SENSORS FOR MASTITIS MANAGEMENT

Jens Yde Blom
BIOSENS, Agro Business Park, 2 Niels Pedersens Alle, DK-8830 Tjele, Denmark

SUMMARY

With the introduction of automated milking in the late 1990ties sensors were needed to automatically monitor milk quality. The first sensors provided were measurements of electrical conductivity, based on the influx of Sodium Chloride in the process of inflammation. At best, the sensitivity of electrical conductivity for mastitis detection is around 30%, and at similar low specificities. There have been developed other means of monitoring milk quality, including on-line counting of white blood cells), spectral analysis, time between milkings, blood, and quarter yield. Latest, an on-line mastitis detection system measuring Lactate DeHydrogenase (LDH) has been introduced, being marketed in both parlour and robotic milking in 11 countries.

INTRODUCTION

With the advent of robotic milking, new technology has emerged in recent years, including recording of electrical conductivity, milking performance (quarter yield, blood, milking interval in robotic milking) and latest mastitis specific parameters in milk (Lactate Dehydrogenase, LDH) in milk, as used in the novel Danish product "Herd Navigator™").

This presentation will present the present indicators of udder health and milk quality, their advantages and drawbacks in the sense of usability.

RESULTS OF PRIOR AND RECENT INVESTIGATIONS

With the advent of robotic milking in the late 1990ties, a number of new opportunities came to the dairy farmers in terms of monitoring cow performance. Among the selling points were no more milking at 04.00 in the morning, and the opportunity of living a more normal life with the family. European milk producers very quickly adapt to new technologies if they seem to produce better results and/or alleviate work issues.

Along with robotic milking came other focus areas, among these the daily monitoring of cow health and welfare. There are two major reasons for monitoring cows in automated milking: Mastitis detection and milk quality.

Once milk quality cannot be detected manually as in manual milking, there was a need for automated monitoring.

Very soon in the process of moving into automated milking, a number of scientific reports looked into the prospects of using electrical conductivity as a means of monitoring.

Electrical conductivity

The measurement of electrical conductivity, based on very early changes in conductivity due to an influx of Sodium Chloride in udder inflammation has been explored since the 1980ties. Being part of every automated milking equipment since the late 1990ties, electrical conductivity is far from being perfect, as sensitivity is around 30% and specificity around the same value (1). Mein and Rasmussen, however, proposed a sensitivity more than 70% and a specificity of >99% (1) Far from being perfect, measurements add to the awareness of the herdsman as to cows that need attention. Measurements of electrical conductivity are used in Herd Navigator™ (see later) robotic installations to point to the quarter at risk for mastitis.
In robotic milking systems the total number of attentions are counted by cow, but still researchers advocate visual checks of alarm cows (2).

Figure 1. Electrical conductivity profiles from a healthy (left panel) and a mastitic cow (right panel). From Norberg et al. 2004 (3).
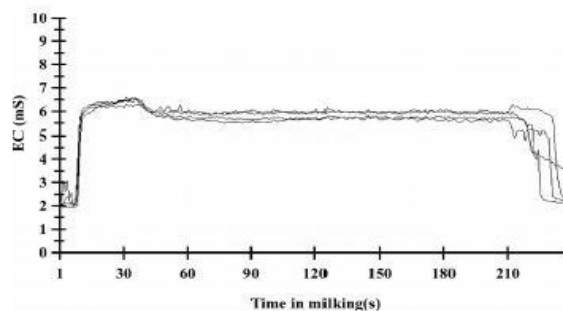

Figure 1. Electrical conductivity (EC) profiles (in milliSiemens [mS]) for all 4 quarters of a healthy cow.
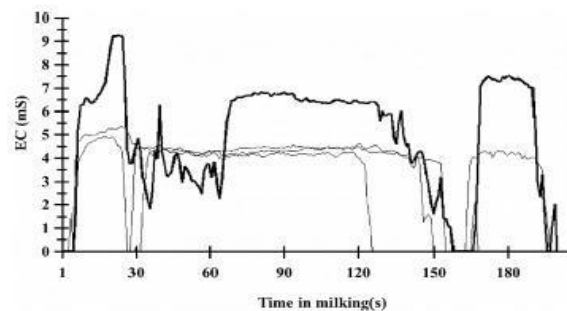
Figure 2. Electrical conductivity (EC) profiles (in milliSiemens [mS]) for all 4 quarters of a cow with clinical mastitis. The bold line indicates the EC profile of the infected quarter.

On-line blood measurements

Blood in milk is a very good indicator of udder injury, including mastitis, and milk should be diverted from the milk line. In Lely and DeLaval milking robots an alarm will appear upon blood being detected, and a diversion protocol can be applied.

On-line Somatic Cell Count

Recently, DeLaval has launched an online Somatic Cell Counter for the Delaval VMS. The device will measure the somatic cell count at predetermined intervals, and warn of probable mastitis. The device will send a message to the operator if the SCC value is above 200,000, and a further message if the SCC is above 500,000. Also the Lely Astronaut is equipped with a somatic cell count device. So far, no software is available to interpret

the measures available, and therefore it is left to the operator to compare measurement results to the individual cow history (treatments, milk recording records, prior on-line SCC results etc.)

Combined mastitis indices

In all robotic milking systems all available data are used for mastitis detection. This includes electrical conductivity, milking interval, blood, quarter milk yield and milking intervals, but still the sensitivity of the indices are not promising, leaving the farmer with a significant number of false alarms. Steenevold et al. (5) investigated the combined use of electrical conductivity and on-line measurements of somatic cell counts. The addition of somatic cell count data moved the success rate of mastitis detection to 32 %, but moved the specificity to 98.8%. The authors advised visual checks of attention cows to verify clinical mastitis.

Measurement and interpretation of Lactate Dehydrogenase

Recently a new system for the detection of mastitis was developed under the name of Herd Navigator™. The system, being marketed by DeLaval, monitors cow reproduction, ketosis, feeding and mastitis by use of in-line measurements of milk. For mastitis management, measurements of Lactate Dehydrogenase (LDH) is used. Research showed a close relationship between LDH and somatic cell counts (figure 2).

Figure 2. The correlation between Somatic Cell Count (upper line) and LDH lower line) is very high, indicating that LDH is a good indicator of mastitis, base (3), based on 11,893 data records).
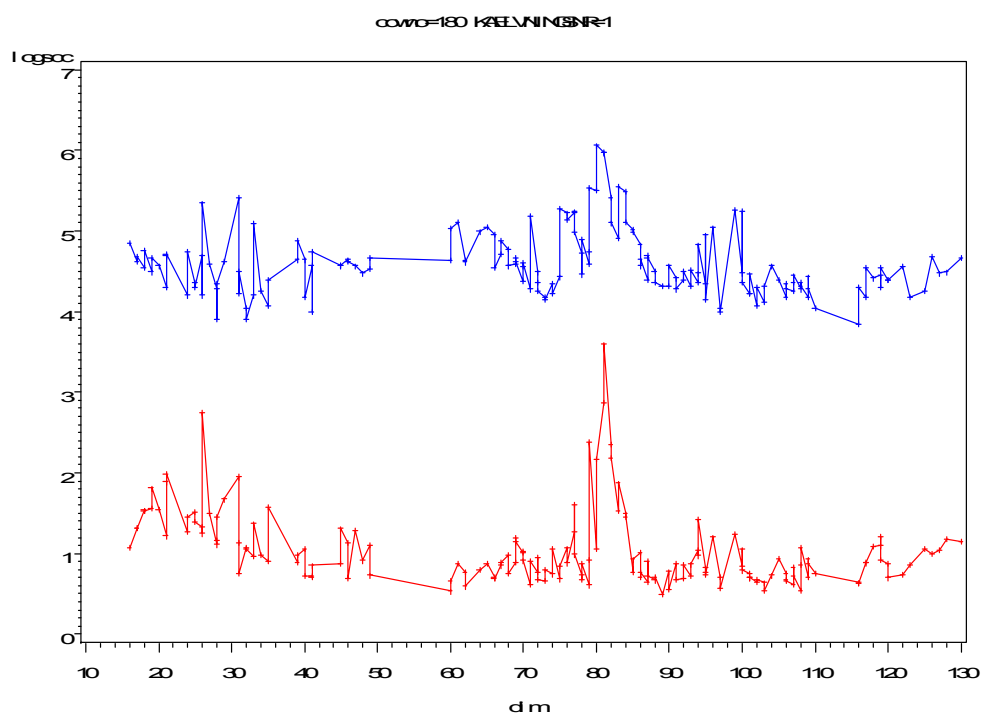
The system can be applied in robotic and parlour milking. The measurements of the four parameters in Herd Navigator are validated in biological models which will issue a risk value for a given condition. Once the risk goes beyond a pre-set value, the risk will be shown to the operator on the Herd Management System.

The Herd Navigator™ system monitors mastitis on a regular basis throughout the entire lactation, being very attentive in the early lactation where the risk of mastitis is high. A model to interpret LDH measurements was developed and tested (4,5) and the system is now in use in more than 50 dairy herds in more than 11 countries worldwide.

The system will warn the user of probable mastitis. The sensitivity of the system is above 92% with a specificity of 99% (5).

With Herd Navigator™, Standard Operation Procedures are envisaged, including on-farm or off-farm culturing before any treatment decision is made.

Results from a Danish robotic test farm showed a reduction in both treatment numbers and Bulk Tank Somatic Cell Counts by using the system. The farm has applied on-farm culturing of mastitis bacteria, and if , culture negative, *E. Coli* or Coagulase Negative Bacteria (in the absence of fever/inappitence) treatment is not performed.

Figure 3. Reduction in mastitis treatments in a Danish Herd Navigator™ VMS farm (5 months in the year before use and 5 months in 2010). Before using Herd Navigator™ and applying on-farm culture of mastitis bacteria the treatment rate was 35%, typical of Danish dairy farms.
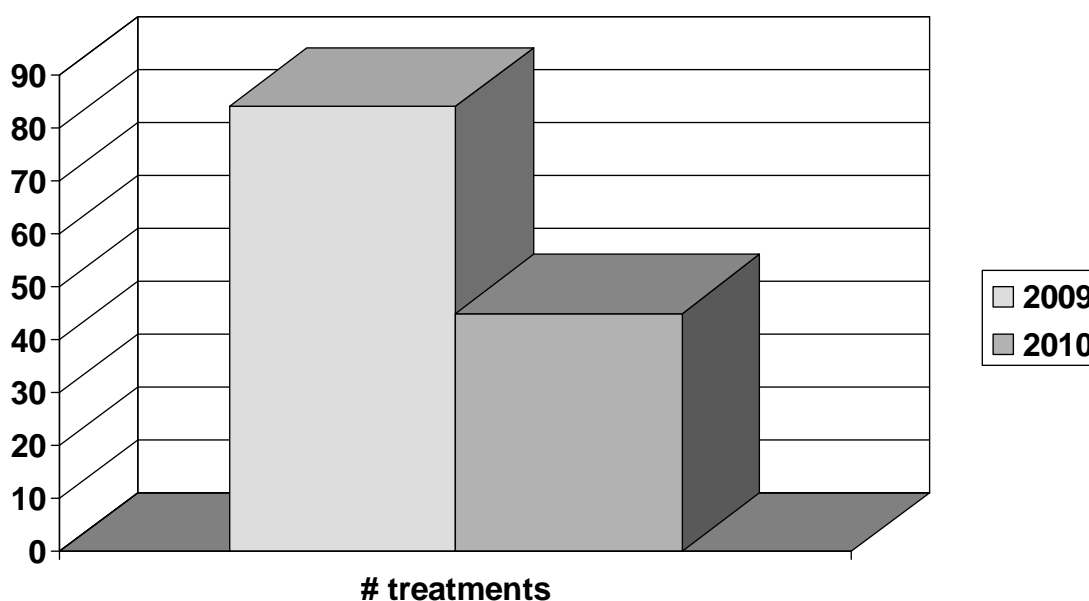
CONCLUSIONS

Far from being perfect, a number of sensors are now available to both parlour and robotic farms for monitoring udder health and other conditions in the high yielding dairy cow. At the moment systems have been developed for automated milking but also for parlour systems (Herd Navigator™).

Based on prior experience there is still a need for the operator of the dairy farm to do follow-ups on system alarms in order to select cows to be treated for mastitis.

REFERENCES

1. Mein, G.A. & M.D. Rasmussen (2008): Performance evaluation of systems for automated monitoring of udder health: would the real gold standard please stand up? In: Lam, T.J.G.M (ed.) Mastitis Control – from science to practice. Wageningen Academic Publishers, Wageningen the Netherlands, 259-266.
2. Steeneveld, W., C. Kamphuis, H. Mollenhurst, T van Werven & H. Hogeveen (2011): The role of sensor measurements in treating mastitis on farms with an automatic milking system. Proceeding of Udder Health and Communication, Utrecht, the Netherlands, 399.
3. Norberg, E., H. Hogeveen, I.R. Korsgaard, N.C. Friggens. K.H.M.N. Sloth & P. Løvendahl (2004). Electrical Conductivity of Milk: Ability to Predict Mastitis Status. J. Dairy. Sci., 87, 1099-110
4. Chagunda, M.G.G., N.C. Friggens, M.D. Rasmussen and T. Larsen(2006): A Model for Detection of Individual Cow Mastitis Based on an Indicator Measured in Milk. J. Dairy Sci., 89, 2980-2998.
5. Friggens, N.C., Chagunda, M.G.G., Bjerring, M., Ridder, C., Højsgaard, S., Larsen, T. (2007): Prediction of degree of mastitis from repeated measurements in milk: A test of a model based on lactate dehydrogenase measurements. J. Dairy. Sci., 90:5415–5427.