Animal Health: ADSA-NMC Platform Session: Milk Quality and Mastitis Control in a Changing Dairy Industry

59  Rethinking milking efficiency in a dynamic dairy industry. R. Erskine*1, Michigan State University, East Lansing, MI.

The dairy industry is consolidating, but also becoming more diverse in employment organization. Many dairy managers have limited human resource knowledge and experience; this often leads to frustration with protocol drift and a sense that employees are not engaged in the success of the farm beyond prescribed instructions. Additionally, the role of immigrant labor can complicate communication barriers and management–employee relationships. Education, training, and translation tools have been developed by land grant universities, consultants and agricultural agencies. However, these programs were developed from a management-directed perspective with minimal input from employees. Furthermore, the effectiveness of employee training, or education programs, relative to farm protocols and productivity, has not been evaluated for short or long-term success. Dairy herds that ensure strict compliance of milking protocols have lower bulk tank somatic cell counts than herds that have difficulties with protocol compliance. Thus, further advances in milk quality must address the gap between human resource needs and the capacity of producers and managers to address them. Superimposed on these labor issues, many dairy operations increase the pressure on employee performance by striving to maintain a high level of milking parlor throughput. Thus, milking efficiency is often defined in terms of cows milked per hour, or milk produced per hour. While this definition of milking efficiency is pervasive, recent research by our Quality Milk Alliance (http://qualitymilkalliance.com/) project team suggests that we may need to reconsider the definition of milking efficiency to include milk quality, harvest, and employee performance.

Key Words: human resources, milking protocol, milking efficiency

60  Automated mastitis detection for robotic milking systems using deep learning and recurrent neural networks. M. T. M. King*1, S. A. Naqvi2, M. Champigny3, R. Deardon2, H. W. Barkema2, and T. J. DeVries1, 1Department of Animal Biosciences, University of Guelph, Guelph, ON, Canada, 2Department of Production Animal Health, University of Calgary, Calgary, AB, Canada, 3PhenoLogic Co., Toronto, ON, Canada.

With the abundance of data collected by automated milking systems (AMS) comes the need for reliable, validated algorithms for disease detection. The objectives of this study were to (1) integrate AMS data to develop accurate mastitis detection models using recurrent neural networks; (2) determine the relative importance of variables and their effect on model performance; and (3) assess the accuracy of our models. Milking data (including milk yield, visit frequency, duration, temperature, conductivity), cow behavior (rumination time, activity), cow data (DIM, parity), and mastitis records were collected from 13 commercial AMS dairy herds in Ontario, Canada for the first 30 d of lactation for 822 cows. Clinical mastitis was diagnosed when a cow had poor quality or quantity of milk production, as measured by the AMS, and abnormal milk or udder upon visual examination, and the cow was treated using an antimicrobial. Deep learning models were used to predict the daily probability of a cow being diagnosed with mastitis, based on 54 possible input variables (i.e., milking, behavior, and cow data, for each milking and variance for each day). Initial models were run only using healthy cows (no recorded health disorder) and cows having only mastitis. Recurrent neural networks, with varying numbers of long short-term memory cells, were trained using different lengths of time windows when cows were classified as sick for 3, 5, 7, and 15 d centered around diagnoses. Farms were divided into 3 groups: 9 farms for model training and development (n = 240 cows, 20 mastitis cases), 2 farms for model testing (n = 81 cows, 6 mastitis cases), and 2 farms for hold-out validation. Using a combination of milk and behavior data and prediction windows of 3, 5, 7, and 15 d centered around the day of diagnosis, models achieved 82, 85, 79, and 93% accuracy during testing, respectively. Excluding behavior data reduced prediction accuracy by 5% units. Excluding daily variances reduced prediction accuracy by 7% units. Overall, these methods and resulting algorithms have great potential to improve the reliability and timeliness of automated mastitis detection for dairy producers using AMS.

Key Words: robotic milking, mastitis detection, machine learning

61  Detection of bovine mastitis biomarkers in milk by porous silicon optical biosensors. N. Pinker*1 and G. Shitenberg2, 1the Hebrew University, Rehovot, Israel, 2The Volcani Center, Bet Dagan, Israel.

The proposed research specifically addresses the most prevalent health problem in dairy cows, the bovine mastitis (BM), by developing a generic biosensing platform for on-site monitoring applications. Traditional diagnostic methods check the quality of milk through the detection of mammary gland inflammation, infection diagnosis and its causative pathogens. However, all these techniques lack the ability to detect analyses in real-time or outside the laboratory boundaries. Therefore, there is an urgent need for a rapid, accurate, cost effective, simple and portable method to evaluate in real-time new cases of BM, followed by corrective and preventive actions, leading to a positive effect on animal health and overall economy of the dairy farms. Herein, we have designed and fabricated an optical biosensing platform, based on porous silicon nanostructures, Fabry-Pérot film, for the detection of BM-predicting biomarkers, haptoglobin (Hp) and N-acetyl-β-D-glucosaminidase, which are monitored in real-time by reflective interferometric Fourier transform spectroscopy. Indeed, increased Hp levels cause a profound increase in the relative optical signal as specific hemoglobin-Hp complexes are formed. Thus, for clinical and subclinical BM values a red shift of 0.36 ± 0.04% and 0.24 ± 0.006% in the effective optical thickness are obtained. These results correlate to Hp concentrations obtained by ELISA test in which values of 9.6 ± 0.3 and 2.3 ± 0.1µg/mL are received for clinical and sub-clinical milk samples (both positive to S. dysgalactiae pathogen), respectively. Control experiment of healthy milk (SCC < 100,000, with negative microbial contamination) presented a minor increase of 0.06% in optical output as insignificant values of Hp are obtained (1.1 ± 0.1 µg/mL). Similar differentiation is shown for the latter biomarker. Our studies reveal that the optical nanostructure capable of multiskilling: immobilization, size-exclusion, rapid and sensitive detection of specific biological targets in real milk samples, offering simultaneous real-time detection based on physical characteristics. Thus, the main advantage of the presented biosensing concept is the ability to detect BM predicting biomarkers in milk, using a simple and portable experimental setup.

Key Words: bovine mastitis, optical biosensor, porous Si

The decline in dairy farms in the Southeast United States has outpaced the decline in the United States overall. Although the inventory of dairy cows has remained roughly unchanged in the last decade, the number of US dairy herds has declined by 58% while the southeast lost 71% of its herds. Challenges of consistently producing high quality milk have likely contributed to this decline. The focus of this study was to identify farm/farmer characteristics and farmers’ attitudes and perceptions about mastitis and mastitis management related to SCC (as a marker of milk quality) and to dairy farm closure. A mail survey of dairy farms in operation, or which had ceased milk production over the previous 3 years, in 7 Southeast states captured information about BTSCC levels, farm characteristics, operator characteristics, farm management practices, information sources accessed by the operators, and operators’ perceptions of and attitudes about mastitis and mastitis management. A probit regression model was used to determine factors were associated with the dairy’s operational status (closed or operational). Closed dairies had lower average milk production per cow, smaller herd size and greater age of the farm’s primary operator. Operators of closed dairies reported that the lowest level of bulk tank SCC (BTSCC) that caused them concern was on average 418,000 cells/mL, while operators of dairies still in business reported concern at 338,000 cells/mL. Several variables reveal a relationship between milk quality and dairies’ operational status. The positive influence of the presence of both incentives for high quality milk and penalties for milk of quality below a specific threshold demonstrates that milk payments supplemented by incentives and/or penalties are contributing to dairies remaining operational. Some management practices also contribute to dairies’ operational status. Having the primary dairy operator in the parlor routinely for milking is associated with dairy closure and may reflect either small-sized dairies or understaffed dairies. Routine bacterial culturing, participation in DHIA testing, and using antibiotic therapy to treat clinical mastitis each have negative marginal effects and are associated with dairy closure. While each of these dairy practices has a role in good herd and dairy management, this finding may suggest that poor performing dairies are turning to these practices because of consistently high BTSCCs and/or high rates of clinical mastitis, both of which could be associated with poor awareness of or poor execution of other mastitis prevention and management practices.

Key Words: mastitis, udder health, mixed treatment comparison

64 Antimicrobial resistance of Klebsiella species from milk submitted to Wisconsin Veterinary Diagnostic Laboratory for mastitis testing, 2008–2018. E. Furmaga*, N. Aulik, and M. F. Valenzuela, Wisconsin Veterinary Diagnostic Laboratory, Madison, WI.

The purpose of this retrospective study was to evaluate trends in antimicrobial resistance (AMR) in Klebsiella from milk samples submitted to the Wisconsin Veterinary Diagnostic Laboratory (WVDL) for bovine mastitis testing. At WVDL, the CMV1AMAF panel by the Thermo Scientific Sensititre system is used to run minimum inhibitory concentration (MIC) panels. The Sensititre database was reviewed for milk submitted for mastitis testing where Klebsiella species was determined to be the primary pathogen. The mastitis cases were finalized from January 1, 2008 through December 31, 2017. Clinical Laboratory Standards Institute (CLSI) guidelines were used to determine MIC breakpoints. Due to the lack of Klebsiella-specific breakpoints in CLSI, MIC cut-offs for antibiotics on the mastitis panel were used from E. coli; both bacteria are members of the Enterobacteriaceae family. The percent of samples resistant to the antibiotics was calculated; Klebsiella was found to be completely resistant to most antibiotics on the panel except for cefotaxime and tetracycline. For cefotaxime, resistance ranged from 0% (2010) to 22.7% (2017), and for tetracycline, from 13.8% (2011) to 40.9% (2013) (Table 1). Overall, there was no significant change in antimicrobial resistance of Klebsiella over the 10-year period of data.

63 Comparative efficacy of teat sealant protocols: A systematic review and network meta-analysis. C. B. Winder*1, J. M. Sargeant1-2, A. M. O’Connor1, and D. F. Kelton1, 1Department of Population Medicine, University of Guelph, Guelph, ON, Canada, 2Centre for Public Health and Zoonoses, University of Guelph, Guelph, ON, Canada, 3Department of Veterinary Diagnostic and Production Animal Medicine, College of Veterinary Medicine, Iowa State University, Ames, IA.

Treatment and prevention of intramammary infections (IMI) represent a large portion of antibiotic use in the dairy industry. Dairy producers have multiple intervention choices to prevent IMI in the dry period, including use of internal teat sealants with or without antibiotics. Generally, producers and advisors are interested in relative efficacy, as opposed to pair-wise comparisons to non-treated controls or a single comparator. Network meta-analysis assesses relative efficacy of multiple interventions through direct and indirect evidence. The objective of this review was to assess the efficacy of teat sealants to prevent new IMI and clinical mastitis in the subsequent lactation. Five databases, relevant conference proceedings, and FDA NADA summaries were searched. Eligible studies assessed teat sealants with or without antibiotics, compared with no treatment or other treatment (e.g., antibiotics alone) in pre-partum heifers or dairy cows at dry-off, and assessed one or more of the following critical outcomes: incidence of IMI at calving, incidence of IMI in the first 30 DIM, or incidence of clinical mastitis in the first 30 DIM. Study screening and data extraction were done independently in duplicate. From 2280 initially identified records, 199 were assessed at full text, with 75 studies containing 82 trials passing this stage. 40 trials had full data extracted, with network meta-analysis performed using 23 trials reporting incidence of IMI at calving. Use of an internal teat sealant significantly reduced the risk of IMI at calving compared with non-treated controls (RR = 0.36, 95% CI = 0.25, 0.72), but the use of any category of antibiotic in addition to teat sealants did not reduce the risk beyond that of teat sealant alone. Exploration of sources of heterogeneity is ongoing. This work revealed important challenges with comparable outcomes, replication and connection of interventions, and quality of reporting of study conduct. Consideration of use of reporting guidelines, standardized outcomes, and inclusion of at least one intervention arm used in other research would increase the value of primary research in this area.

Key Words: mastitis, udder health, mixed treatment comparison
Table 1 (Abstr. 64). Percent of *Klebsiella* samples resistant to ceftiofur and tetracycline, 2008–2017

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>2008 (n = 71)</th>
<th>2009 (n = 59)</th>
<th>2010 (n = 57)</th>
<th>2011 (n = 29)</th>
<th>2012 (n = 39)</th>
<th>2013 (n = 44)</th>
<th>2014 (n = 43)</th>
<th>2015 (n = 40)</th>
<th>2016 (n = 30)</th>
<th>2017 (n = 75)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceftiofur(^2)</td>
<td>1.4</td>
<td>6.8</td>
<td>0</td>
<td>0</td>
<td>7.7</td>
<td>11.4</td>
<td>7.0</td>
<td>7.5</td>
<td>3.3</td>
<td>22.7</td>
</tr>
<tr>
<td>Tetracycline(^2)</td>
<td>21.1</td>
<td>23.7</td>
<td>26.3</td>
<td>13.8</td>
<td>41.0</td>
<td>40.9</td>
<td>25.6</td>
<td>30.0</td>
<td>26.7</td>
<td>25.3</td>
</tr>
</tbody>
</table>

\(^1\)CLSI breakpoint concentrations (µg/mL) used to classify samples as antibiotic resistant (R).

\(^2\)Bacteria species/sample source for antibiotic: for ceftiofur, *E. coli* bovine mastitis (R >4), and for tetracycline, *Enterobacteriaceae* family/humans (R >8).