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Research and Teaching of Dairy Cattle Well Being: Finding Synergy Between Ethology and Epidemiology

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Epidemiology is a tool used to identify and quantify risk factors that contribute to the state of health or disease. In addition, the maintenance of health and recognition of nonhuman animal welfare are both key principles of health management. Animal welfare and ethology provide important contributions to our ability to understand and improve health. As such, there can be a strong connection between the disciplines of ethology and epidemiology. This connection becomes a synergy through collaborative research. At the University of Guelph, and at other institutions, dairy health management research efforts involving collaborations between faculty trained in ethology and epidemiology have led to refined and improved research programs, improved access to funding, and a broader extension audience. Furthermore, these collaborations have enhanced teaching programs and facilitated the integration of ethology and welfare topics throughout the veterinary medical curriculum. The paper provides the basis and context for the synergy between ethology and epidemiology and describes examples of teaching and research programs built upon this synergy for the enhancement of dairy cattle well being.

On a worldwide basis, there is a growing awareness and interest in the welfare of food nonhuman animals. Coincident with this awareness is a “gate to plate”
view of food production and a recognition of consumer concern about how food is produced. One of the major elements of this concern is the question of the welfare of animals raised for food. The exposure of inhumane practices toward cull dairy cows in a California slaughter plant in 2008 has brought welfare issues in dairy cattle to the forefront of public scrutiny.

Commercial companies are selling their products into niche markets for specialty foods and are incorporating the welfare of their source animals as a component of their marketing programs.

The topics of animal welfare and on-farm welfare audits are now common components of professional dairy meetings. Despite the increasing awareness of animal welfare issues and the existence of voluntary codes of practice being in place for the humane treatment of dairy animals, several management practices currently conducted by either producers or by veterinarians are questionable from an animal welfare perspective. Recently, there have been a number of papers published describing attitudes about, and practices employed for, pain management in food animals. In Canada, researchers surveyed food animal veterinary attitudes with respect to use of analgesia (Hewson, Dohoo, Lemke, & Barkema, 2007). In another publication, both dairy producers and veterinarians were surveyed concerning their approaches to the use of anesthetics and analgesia for dehorning dairy calves (Misch, Duffield, Millman, & Lissemore, 2007).

Similar surveys have been conducted in other countries (Huxley & Whay, 2006; Fulwider et al., 2008). The general consensus from this current body of work is that a major gap exists between many current producer and veterinary practices when compared with recommended codes of practice for dairy production systems. For example, the Canadian dairy code of practice advises the use of local anesthetics for routine surgeries such as dehorning to avoid unnecessary pain (Agriculture Canada, 1990). However, only about 35% of dairy calves in Ontario are dehorned with the benefit of local anesthetic (Misch et al., 2007). In the United States, the percentage of calves receiving local anesthetic falls to 10% (Fulwider et al., 2008). Although there are many reasons for the gap between recommendations and practice, lack of education and lack of applied research data are two very important components.

Recommendations become industry standards only through the research-education-extension feedback cycle (Figure 1). As much as is possible, both decisions and recommendations should be evidence based. The highest levels of evidence come from the results of laboratory experiments and ultimately from randomized clinical trials. Biological plausibility is the next level of evidence. Although plausibility is perhaps better than some other forms of evidence, such as experience and tradition, the assumptions made through this extrapolation are not always correct. Unfortunately, many individuals continue to utilize the same practice because of either a belief that it works (experience) or because it has
always been done that way (tradition). One potential limitation of some animal welfare recommendations is, in fact, lack of evidence to support them. This lack of evidence should fuel well-designed research. The animal well-being issues need to be taught and the research results reported. Finally, both the issues and the results need to be extended to various jurisdictions in the dairy industry, such as to producers, professionals, and regulatory bodies. This evidence-driven process of technology transfer is termed a feedback cycle because there can, and often is, feedback by students and extension audiences to researchers that may trigger new research projects or teaching initiatives.

The Department of Population Medicine at the University of Guelph has been very fortunate, over the past several years, to have a faculty member in the department who is trained in ethology and animal welfare. Interactions between faculty colleagues in ethology, health management, and epidemiology have created a strong synergism for new research efforts across species in the field of food animal welfare. The dairy health-management research team has been a profound beneficiary of this excellent collaboration. Similarly, collaborations with the veterinary team have strengthened the animal welfare research efforts by directing research questions toward the complexities of how animal welfare factors interact in practice and by contributing medical knowledge, particularly

FIGURE 1 The Research/Teaching/Extension Feedback Cycle. Research fuels teaching subject matter and leads to extension to the industry. Questions from students or industry lead to new research. Ultimately, educated industry changes or modifies the industry standard.
in terms of pain and sickness behavior in the commercial environments versus the laboratory. However, this synergism does not end with the research efforts. In fact, the collaborations cross into both teaching and extension. It is believed that the synergy stems from a strengthened approach to animal welfare and ethology research and teaching. This paper discusses the various aspects of the synergy between animal ethology and epidemiology.

WELFARE AND EPIDEMIOLOGY TEACHING

Since 2000, revisions to the curriculum of the Doctor of Veterinary Medicine program at the Ontario Veterinary College, University of Guelph, have resulted in a marked increase in the focus on animal welfare and ethology in the material that is being taught. A restructured series of courses called Health Management (I, II, III) contain elements of food animal welfare, which are integrated with blocks of material on each major animal species, public health, and epidemiology. Health management is defined as the promotion of health, improvement of productivity, and prevention of disease in animals within the economic framework of the owner and industry, while recognizing animal welfare, food safety, public health, and environmental sustainability (Duffield, Lissemore, & Sandals, 2003; LeBlanc, Lissemore, Kelton, Duffield, & Leslie, 2006; Millman, Adams, & Turner, 2005).

As such, the definition of health management includes animal welfare as one of its core elements. It is considered very important that animal welfare is taught both implicitly and explicitly. In other words, rather than having the animal welfare topics delivered solely by an ethologist, they are addressed as a component of health management by several different instructors. For example, in the 1st-year curriculum, the important issues of farrowing crates for sows and battery cages for layer hens are discussed by the swine and poultry health management faculty, respectively. Welfare topics continue to be addressed throughout the curriculum, focusing on the clinical aspects involved in specific rotations in senior year.

Since 2004, a 1-week final year elective in animal welfare has been offered to provide training in the veterinarian’s role in animal cruelty investigations as well as animal welfare auditing programs on farms and at livestock markets (Millman et al., 2005). Also, in the ruminant health management rotations, students are specifically taught techniques such as cornual nerve blocks for dehorning dairy calves, current roles and understanding of nonsteroidal anti-inflammatory drug (NSAID) therapy, timely management (and euthanasia) of downer cows, and therapy for chronic lameness. In addition, there is a strong emphasis on prevention of disease for the maintenance of animal well being. However, the on-label use of therapeutic agents is greatly encouraged, as is
the food safety responsibilities of veterinarians, as well as both the merits and cautions of extralabel drug use. These latter issues may conflict with welfare recommendations. Hence, regulatory issues and various regulatory agencies need to be an important and growing focus for the extension of the results from animal welfare research.

**WELFARE AND EPIDEMIOLOGY RESEARCH**

Traditionally, epidemiology has focused on the study of disease, particularly quantifying frequencies on-farm, investigating risk factors for occurrence, and—perhaps most important—studying disease in the “natural” or “on-farm” setting. The nature of these large-scale epidemiological investigations often necessitates a compromise in the research methods utilized by employing surrogate outcome measures rather than the collection of more precise variables, due to both cost and practicality.

Traditional animal welfare research has historically been subjective in some cases but precise and exact in others. Such studies have often involved a small number of animals measured intensively at a research facility. Both of these approaches to research can have great merit, depending on the application of the findings. However, independent approaches to welfare research by either the epidemiologist or the ethologist may lead to very different research designs.

The research synergy is derived from both sides. For example, the researcher trained in epidemiology might argue for increased sample size to provide more power to the study, realizing (from uncontrolled field research) that biological variation often limits power in many small-scale studies. Alternatively, the epidemiologic researcher may try to refocus outcomes on more practical on-farm or similar-to-farm types of questions. On the other hand, the ethology-trained researcher might argue for more objective measures or even the conducting of some research at a research center (instead of the field), where more rigor and intensity can be conducted and controlled. The end result of either scenario is strengthened study designs.

Examples of the collaborations between ethologists and epidemiologists include the producer and veterinary dehorning surveys (Misch et al., 2007), trials assessing the role of meloxicam in addition to lidocaine for pain management at dehorning (Heinrich, 2007), and the use of meloxicam as an adjunct therapy in cases of neonatal calf diarrhea complex (Todd, 2007). On the epidemiology and health management side, there is a collective experience with working in the field, collecting field level data, and a strong understanding of both practitioner and producer concerns and limitations.

The ethology expertise has highlighted the welfare issues and concerns more prominently and added strong scientific methodology. These ideas have com-
plemented traditionally strong, epidemiologic analytic approaches. Furthermore, both parties often have a unique set of contacts that have led to excellent funding opportunities for welfare research. It is our ongoing mission to conduct research that addresses specific, practical welfare needs on-farm. In addition, there is a defined goal to have a direct impact on the daily routine in dairy production and in ruminant health-management veterinary practice by providing evidence-based recommendations.

WELFARE AND EPIDEMIOLOGY EXTENSION

Traditionally, extension efforts are often considered translation of research results to the layperson (or animal industry personnel). However, animal welfare extension education should also include professionals (including veterinarians, animal scientists, and nutritionists), regulatory agencies, purchasers (such as procurement officers for supermarket and restaurant companies), and animal-protection organizations.

The synergy between ethology and epidemiology described in this paper has included access to key producer meetings, broader extension (welfare meetings, veterinary meetings, and animal science meetings), and access to regulatory agencies and international organizations. The dehorning research collaborations represent a good example of the breadth of extension that can occur. Among the authors involved, presentations on the dehorning research have been delivered at several international professional meetings, including the American Dairy Science Association, the American Association of Bovine Practitioners, the World Buiatrics Congress, and International Society of Animal Ethology.

In addition, we have presented at meetings of both dairy veterinarians and dairy producers in Ontario and in the United States on several occasions over the past 3 years. Of considerable interest and importance, a meeting with the Canadian veterinary drug regulatory agency, Veterinary Drugs Directorate (VDD), was organized with integrated presentations from both ethologists and epidemiologists regarding the possibility of a label claim for NSAID therapy in dairy calves for pain at dehorning and for malaise during diarrhea. The impact of this combined and integrated approach of these disciplines is remarkable.

THE RESEARCH/TEACHING/EXTENSION FEEDBACK CYCLE

Dehorning Example

Several years ago, a 3rd-year veterinary student approached two of the authors of this paper with a simple question and a research proposal. The question
was, “Why is it that in small animal surgery there is tremendous attention paid to postsurgical pain management, yet there is seemingly little focus on pain management in food animals?” The proposal was to conduct a dehorning study to assess the potential role of ketoprofen in addition to lidocaine for providing additional pain relief when dehorning young dairy calves.

The student involved had a compelling argument. As such, a small amount of funding was secured, and the study was conducted. The results, which involved dairy calves dehorned between 2 days to 2 weeks of age with a small butane dehorner, showed little behavioral benefit to therapy with ketoprofen. However, there was a small reduction in serum cortisol at 3 hr following dehorning (Milligan, Duffield, & Lissemore, 2004). Previous research had demonstrated strong behavior benefits for ketoprofen in older calves (Faulkner & Weary, 2000). However, in that study, the ketoprofen was administered three times in 24 hr. We wanted to test something that was more practical for on-farm use (one treatment of ketoprofen at the time of the lidocaine nerve block). Thus, a follow-up study was conducted with the same design as Milligan et al. but with calves 4 to 8 weeks old dehorned with the larger electric cautery device (Rhinehart).

In this study, there was a significant reduction in ear flicks, an established behavioral indicator of dehorning pain in the calf (Faulkner & Weary, 2000; Milligan et al., 2004) for the ketoprofen group, and a tendency for greater calf starter intake in the 24 hr following dehorning (Duffield et al., in press). The results of both of these studies have been presented to regional veterinary and producer audiences. The key message delivered was to dehorn young and to use lidocaine local anesthetic. If it is necessary to dehorn older calves, then both lidocaine and ketoprofen should be used.

A repeated comment received during these extension efforts was that the lidocaine local anesthetic makes no difference to calf behavior at the time of dehorning. Although there had been studies documenting physiologic responses to dehorning without anesthesia in older calves, we could find no information on younger calves (<2 weeks old). In response to these comments a study was designed to compare lidocaine versus ketoprofen versus no therapy in calves dehorned with a butane dehorner.

The farm used for the study routinely dehorned calves without lidocaine. The research technician who conducted this research was blinded to the treatment groups but was nine for nine in identifying the lidocaine-blocked calves. A surprise for many observers of this research was that calves not given a lidocaine nerve block did not frequently vocalize. The most common behavioral reactions to the acute pain were foot stamping and tail flicking. The blocked calves allowed their tails to hang in a relaxed posture more frequently. The videotaped contrasts of these treatment groups have been a tremendous extension tool.

The next major component of this work was to survey the dairy industry and dairy veterinarians to determine what is actually happening in the field. It
is clear that recommendations for approaches to dehorning should be tailored for the industry. From this work, it was discovered that the majority of dairy producers dehorn their own calves, primarily with the electric Rhinehart device at 4 to 8 weeks of age (Misch et al., 2007).

Therefore, recommendations need to address producers and should be relevant for calves of this age and for this method of dehorning. It was also found that most veterinarians used lidocaine and were highly influential in producer-dehorning decisions.

The dehorning effort to this point has led to the following industry recommendations:

1. Dehorn calves at a young age (ideally less than 2 weeks of age).
2. Use a lidocaine nerve block on all calves for dehorning (unless using caustic paste).
3. Use an NSAID (for example, ketoprofen) for all calves dehorned at greater than 4 weeks of age.
4. Consult your veterinarian to develop a dehorning protocol for your farm.

It is our hope that these recommendations will become the industry standard. The final component of this dehorning research and extension effort is the regulatory approval aspect. The lack of an approved NSAID for dehorning pain requires using extralabel drugs for this purpose. In Canada, this approach can be used. However, the use of off-label medication conflicts somewhat with our teaching philosophy, and it is not at all legal in the United States (Smith, Davis, Tell, Webb, & Riviere, 2008).

A recent study has been completed on the efficacy of meloxicam for reducing pain at dehorning. The VDEE Efficacy Evaluation Group provided input into the study design and indicated that the research team should provide evidence of pain relief through multiple modalities (behavior, physiology). This research has demonstrated that one injection of meloxicam at the time of the lidocaine nerve block (10 min prior to dehorning) improves physiologic outcomes (heart rate, respiratory rate, serum cortisol), reduces pain sensitivity, and provides behavioral benefits for up to 44 hr post dehorning (Heinrich, 2007). Regulatory submission for approval of meloxicam for alleviation of pain associated with dehorning is under way.

Tail Docking Example

Another revealing example of the research, teaching, and extension feedback cycle is evident with approach of the dairy industry following research and extension on the practice of tail docking. Approximately 10 years ago, it had become dogma that docking tails improved cow cleanliness in freestall situations
and reduced the risk of mastitis. In a relatively short period of time, tail docking became widespread in parts of the United States and Canada.

However, appropriately conducted research has subsequently investigated this practice and has shown that there is no benefit to the cow for docking tails (Schreiner & Ruegg, 2002), despite only mild behavioral responses of acute pain associated with docking in either young calves or adult cattle (Tom, 2001). Although many farms still tail dock, particularly in herds using parallel-milking parlor systems, extension of the research information has caused numerous farms to reevaluate the need for this practice and cease doing it.

FUTURE SYNERGY OF WELFARE AND EPIDEMIOLOGY IN DAIRY RESEARCH, TEACHING, AND EXTENSION

It has been argued that the most important advance in dairy health management over the past 25 years has been the shift from treatment to prevention of disease and a focus on the herd rather than on the individual (LeBlanc et al., 2006). Epidemiology was described as a tool that helped to quantify the interconnected risk factors that affect the frequency of disease. It is distinctly possible that when looking back on the current and near-future years for groundbreaking developments, a focus on animal welfare as a component of health management might be seen as the most important advance during this time.

However, this development goes well beyond the recognition of humane practices and collaborative research on finding best management practices: invoking new industry standards, even helping to force regulatory change. There is a growing recognition that animal welfare is an integral component of animal health. For example, recent research has documented that cows developing metritis 5–10 days postcalving ate significantly less than their healthy counterparts during the last 2 weeks precalving (Huzzey, Veira, Weary, & von Keyserlingk, 2007). Frequent group changes that result in social stress, increased pen density, and limited feeding space are possible reasons that cause a reduction in feed intake and subsequent postpartum disease. It is quite likely that understanding the behavioral changes that occur will yield a positive improvement in animal health.

Another example of the synergy between ethology and epidemiology is evident with the research on pain management as adjunctive therapy for neonatal calf diarrhea complex in dairy calves. The multiple causes and treatment for diarrhea are well documented in food animal medicine textbooks (veterinary medicine). However, there is currently limited information that quantifies the pain associated with calf diarrhea or evidence to support a recommendation to use NSAIDs as an adjunctive therapy.
Hence, a recent research program has been completed and has documented large benefits for adjunctive administration of meloxicam (in addition to traditional therapy such as fluids) for recovery from diarrhea caused by Cryptosporidium parvum (Todd, 2007). In this study, calves treated with meloxicam rested more (less active) early in the course of the disease and were more active later, during the 5 days following treatment. In addition, meloxicam-treated calves needed less assistance at milk feeding, ate calf starter sooner, and were weaned earlier than their untreated counterparts. Thus, the concept of sickness behavior and provision of pain relief to allow normal convalescence during disease is an emerging field of importance that links welfare and epidemiology to maintenance of health.

Other areas of dairy health management that need future research include investigating the potential benefits of managing postsurgical pain in adult dairy cows (following Caesarian sections or abomasal displacement surgeries), research into the potential role of NSAIDs following normal and assisted parturition, and methods to control the pain of lameness and clinical mastitis. Furthermore, empirical data are needed at the end of the cow’s productive life to support decision making in terms of culling, euthanasia techniques, and humane end points.

CONCLUSION

Recognition of animal welfare is one of the five principles of health management. Epidemiology is an important tool of health management. Therefore, it is contended that the disciplines of ethology and epidemiology are integrally interrelated. Since the formation of the Department of Population Medicine at the University of Guelph in 1987, there has been a strong focus on health management and an emphasis on the utility of epidemiology for quantifying and preventing animal health problems.

Yet, the introduction of a faculty member who is trained in food animal ethology into this department has been a key to recognizing that there is a synergy between welfare and epidemiology. This synergy has provided complementary research and teaching methods, has strengthened access to research resources and funding, and has provided new avenues of dairy extension education. Furthermore, there has been an evolving recognition that welfare is more than a component of health management and is quite possibly a risk factor for health and disease.

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