Detection of mastitis during milking
current solutions and prospective ideas

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Introduction

2. Frequency of subclinical mastitis
   ▪ Frequency of clinical cases
   ▪ Reduced milk yield & increased risk for infection of other cows
   ▪ Susceptibility for other diseases
   ▪ Milk composition, milk quality

Mastitis detection – current solutions
State of udder health in AMS farms

Study on udder health in 12 AMS farms in Northern Germany
(Brandt et al., 2012)
- 3 times per farm, weekly intervals, samples of all lactating cows

Sampling routine:
I. Foremilk inspection;
II. Samples for cyto-bacteriology

Prevalence

GSclin Clinical mastitis
GS100 SCC > 100,000 cells/ml & mastitis pathogens
GS500 SCC > 500,000 cells/ml & major mastitis pathogens

Mastitis detection – current solutions
State of udder health in AMS farms

Study on udder health in 12 AMS farms in Northern Germany
(Brandt et al., 2012)
Mastitis detection – current solutions
Performance of basic commercial sensors

“Basic Alerts” (EC + blood/colour) – entire sampling period (15 d)
Table: Sensitivity and Specificity

<table>
<thead>
<tr>
<th>Alert period</th>
<th>Sensitivity [%]</th>
<th>Specificity [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual milking</td>
<td>13-50</td>
<td>87-100</td>
</tr>
<tr>
<td>Test days</td>
<td>22-100</td>
<td>85-100</td>
</tr>
<tr>
<td>Previous week</td>
<td>43-100</td>
<td>35-100</td>
</tr>
</tbody>
</table>

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“At present, the sensitivities and specificities are generally too low for automatic diversion of abnormal milk” (Rasmussen & Bjerring, 2005)

Gold standard: clinical mastitis
Homogeneity Foremilk cup with 0.1 mm filters
Colour Visual scoring
CMT-score > 3 CMT scoring plate

Mastitis detection – current solutions
Performance of basic commercial sensors

AMS “basic alerts” (i.e.: electrical conductivity); Rasmussen & Bjerring (2005): 5 AMS models, six herds


<table>
<thead>
<tr>
<th>What? (Gold standard, pathogen type)</th>
<th>Time frame? (alert period)</th>
<th>Sensor type? (mastitis indicators)</th>
<th>Mathematical function? (alert combination)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact milk and udder integrity</td>
<td>Actual milking</td>
<td>Visual scoring</td>
<td>CMT-score (≥ 3)</td>
</tr>
<tr>
<td>Electrolytes</td>
<td>Test days</td>
<td>Foremilk杯 with 0.1 mm filters</td>
<td></td>
</tr>
<tr>
<td>Somatic cells</td>
<td>Previous week</td>
<td>Visual scoring</td>
<td></td>
</tr>
<tr>
<td>Cell counter</td>
<td></td>
<td>CMT-score (≥ 3)</td>
<td></td>
</tr>
<tr>
<td>Viscosity</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Mastitis detection – current solutions

Performance of SCC sensors

Sensitivity [%]

GS clin
EC alert * Blood / Colour * SCC alert

Sensitivity > 70 %
Specificity > 99 %
(ISO 20966)


Mastitis detection – prospective ideas

Indicators in milk

Diagnostic test criteria of different milk constituents to identify newly infected udder quarters (Krömker et al., 2001)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Milk fraction</th>
<th>Parameter threshold (%)</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Probability of misclassification (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAGase</td>
<td>FM</td>
<td>0.42 mmol / ml</td>
<td>71.7</td>
<td>79.8</td>
<td>22.3</td>
</tr>
<tr>
<td></td>
<td>EC</td>
<td>0.47 mmol / ml</td>
<td>60.8</td>
<td>80.6</td>
<td>26.1</td>
</tr>
<tr>
<td>Lactose</td>
<td>CM</td>
<td>4.7 %</td>
<td>60.8</td>
<td>80.6</td>
<td>26.1</td>
</tr>
<tr>
<td>Lactate</td>
<td>CM</td>
<td>80 nmol / ml</td>
<td>43.3</td>
<td>94.7</td>
<td>22.9</td>
</tr>
<tr>
<td>EC</td>
<td>CM</td>
<td>6.5 mS/cm</td>
<td>35.6</td>
<td>95.1</td>
<td>19.9</td>
</tr>
<tr>
<td>Chloride</td>
<td>CM</td>
<td>35 mmol / ml</td>
<td>33.5</td>
<td>94.7</td>
<td>26.3</td>
</tr>
</tbody>
</table>

Gold standard: cyto-bacteriological findings (DVG, 2002)

Mastitis detection – prospective ideas

Near infrared spectroscopy

Prediction of lactose in milk
in line during milking
(fully random validation set)
(Melfsen et al., 2012)

Sensor performance to predict milk contents during milking validated in independent farms?
→ Session 27

J. Dairy Sci. 95, in press

Mastitis detection – prospective ideas

Mastitis indicators and technical solutions

Visible alterations
milk / udder

Electrolytes

Somatic cells

Enzymes

Lactose

Pathogens
(e.g. DNA, volatile metabolites)

Security

Milker

Spectral analysis

Electrical Conductivity

Cell counter

Viscosity (CMT,...)

Biosensors

Mid/Near infrared spectroscopy

Chemo PCR
Mastitis detection – prospective ideas
Real-time PCR

1. Highly sensitive for detecting bacteria in quarter milk samples
   - Infection or contamination?

2. Bulk milk
   - Very specific for classification of herd status in respect of specific contagious pathogens (Syring et al., 2012)
   - No precise estimation of mastitis prevalence in the herd (Spohr & Breitenwieser, 2012)

3. Milk meter samples
   - Identification of S. aureus, esculine-positive and -negative streptococci (Friendship et al., 2010; Spohr & Breitenwieser, 2012)
   - High risk for false positive results in respect of environmental mastitis pathogens (Spohr & Breitenwieser, 2012)

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Mastitis indicators and technical solutions

Infrared thermography (e.g. udder surface temperature)

Pathogens (e.g. DNA, volatile metabolites)

Viscosity

Somatic cells

Cell counter

Spectral analysis

Electrical conductivity

Lactose

Enzymes

Electrolytes

Visible alterations milk / udder


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Field experiments

<table>
<thead>
<tr>
<th>N</th>
<th>Threshold Diagnostics</th>
<th>Conditioning</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>62 Brown Swiss dairy cows</td>
<td>SCC &gt; 400,000/ml</td>
<td>SN: 96%; SP 94%</td>
<td>Polat et al. 2010</td>
</tr>
<tr>
<td></td>
<td>SCC &gt; 200,000/ml and no clinical sympt.</td>
<td>SN: 94%; SP 100% Cut-off: 34.7°C</td>
<td></td>
</tr>
<tr>
<td>552 HF dairy cows</td>
<td>SCC &gt; 100,000/ml &amp; bacteria findings</td>
<td>SN: 30%; SP: 70%</td>
<td>Franze et al. 2012</td>
</tr>
</tbody>
</table>

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IR thermography

1. Initial investigations (Barth, 2000):
   - Highly sensitive infrared-thermo camera
   - Indication of quarter SCC > 100,000/ml and of clinical mastitis, but
   - Susceptible to location of measuring point and perspective (medial, lateral or caudal)

2. Profound experiments (Hovinen et al., 2008):
   - E. coli mastitis experimentally induced on left forequarters
   - Detection of clinical mastitis: udder & rectal surface temperature 4 h post challenge
   - Local signs on udder, changes in milk appearance: already 2 h post challenge

   Clinical mastitis influenced the relation of medial:lateral teat surface temperature (Barth, 2000; Hovinen et al., 2008)


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Take home questions

- Development and test of new mastitis detection methods and sensors is still an important task
- Mathematical functions?
- Combination of indicators and sensor techniques?
- Need to be more specific on kind of pathogens?
- On-farm or in-line utilisation (robust, cheap, easy-to-handle, and rapid) is not applicable for all techniques
- Best solutions for herd management?
- Best “Gold Standard” for prevention of mastitis?
- Abnormal milk vs. subclinical mastitis
Thanks to... 

- Monika Brandt and Andreas Melfsen who sampled and evaluated a good part of the data on udder health and/or sensors used in this presentation.
- Karin Knappstein and the Max-Rubner-Institute Kiel for scientific and technical support in our study on udder health.
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Thank you for your attention!

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