174 Mastitis control: Past, present, and future, and milk quality globally. L. Timms*, Iowa State University, Ames, IA.

Global technologies and strategies have been implemented in the past 60+ years and greatly enhanced mastitis control, resulting in improved quantities and quality of milk and dairy products. Continued demands for the highest quality, safest quality milk as a foundation for human nutrition is recognized and supported, and abilities to transport and export dairy products with greater shelf life has been a direct effect of this. While public health standards or SCC limits vary among countries globally, measurements assessing mastitis and milk quality such as SCC, milk nutrient composition values, antibiotic testing, and enhanced shelf life are similar among domesticated countries and milk supplies. Yet, many countries around the world with limited milk supplies, capital, and infrastructure can’t implement the simplest mastitis control strategies. The initial very successful 5-point mastitis control plan was developed in the 1960s by NIRD in the UK and then adopted globally. The aim was to reduce levels of subclinical and clinical mastitis primarily through the control of mastitis pathogens. Five points were (1) Record and treat clinical cases; (2) post milking teat disinfection; (3) dry cow therapy; (4) cull chronic cases; and (5) milking machine maintenance. With the control of contagious mastitis pathogens and the advent of environmental mastitis and other pathogens, focus on animal health and immunity and factors affecting this as well as pathogen exposure (nutrition, proper and clean animal environments) received attention and strategies and a 10-point plan. Over these years, our abilities to rapidly monitor milk components and disseminate information for monitoring and making changes rapidly has been astounding. Also, focused antibiotic use increased and so did enhanced continual regulatory testing for B-lactams and other compounds in the 1990s, with also some global concerns of antibiotic resistance. Our focused plans have resulted in an abundant supply of the highest quality, safest dairy products. Advent of genomic testing and large data handling, new therapeutic strategies and alternatives, and recognition and focus on personnel as the brains of milk quality exemplify our future opportunities.

Key Words: mastitis, control, milk quality, somatic cell counts

175 Genetics, genomics, and improving mastitis resistance. G. M. Pighetti*, University of Tennessee, Knoxville, TN.

Resistance to intramammary infection requires recognition of the invading organism, recruitment and activation of immune defenses, elimination of the organism, and return to homeostasis. The effectiveness of this response reflects a complex series of interactions among the cow’s immune system, her environment, and mastitis causing organisms. As such, the genetic contribution or heritability of mastitis is relatively low when compared with these other factors and genetic progress will be slow. To improve the rate of genetic change, gains must be made relative to reliability, selection intensity, and/or heritability of the trait itself or highly correlated traits. With changes in the industry and technology, we have newfound opportunities to increase the speed and accuracy of genetic gains for mastitis resistance. The keys to this opportunity reflect greater use of producer recorded data to improve reliability of genetic predictions, creation of novel phenotypes from currently recorded data such as SCC to improve reliability, selection intensity and/or heritability, as well as creation of novel measures of the immune system. These changes are coupled with another significant event in the industry, sequencing of the bovine genome, which has enabled the association of individual differences in DNA sequence with traits of interest – e.g., genomics. This has reduced the generation interval and thereby the rate of genetic change by identifying superior sires at younger ages, without the need for daughters to complete their first lactation. Furthermore, a DNA sequence is more “heritable” when compared with a phenotype which is influence by genetic and environmental factors. As we continue to progress, genomic evaluation of current and novel phenotypes will increase the speed and accuracy of selecting for mastitis resistance. Perhaps just as important, genomic markers can provide model systems to better understand the mechanisms that lead to mastitis resistance and enable a more targeted approach to new strategies against mastitis. This symposia will summarize recent advances in relation to historical practices.

Key Words: mastitis, genomic, immunity

176 Novel genomic and phenotypic strategies to improve mastitis resistance and milk quality. P. Martin1, H. Barkema2, S. G. Narayana1,2, and F. Miglior*1,3, 1CGII, Dept of Animal Biosciences, University of Guelph, Guelph, ON, Canada, 2Dept of Production Animal Health, Faculty of Veterinary Medicine, University of Calgary, Calgary, AB, Canada, 3Canadian Dairy Network, Guelph, ON, Canada.

Bacterial mastitis (inflammation of the mammary gland) is the most frequent and costly disease of dairy cattle. As disease-recording systems compiling data from large numbers of farms are not widely implemented, selection for mastitis resistance is often based on genetically correlated traits, including somatic cell count (SCC), udder depth and fore udder attachment. However, in Canada, a national health collection system for dairy cattle was started in 2007, with producers recording the incidence of 8 diseases, including mastitis. Participation is voluntary, but already includes >40% of all Canadian herds enrolled in milk recording. In several studies using these Canadian data, various traits with potential to predict mastitis resistance were investigated. The relation between mastitis and SCC (and its variations during lactation) were also studied, with the most important being mean somatic cell score (SCS) in early lactation, standard deviation of SCS and excessive test-day SCC pattern. Genetic correlations between mastitis and other traits were also estimated. Selection for mastitis resistance would also improve resistance against other diseases, as well as enhance both fertility and longevity. However, milk yield was negatively correlated with clinical mastitis, emphasizing the importance of including health traits in genetic selection. Based on these studies, routine genomic evaluation for mastitis resistance was initiated in Canada (August 2014). The new evaluation incorporated mastitis, patterns of SCC, udder depth, fore udder attachment and body condition score. By including predictor traits in multiple-trait evaluations, EBV reliability increased 22 points. Furthermore, with genomics, reliability increased by 16 and 8 points for young and proven bulls, respectively. Further research, including the bacteriology of mastitis and development of a new female reference
population to improve reliability of genomic evaluation, are still under study and should result in further improvements.

Key Words: mastitis, genetics, genomics

177 Genome-wide association analyses identify loci associated with mastitis phenotypes generated from Streptococcus uberis experimental challenge data. L. Siebert*, M. E. Staton, S. P. Oliver, and G. M. Pighetti, University of Tennessee, Knoxville, TN.

Control and prevention of mastitis is a long standing goal of the dairy industry considering it affects 20 to 50% of any given herd and significantly decreases milk quality. Recent identification of genetic markers for mastitis have relied on somatic cell count (SCC) or clinical mastitis (CM) observation or averaged across a sire’s daughters. We propose utilizing novel phenotypes derived following an intramammary experimental challenge with S. uberis, which causes a high proportion of both clinical and subclinical mastitis cases. Aseptic milk samples were collected on each cow, n = 35 Holsteins, and used to determine both SCC and colony forming units (cfu) of S. uberis in milk. SCC was used to generate 3 novel phenotypes: area under the curve (AUC) of SCC for 0–7 d and 0–28 d post-challenge; and individual cows were placed in one of 3 categories (<21 d, 21–28 d, or > 28 d) based on when their SCC returned to below 200,000 cells/ml post-challenge. S. uberis cfu was used to create 4 additional phenotypes: S. uberis clearance S. uberis shedding cycles, and AUC of S. uberis cfu for 0–7 d and 0–28 d post-challenge. To identify loci of interest a 50K SNP chip analysis was performed using the BovineSNP50 v2 DNA Analysis BeadChip from Illumina and associations were tested using Plink. A total of 40 SNPs (P < 9.34 x 10^-5) were identified across the 7 phenotypes. Of the SNPs identified, 12 are in regions with prior mastitis evidence lending validity to the use of our novel phenotypes to identify loci of interest. Furthermore, 14 of the SNPs identified are in genes with known functions linked to inflammation/immunity or regulation of gene expression, providing many potential candidate genes. These loci and candidate genes should be further investigated to identify potential roles in controlling S. uberis mastitis. Such investigations could lead to novel treatment or prevention compounds/protocols for S. uberis mastitis or genetic selection methods for cows with greater potential to resist S. uberis infection.

Key Words: mastitis, GWAS, phenotype

178 Mastitis therapy: Past successes, current challenges, and vision for the future. J. Middleton*, University of Missouri, Columbia, MO.

Mastitis is an inflammation of the mammary gland most often caused by a bacterial intramammary infection. Antimicrobials are often used for mastitis treatment and control, and dairy cattle receive more antimicrobial therapy for mastitis than for all other dairy cattle diseases combined. Mastitis can be categorized based on the severity of the inflammatory response as subclinical, having no overt clinical signs, or clinical, having overt changes in the milk, mammary gland, and/or cow. Clinical mastitis is divided into mild (overt changes in the milk), moderate (overt changes in the milk and udder inflammation such as redness, heat, pain, and swelling), or severe (overt changes in the milk, mammary gland, and systemic signs in the cow). Treatment decisions will not only be dictated by the severity of the disease, but also by the inciting agent and the predicted outcome of therapy based on empirical or scientific evidence. A common strategy is to try to clear the bacterial invaders with antibiotics in the hope of returning the mammary gland to normal function, but this strategy may not always be warranted or effective and thus understanding basic principles of therapy are critical. Challenges faced by the dairy industry include public concerns about cattle welfare and antimicrobial drug use and resistance. These concerns are driving policy aimed at reducing or eliminating certain types of antimicrobial use in food-producing animals because of real or perceived concerns about resistance in pathogens of human health importance. It is clear that antimicrobial use in food-producing animals is an evolving situation and one that likely will be more restrictive in the future. Prudent use of antimicrobial drugs, i.e., only applying antimicrobials where there are clearly demonstrated production and animal welfare benefits is a logical step in potentially reducing antimicrobial use on farms while preserving the ability to treat disease and optimize animal well-being. The future of mastitis treatment lies in optimizing management practices that promote animal health and reduce disease incidence while developing novel intervention strategies aimed at reducing antimicrobial usage.

Key Words: mastitis, therapy

179 Modulating adipose tissue lipolysis and remodeling to improve immune function in early lactation. G. A. Contreras*, C. Strieder Barboza, and J. De Koster, Department of Large Animal Clinical Sciences, East Lansing, MI.

Despite major advances in our understanding of transition and early lactation cow physiology and the use of advanced dietary, medical, and management tools, at least half of early lactation cows are reported to develop disease and 57% of cow deaths occur during the first week of lactation. Excessive lipolysis (measured as plasma FFA) is a major risk factor for the development of displaced abomasum, ketosis, fatty liver, and metritis, and may also lead to poor lactation performance. Lipolysis triggers adipose tissue (AT) remodeling that is characterized by enhanced humoral and cell mediated inflammatory responses, and changes in its cellular populations distribution and extracellular matrix composition. Uncontrolled AT inflammation perpetuates lipolysis as we have observed in cows with displaced abomasum. Efficient transition cow management ensures a moderate rate of lipolysis that is rapidly reduced as lactation progresses. Adequate formulation of pre- and postpartum diet reduces AT lipolysis intensity. Additionally, supplementation with niacin, monensin, and rumen-protected methyl donors (choline and methionine) during the transition period are reported to minimize FFA release into systemic circulation. Feeding saturated FA and other energy dense compounds during early lactation improves energy balance and increases insulin concentration that limit AT lipolytic responses. Independently of the type of intervention used to modulate lipolysis around parturition and early lactation, its benefits on immune function are well documented. In general, cows with moderated postpartum lipolysis exhibit improved immune response. For example, these animals have effective PMN phagocytic activity and adequate proliferation of mitogen stimulated PBMC compared with cows with high lipolysis. To further improve the modulation of AT lipolysis and remodeling, it is necessary to identify novel biomarkers of AT function as prepartum plasma FFA and BHB lack specificity and are retrospective in nature. Understanding the inherent characteristics of AT biology in transition and early lactation cows will reduce disease incidence and improve lactation performance.

Key Words: adipose tissue remodeling, lipolysis, early lactation

The bovine innate immune system has a strong repertoire of antimicrobial defenses to rapidly attack infectious pathogens that evade physical barriers of the udder. Exploration of the intracrine vitamin D pathway of bovine macrophages has generated a better understanding of the signals that initiate antimicrobial defenses that protect the udder. In the intracrine vitamin D pathway, pathogen recognition receptors upregulate CYP27B1 mRNA that encodes for the enzyme that converts 25-hydroxyvitamin D (25D) to the active vitamin D hormone, 1,25-dihydroxyvitamin D$_3$ (1,25D). The 1,25D, in turn, increases nitric oxide and b-defensin antimicrobial responses of bovine macrophages. Investigation of the intracrine vitamin D pathway using experimental models of mastitis of dairy cows has revealed that vitamin D signaling in innate immune cells contributes to defense of the mammary gland. Expression of the CYP27B1 and the vitamin D receptor genes rapidly increased in macrophages and neutrophils of the udder in experimental models of mastitis in dairy cows. Intramammary 1,25D treatment increased expression of inducible nitric oxide synthase and b-defensin genes in immune cells of the mammary gland. Furthermore, Intramammary 25D treatment slowed onset and decreased severity of experimental Streptococcus uberis mastitis. The evidence that vitamin D contributes to defense of the mammary gland provides a path for development for alternative solutions (i.e., nutritional, genetic, therapeutic) to increase mastitis resistance of dairy cows. Continued exploration of the intrinsic cellular pathways that specifically promote antimicrobial defenses of the udder, as demonstrated with the vitamin D pathway, is needed to support mastitis control efforts for dairy cows.

Key Words: vitamin D, innate immunity, mastitis

181 Challenges to milking efficiency: Quality versus quantity. R. Erskine* and R. Moore-Foster, Michigan State University, East Lansing, MI.

The dairy industry is rapidly intensifying and becoming more diverse in terms of 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 motivated to engage 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 (BTSCC) than herds that have difficulties with protocol compliance. Thus, further advances in milk quality may be impeded by the gap between the human resource needs arising within the industry’s labor force and the capacity of producers and managers to address them. Superimposed on these labor issues, many dairy operations increase employee management is becoming a more important part of many dairy operations. A recent study of dairy herds in 3 states showed that larger herds (>500 cows) tended to have higher bulk tank somatic cell counts (BTSCC) compared with small (≤250 cows) or medium (250–500 cows) herds (Schewe et al., 2015). Herds who had an increasing number of non-family employees also had increasing herd BTSCC. Herds that place an emphasis on hiring and retaining good employees and ensure that protocols are maintained have lower BTSCC compared with those who do not emphasize the same values (Schewe et al., 2015). Comprehensive mastitis evaluations were completed in 64 Michigan dairy herds that assessed: 1) Management and monitoring of infected cows, 2) Milking proficiency, 3) Milking system function and 4) Cow environment. Additionally, fifth element of the evaluation, identified as a critical need by interviewing producers and employees, termed “Farm Management Culture” was included in the evaluation. VaDia vacuum recorders (Biocontrol, Rakkestad, Norway) allow cows to “rate the milking protocol” by describing parameters of the milking event, such as milk let-down and overmilking. 3822 milkings events were recorded, with an average of 61 recordings per herd. Statistical analysis found significant (P < 0.05) positive correlations between 2 herd-level dependent milking outcomes, average overmilking time, and percent of cows with bimodal milk let down and a third dependent variable, new intramammary infection (as defined by indi-

182 Data, decisions, and mastitis. J. M. Bewley*, University of Kentucky, Lexington, KY.

Adoption of sophisticated on-farm decision-making tools has been scant in the dairy industry to this point. Yet, the dairy industry remains a perfect application of decision science because (1) it is characterized by considerable price, weather, and biological variation and uncertainty, (2) technologies, such as those characteristic of precision dairy farming, designed to collect data for decision making abound, and (3) the primary output, fluid milk, is difficult to differentiate, increasing the need for alternative means of business differentiation. In “Competing on Analytics: The New Science of Winning,” Davenport and Harris (2007) pose that in industries with similar technologies and products, “high performance business processes” are one of the only ways that businesses can differentiate themselves. The basis for most of our mastitis decision tools thus far has been DHIA (Dairy Herd Information Association). DHIA records are an essential part of dairy herd management for many progressive dairy operations. Given the economic importance of both clinical and subclinical mastitis, early detection of mastitis is one of the most exciting precision dairy farming applications. Real-time data can be used for monitoring animals and creating exception reports to identify meaningful deviations. In many cases, dairy management and control activities can be automated. It’s important to remember that information obtained from precision dairy farming technologies is only useful if it is interpreted and utilized effectively in decision making. Integrated, computerized information systems are essential for interpreting the mass quantities of data obtained from Precision Dairy Farming technologies. This information may be incorporated into decision support systems designed to facilitate decision making for issues that require compilation of multiple sources of data. New technologies that measure SCC, LDH, conductivity, temperature, and behavior open up opportunities for additional data streams. Economic based decision tools may help farmers make more economically driven treatment and culling decisions.

Key Words: data, mastitis

183 Measuring parlor performance from a cow’s perspective. R. Moore-Foster* and R. Erskine, Michigan State University, East Lansing, MI.

As average herd size is increasing employee management is becoming a more important part of many dairy operations. A recent study of dairy herds in 3 states showed that larger herds (>500 cows) tended to have higher bulk tank somatic cell counts (BTSCC) compared with small (≤250 cows) or medium (250–500 cows) herds (Schewe et al., 2015). Herds who had an increasing number of non-family employees also had increasing herd BTSCC. Herds that place an emphasis on hiring and retaining good employees and ensure that protocols are maintained have lower BTSCC compared with those who do not emphasize the same values (Schewe et al., 2015). Comprehensive mastitis evaluations were completed in 64 Michigan dairy herds that assessed: 1) Management and monitoring of infected cows, 2) Milking proficiency, 3) Milking system function and 4) Cow environment. Additionally, fifth element of the evaluation, identified as a critical need by interviewing producers and employees, termed “Farm Management Culture” was included in the evaluation. VaDia vacuum recorders (Biocontrol, Rakkestad, Norway) allow cows to “rate the milking protocol” by describing parameters of the milking event, such as milk let-down and overmilking. 3822 milkings events were recorded, with an average of 61 recordings per herd. Statistical analysis found significant (P < 0.05) positive correlations between 2 herd-level dependent milking outcomes, average overmilking time, and percent of cows with bimodal milk let down and a third dependent variable, new intramammary infection (as defined by indi-
individual cow SCC) and a variety of independent variables that included employee factors such as, number of hours spent milking per day, total distance each employee moves per milking shift, employee turnover and cows milked per employee per hour. Negative correlations were found between the percent of cows with bimodal milking and the average teat stimulation and number of passes during the preparatory procedure. These results suggest that VaDia analysis of milking procedures can help identify opportunities to improve milking performance and that factors deemed to increase parlor throughput pressure on employees may result in decreased milking performance.

**Key Words:** mastitis, employees, education