Comparison of two gold standards for evaluation of a mastitis detection model in AMS

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Mastitis detection in AMS

• Mandatory visual control of milk
• Not possible with automatic milking
• Rely on sensor systems
Automatic mastitis detection

- Electric conductivity
- Milk color, temperature
- Bio-sensors (milk enzymes)
- Somatic cell count (OCC)
How good is a detection system?

• Sensor type (inline, online)
• Detection algorithm
• Alert definition (what do we want to detect?)
• Gold standard
• How to link alert with gold standard
• Validation criteria (Se, Sp, FAR, SR)
Study objectives

• Suitability of qPCR results as gold standard (cross-sectional study)
• Comparison with recorded mastitis treatments (case-control study)
Data

- 1 research and 5 commercial dairy herds
- 2,766 cow lactations (> 50 milkings)
- 321 recorded mastitis treatments
- 1,117 collected milk samples for qPCR
Validation setup

Thresholds

EMR: Relaxed and stringent

PCR: As recommended, Ct-value ≤ 37
Time window analysis

Days relative to treatment
-15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5

CM episode

Treatment/qPCR

Time window

FP FP TP TP_{Late} TP FP

Study period
Validation parameters

**False alert rate (FAR)**
Number of false alerts per 100 milkings

**Success rate (SR)**
Proportion of true model alerts

**Sensitivity (Se)**
Proportion of detected mastitis episodes

**Specificity (Sp), only PCR**
Proportion of healthy cows not detected
Gold standards

Mastitis prevalence: 11.6 %
Proportion of positive PCR results: 34 %
## Validation results

<table>
<thead>
<tr>
<th>Validation parameter</th>
<th>Alert threshold</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Relaxed</td>
<td>Stringent</td>
<td></td>
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<tr>
<td></td>
<td>Treatment</td>
<td>PCR</td>
<td>Treatment</td>
</tr>
<tr>
<td>False alert rate, %</td>
<td>0.6</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Success rate, %</td>
<td>80</td>
<td>71</td>
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<tr>
<td>Sensitivity, %</td>
<td>91</td>
<td>25</td>
<td>78</td>
</tr>
<tr>
<td>Specificity, %</td>
<td>-</td>
<td>97</td>
<td>-</td>
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</tbody>
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Take home messages

qPCR is:
• not useful for validation purposes
• too sensitive – detection of non-viable pathogens
• costly but objective in nature
• more useful from a practical point of view

Also:
• qPCR and treatments may cover different aspects of mastitis
Acknowledgements

Project funded by:

• Danish Council for Independent Research | Technology and Production

• Danish Milk Levy Fund