treatments per 100 cows per year, with a range from 15.1 to 132.7. Lesions typically associated with laminitis were responsible for 34% of foot treatments, with the remainder due to infectious causes.
Existing data regarding the significance of risk factors such as overcrowding, limited access to feed, heat stress, exposure to concrete, stall usage and pen design will be reviewed. New data from two surveys of lameness on well managed Wisconsin dairy farms will be presented, demonstrating significant differences in lameness prevalence between different housing systems and different stall surfaces.
Preliminary cow behavior and locomotion scoring data from current research conducted on herds utilizing freestall housing, using 2 or 3 row pen designs, and either sand or a rubber crumb filled mattress stall surface will be presented, which will test the working hypothesis that the environment in which we place the cow is the final determinant of the prevalence of lameness and laminitis on the farm.

Key Words: Lameness, Laminitis, Environment

110 Nutritional approaches to minimize subacute ruminal acidosis in dairy cattle.

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Subacute ruminal acidosis (SARA) is very costly to the United States dairy industry. Reduced ruminal efficiency, liver and lung abscesses, and laminitis are all thought to be related to SARA. Both the nutritionist and the dairy's management are responsible for the delivery and consumption of a ration that is likely to be ruminally pH healthy. Nutritionists should consider the expected amount of physically effective NDF provided by ration ingredients, along with their expected ruminal fermentabilities and resultant microbial acid production. Environmental conditions, such as heat stress, over-crowding, and uncomfortable stalls, which may alter feed intake patterns and animal behavior should also be considered in ration formulation. Additional physically effective NDF, and/or a reduction in ruminal NSC availability, may well be warranted during times of increased animal stress. Higher levels of intake may also predispose the rumen to SARA, since buffer production may not adequately compensate for additional acid production. The addition of dietary buffers, biotin, and organic zinc may also aid in reducing acidosis and laminitis. Dairy managers and feeders are responsible for delivering the formulated ration. Forage dry matters should be taken biweekly, or more frequently if results vary by more than five percent of the DM value. Ration variability can be further reduced by premixing individual forages, or at least attempting to make each loader bucket of feed a uniform mix obtained from the entire height of the silo. Dairies should consider investing in electronic feed recording systems. These systems record the precision of ration manufacture by the feeder, and foster the development of healthy competition among feeders, resulting in enhanced mixing accuracy. Ingredient sequencing and mixing time should be standardized on a given dairy. Techniques to minimize sorting, including frequent feed pushups, the addition of water or a low dry matter byproduct, and appropriate forage processing, should be adopted by managers.

Key Words: SARA, Laminitis, Dairy cattle

111 Biomechanical aspects of the pathogenesis of claw horn disruptions in dairy cattle.

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Despite intensive study, knowledge of the precise aetiology and pathogenesis of bovine laminitis is still incomplete. It is often hypothesized that changes in the microcirculation of the corium (dermis) of the bovine claw contribute significantly to the development of laminitis. The cause of laminitis should be considered as a combination of predisposing factors leading to vascular reactivity and inhibition of normal horn synthesis. Nutrition, disease, management and behaviour appear to be closely involved in the pathogenesis of bovine laminitis. The only consistent feature in chronic laminitis is the sinkage of the pedal bone that compresses the corium in the sole and heel. However, the relationship between the development of these lesions and the anatomical structures of the distal phalanx or the supportive heel cushion under the bone are unclear. These structures were therefore examined in 19 cows with an ulcer at the typical site. There was a direct relationship between displacement of the third phalanx and ulceration of the sole or heel; the third phalanx had dropped in all the ulcerated claws and the corium and the subcutis under the bone were thinner than in the controls. The supportive cushions of the ulcer group contained less fat tissue. There was no histological evidence of damage to the epidermis or the corio-epidermal junction in the ulcerated claws nor were the lamellae elongated. Similarly, there were no morphological alterations in the connective tissue layer (submural dermis). The lack of support for the theory that the separation of tissue layers at the laminar interface is an essential requirement for the third phalanx to sink leaves the only alternative explanation; the properties of the connective tissue of the suspensory apparatus must have undergone a change that resulted in excessive flexibility of the dermal segment. Details on the biochemistry of the connective tissue of the suspensory apparatus are presented by Webster and Tarlton at this conference.

Key Words: Laminitis, Dairy cattle, Claw horn disruption

112 Monitoring techniques to minimize laminitis.

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Lameness in dairy cows includes many disease conditions caused by a wide variety of infectious, nutritional, traumatic, genetic, housing, and behavioral factors. Laminitis and its sequelae are the most common conditions in several surveys of dairy cow lameness. While laminitis is a multi-factorial disease, many dairy operators and advisors focus prematurely on ruminal acidosis as a primary cause. Accordingly, nutritionists frequently find themselves in a default defensive position while servicing herds with lameness problems. In the last decade, a variety of practical field tools have been developed that can differentiate lameness conditions in a specific herd and identify primary risk factors.
Lameness prevalence can be quantified using a modification of a published lameness scoring system. Entire herds can be scored quite easily as they walk access lanes. Hoof health record systems have improved and are used by many professional hoof trimmers, which has made it easier to monitor the prevalence of digital dermatitis, laminitis, and other conditions. If laminitis is a herd problem, the primary risk factors of subacute ruminal acidosis (SARA), excess standing time on concrete, and replacement heifer management should be evaluated.
Stall usage indexes are being developed to estimate time spent lying down in stalls. Recent research is providing information on factors related to freestall design which influence lying time. Time in holding areas and parlors can be assessed, with an emphasis on the longest times for the last individual cows to come through the parlor.
Field tests for ruminal acidosis have emerged to compliment ration analyses. Rumenocentesis is a direct measure that provides diagnostic information when adequate samples are collected. Visual evaluations of washed screened feces provide useful information about rumen passage rates. Production records, combined with clinical signs of SARA such as diarrhea, irregular and reduced dry matter intake, laminitis, multifocal hepatic and pulmonary abscess, and hemoptysis or epistaxis, can provide useful diagnostic information.

Key Words: Laminitis, Ruminal, Acidosis

Food Safety Symposium: Emergence of antimicrobial resistance and implications to animal agriculture

113 Epidemiological principles relating to the study of antimicrobial resistance in animal agriculture.

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The emergence and spread of antimicrobial resistance among bacterial populations has major health and economic consequences in both human and animal populations. Of particular concern is the impact of animal agricultural antimicrobial use on human health. Understanding the epidemiology and ecology of antimicrobial resistance and finding solutions to counter this problem will be difficult, primarily due to the complexity of the issue. The purpose of this presentation is to highlight key epidemiological principles that are often overlooked and always problematic in antimicrobial resistance studies. One key epidemiological principle that must be considered is the background level of antimicrobial resistance. For example, to state that a certain antimicrobial use causes changes in

antimicrobial resistance, we must estimate the level of resistance in the absence of this use. Another difficulty in comprehending antimicrobial resistance relates to the diversity of ways in which antimicrobial resistance can be defined. Elevated MIC of the bacterial isolate, presence of a resistance gene in the bacterial isolate, or presence of a resistance gene in the total community DNA of the sample have all been used as resistance definitions and each necessitates a different study design and warrants different conclusions. Implicit in the methods of epidemiology is the ability to describe and predict distributions, trends and patterns; these methods can be problematic in relation to antimicrobial resistance. One difficulty is determining whether fluctuations are due to real changes in the prevalence of resistance mechanisms or simply due to changes in the prevalence of a single resistant bacterial clone. Assessing trends is also made more difficult by the presence of genetic linkages, thus enabling genes that are not under selection pressure to persist or even increase in prevalence. In conclusion, there are many factors that can dramatically affect antimicrobial resistance investigations and their inferences made from these studies. Research into the effects that these factors have on perceived outcomes and the means by which these factors can be controlled is essential if we are to make accurate inferences about the dynamics of antimicrobial resistance.

Key Words: Antimicrobial resistance, Epidemiology, Molecular

114 Transfer of antibiotic resistance genes from farm animals to man - how likely, how dangerous?

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A safety issue that has been central to the debate over agricultural use of antibiotics has been the possibility that antibiotic-resistant bacteria or antibiotic-resistance genes would move through the food supply and into the human intestine. A number of studies have shown that bacteria from the intestines of animals are unlikely to be able to colonize the human intestine and would persist only transiently in that site. Transfer of resistance genes, however, is more likely and thus more problematic. The concern is that resistance genes could move into human intestinal bacteria that persist in the human colon for years and are capable under some conditions of causing human disease. Most of the literature on the movement of resistance genes through the food supply and into the human intestine has focused on bacteria such as *E. coli* or *Enterococcus* sp., which are minor components of the human colonic microbiota, accounting for <1% of bacteria in the colon. The more numerous species such as *Bacteroides* species or the Gram-positive anaerobes, which account for 25% and >70%, respectively, of colonic bacteria are the species most likely to encounter incoming bacteria and acquire genes from them. The colonic anaerobes are opportunistic human pathogens that can cause disease if they escape from the colon, e.g., during surgery or trauma to the abdominal area, and enter blood or tissue. A recent survey of *Bacteroides* isolates revealed that a surprising amount of horizontal gene transfer takes place among *Bacteroides* strains in the colon. The gene transfer elements most often involved in these resistance gene transfer events were conjugative transposons, a type of conjugal elements that has not received much attention until recently. Another more recent survey has revealed two new conjugative transposons that may have entered *Bacteroides* species from Gram-positive bacteria. Thus, results obtained to date support the hypothesis that there are few, if any, limits on resistance gene transfer among colonic bacteria. Although these transfers appear to have occurred relatively recently, in most cases the genes are expressed in their new hosts. These studies have provided information about the movement of DNA into one group of colon bacteria, *Bacteroides* species. Nothing is known about gene transfer elements of the Gram-positive anaerobes, the other major group of colonic bacteria.

Key Words: Antimicrobial resistance, Food safety, Bacteria

115 Antimicrobial use in food animals and the search for potential alternatives.

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Antimicrobials have been used for over fifty years in food animal production to maintain herd health and to increase productivity. But the resulting increase in antimicrobial resistance among enteric bacteria has created two principal concerns: 1) the emergence of drug-resistant pathogens leaves the producer with fewer tools to manage disease, and 2) a reservoir of antimicrobial-resistant bacteria has the potential for transmission to humans via the food chain. The most logical intervention strategy to combat the increase in antimicrobial resistance is to reduce the selection pressure. Prevention and control measures seek to promote prudent use of antimicrobial drugs through educational programs and to limit the availability of antimicrobials through regulatory actions. But such measures may not be sufficient to reduce the prevalence of resistance, as linkages of resistance genes allow the selection pressure of a single antimicrobial to co-select for resistance to multiple agents. Thus, simultaneous reductions in the selection pressures of all co-selecting agents may be required to reverse the persistence of antimicrobial resistance in the animal production environment. This necessitates the development of alternative, non-antimicrobial methods to maintain animal health and productivity. Some of the products currently under development include the following: 1) chlorate, to reduce certain populations of the family Enterobacteriaceae in the gut, including *Escherichia coli* O157:H7 and *Salmonella*; 2) immune modulators, to protect against infection through preventive activation of the innate immune system; and 3) competitive exclusion cultures, to prevent gut colonization with pathogens by first treating the gastrointestinal tract of neonates with healthy gut microflora. The application of alternative pathogen control measures will decrease the total usage of antimicrobial drugs and will likely have the greatest impact on reduction of antimicrobial resistance among enteric bacteria in food animals.

Key Words: Antimicrobial resistance, Food safety, Animal health

116 Antimicrobial resistance in commensal and pathogenic bacteria from swine and their implications for the swine industry.

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Resistance to antimicrobials is an increasingly common problem in both veterinary and human medicine and its management is the subject of an important debate. Considering antimicrobial resistance on a broad scale, across an entire industry, can be a complex and daunting task. However, to consider all antimicrobials, all bacteria and all antimicrobial use as respective equals, creates a skewed view of the problem. Therefore a more systematic approach is warranted. The development of antimicrobial resistance in swine pathogens, which can have a direct impact on the health and well being of the animals as well as on production costs, is important to consider. Antimicrobial resistance in zoonotic pathogens is an important occurrence identified worldwide and the industry has a role in the control of these organisms. Additionally, development of antimicrobial resistance in commensal organisms may play an important role in the ecology of resistance overall, thus cannot be ignored. The antimicrobial resistance problem has a broad landscape, however it is important to understand why an organism has become resistant and consider the consequences of the particular antimicrobial resistance. Programs that are in place to answer these questions will be explored as well as a presentation of data resulting from some of these programs. Antimicrobial resistance has had some important impacts on animal production industries, including the swine industry. The swine industry has put forth important efforts to understand antimicrobial resistance in its production systems. With the wide reaching impact of this problem, it is important that efforts to understand and control antimicrobial resistance in all organisms and host species are refined and continued.

Key Words: Antimicrobial resistance, Swine, Bacteria