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SYMPOSIA AND ORAL SESSIONS

CSAS Mastitis: Udder Health Management—A Canadian Perspective

1 Research networks: The Canadian mastitis research experience. D. Scholl*, *University of Montreal*, *Saint-Hyacinthe, Quebec, Canada.*

Innovative partnerships infuse new energy into research on commonplace problems. Funding priority for bovine mastitis research has diminished in the face of competing problems but mastitis remains an important animal and public health issue. In response, Canadian dairy industry and mastitis research leaders have created a unique partnership in the form of a research network. The Canadian Bovine Mastitis Research Network (CBMRN) joins national and provincial industry organizations and 42 researchers in ten institutions. The CBMRN program comprises coordinated mastitis research, student training, and knowledge and technology transfer. The mastitis monitoring and mastitis control research themes integrate applied and fundamental research techniques together. They are supported by a core platform that optimizes data collection through a national cohort of dairy farms, a pathogen strain bank and networked mastitis diagnostic laboratories. The monitoring theme aims to develop and transfer monitoring knowledge and technologies by benchmarking pathogen-specific mastitis incidence, devising efficient monitoring strategies, identifying virulence factors, and testing rapid diagnosis methods. The control theme aims to develop and transfer knowledge and technologies with research on host-pathogen interaction, therapy strategies and antibiotic resistance. The dairy industry contributes management and planning leadership and collaboration. Industry involvement stimulates a sense of program ownership and expectation of transferable results. A national scale network presents challenges related to its size and diversity but advantages include an infrastructure that fosters national and international collaboration and coordination, promotion of trust and mutual-ownership among diverse partners, and an increasing profile for Canadian mastitis research.

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Key Words: Mastitis, Research Partnerships

2 Epidemiology of mastitis: Changes in distribution of pathogens, bulk milk somatic cell count and preventative practices in the last decade. H. W. Barkema*[1], R. G. M. Olde Riekerink[1], R .N. Zadoks[2], and Y. H. Schukken[2], [1]*University of Prince Edward Island*, *Charlottetown, PEI, Canada*, [2]*Quality Milk Promotion Services, Cornell University*, *Ithaca, NY*.

Since the introduction of the standard mastitis prevention program in the 1960s much progress has been made in reducing the prevalence of intramammary infection and mean bulk milk SCC (BMSCC). Standard control methods have been adopted in the majority of dairy herds. In 2004, 96% of Canadian dairy farms applied post-milking teat disinfection, 71% used dry cow treatment on all cows, and 89% used one towel per cow for udder preparation. As a result, Canadian mean BMSCC has decreased from 340,000 in 1989 to 230,000 cells/ml in 2003, an improvement that was stimulated by a stepwise decrease of the regulatory limit from 800,000 to 500,000 cells/ml from 1989 to 1995.

As a result of this program, *Streptococcus agalactiae* is nearly at the point of extinction, although in some low BMSCC herds human strains occur sporadically. *Staphylococcus aureus*, a predominantly contagious pathogen, has become the most prevalent subclinical pathogen. The predominantly environmental pathogen *Streptococcus uberis* is now isolated from an increasing proportion of subclinical cases and has shown to be contagious in some instances. The importance of *Streptococcus dysgalactiae* has decreased. Because of differences in epidemiology and control, grouping of *S. uberis* and *S. dysgalactiae* as environmental streptococci should be avoided. In clinical mastitis samples, *Escherichia coli* has become the most common pathogen, competing for that disputable honor with *Staph. aureus* and, in some countries, *S. uberis*. Approx. 4% of the clinical *E. coli* mastitis cases are recurrent flare-ups of chronic subclinical *E. coli* infections. The importance of coagulase-negative staphylococci in udder health remains to be defined. In conclusion: 1) the effort that farmers are willing to make and the resulting reduction in BMSCC depend on incentive rather than on the current state of knowledge and technology, and 2) we observe an evolution from a black-and-white distinction in environmental and contagious pathogens, or chronic and transient infections, to more omni-potent bacterial species with diverse strains that do not follow these paradigms.

Key Words: Mastitis, Somatic Cell Count, Pathogens

3 Mastitis vaccines: Past, present, and future. G. M. Tomita*[1], B. G. Talbot[2], P Lacasse[3], A. A. Potter[4], X Zhao[5], J Lee[5], and D. T. Scholl[1], [1]*University of Montreal*, *Saint Hyacinthe, Quebec, Canada*, [2]*University of Sherbrooke*, *Sherbrooke, Quebec, Canada*, [3]*AAFC-Dairy and Swine R&D*, *Lennoxville, Quebec, Canada*, [4]*University of Saskatchewan*, *Saskatoon, Saskatchewan, Canada*, [5]*McGill University*, *Montreal, Quebec, Canada*.

Recommended mastitis control practices are at times inadequate in coping with the complex epidemiology of this disease. Therefore, the concept of immunization to enhance resistance to mastitis is a logical approach to augment existing mastitis control procedures. Mastitis vaccine research in the past has led to the commercialization of several products. Cows vaccinated with coliform mastitis vaccines are reported to have a lower incidence and duration of clinical mastitis. However, vaccinated cows are still infected at the same rate as nonvaccinated cows. The administration of vaccines against *Staphylococcus aureus* mastitis has been shown to enhance spontaneous cure rates, but vaccination did not prevent new infections. Therefore, improvements are needed. Advancements in the field of microbial pathogenesis, genomics, and bovine immunology have made the identification of protective antigens a relatively straightforward task. The challenge has been to incorporate these antigens into an effective product. Researchers are currently formulating the next generation of mastitis vaccines which are based on cross-protective antigens from coliform bacteria, *S. aureus*, and *Streptococcus* species. Most vaccines in use today are still formulated and delivered in the same manner as those produced 30 years ago and this will likely be the rate limiting step in the improvement of mastitis vaccine efficacy. The incorporation of novel immunomodulators such as CpG oligodeoxynucleotides, and the employment of alternative vaccine delivery methods such as antigen microencapsulation have the potential to increase the magnitude and quality of the immune response. A successful mastitis vaccine will serve as an additional mastitis control tool in a comprehensive udder health management program. Immunization will complement, but not replace management practices that promote reduction of teat end exposure to pathogens.

Key Words: Mastitis, Vaccines, Immunization

4 Management strategies to maintain udder health. D. Kelton*, *University of Guelph*, *Guelph, ON, Cananda*.

Management strategies employed by Canadian dairy producers to maintain udder health are based on the National Mastitis Council's Ten-Point Plan, encompassing the three broad areas of monitoring, prevention and therapy. The adoption of this plan is supported by an informal network of dairy veterinarians, extension workers and regulatory personnel, who together with the research community are in the process of formalizing a national mastitis network.

Prevention of mastitis is encouraged through the enforcement of somatic cell count (SCC) regulatory limits and the staged implementation of the Canadian Quality Milk (CQM) program. A key component to the CQM is the establishment of standard operating procedures on every farm to ensure that milk is harvested in a manner that safeguards the health of the cow and the product. Current emphasis on providing each cow with a clean and comfortable environment, and on reducing peri-partum disease, are also key components of this effort. A recent study involving over 300 Ontario tie-stall dairy farms confirms the relationship between inadequate stall size and increased SCC at the herd level.

Treatment of sub-clinical mastitis is based on sound dry cow management, which includes the standard recommendation of treating every quarter of every cow. The strategic use of teat sealers/sealants plays a role in preventing new infections during the dry period in some herds. Clinical cases must be appropriately identified, etiologically classified and where appropriate treated based on clearly defined protocols which are consistent with the guidelines established in the CQM program.

Monitoring of udder health is critical to the process, and with approximately 75% of Canadian dairy producers enrolled in milk recording and subscribing to monthly SCC services, there is a strong foundation for this process. Current and future efforts to link diagnostic laboratory culture results to on-farm herd management systems containing clinical case records and SCC data will greatly enhance the monitoring capacity.

5 Mammary tissue damage during mastitis: causes and controls. X. Zhao*[1] and P. Lacasse[2], [1]*McGill University*, *Ste Anne de Bellevue, Quebec, Canada*, [2]*Agriculture and Agri-Food Canada*, *Lennoxville, Quebec, Canada*.

It is well known that mastitis reduces milk production. However, exact underlining mechanisms are not fully understood. Mammary tissue damage causes a reduction of the number and activity of epithelial cells and consequently contributes to decreased milk production. There are two distinct types of cell death, apoptosis and necrosis. Both have been reported to occur during mastitis. Various factors contribute to epithelial tissue damage. Certain bacteria produce toxins that destroy cell membranes and damage milk producing tissue, while other bacteria are able to invade and multiply within the bovine mammary epithelial cells before causing the damage. Breakdown of the extracellular matrix by the plasmin/plasmingen system can also lead to death of epithelial cells. Probably more important but less obvious players are somatic cells, in particular neutrophiles. They are predominant cells in the mammary gland during infection. Their major function is to phagocytose and destroy infectious agents. In addition, they limit the growth of some microbes. At the same time, they can potential harm the mammary tissue by releasing reactive oxygen intermediates and proteolytic enzymes. Different signaling and biochemical pathways leading to tissue damage are being delineated. An *in vitro* co-culture system with activated neutrophils and mammary epithelial cells has been adopted by us to study the potential value of various antioxidant, chelators and enzyme compounds for reducing the damage. The promising compounds were further evaluated using *in vivo* challenge studies. The future challenge is to find economical feed containing active compounds for field study and application. Understanding the biochemical and cellular changes in the mammary gland during mastitis will ultimately lead to means of manipulating mammary function to alleviate the loss of milk production during mastitis.

Key Words: Bovine, Mammary Gland, Mastitis

CSAS Vitamin: Vitamin Nutrition of Livestock Animals

6 Vitamin nutrition of livestock animals: Overview from vitamin discovery to today. L. McDowell*, *University of Florida*, *Gainesville*.

There are 15 vitamins that are of significance to livestock. The term vitamin(e) was first used in 1911-1912. What were later to be known as vitamin deficiency diseases, such as scurvy, beriberi, night blindness and xeropthalmia had plagued the world from antiquity. Around the turn of the 20th century laboratory animals were found not to survive on purified diets containing only fat, protein, carbohydrate, salts and water. Natural foods (e.g. milk) was found to contain small quantities of ?unknown substances essential to life?. Experiments with animals contributed greatly from 1900 through the 1930s to the discovery of vitamins. The development of the concept of vitamins can be roughly divided into four (broadly overlapping) periods. 1) Empirical healing of some diseases by administration of certain foods. 2) Development of analytical capabilities to identify classes of nutrients in foods. 3) Experimental induction of dietary diseases in animals; and 4) Administration of synthetic diets to discover essential nutritional factors. In the 1950s to the present, vitamin deficiencies became more common place when livestock were denied pasture and moved into confinement. Today typical grain-oilseed meal (e.g. corn-soybean meal) monagastric diets are generally supplemented with most vitamins, thiamin and vitamin B_6 seem to be less likely deficient. A number of factors influence vitamin requirements and vitamin utilization and include: physiological make-up and production function; confinement rearing without pasture; stress, disease and adverse environmental conditions; vitamin antagonist, use of antimicrobial drugs, and