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