Investigation Strategies for Laminitis Problem Herds

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ABSTRACT

Lameness in dairy cows includes many disease conditions, and a systematic approach is required to diagnose the predominant causes and identify the important risk factors. Lameness prevalence can be quantified using locomotion scoring systems. Entire herds can be scored quite easily as they walk access lanes. If lameness prevalence exceeds 15% of the herd, it is important to differentiate the cause. Improved hoof health recording systems have become commonplace amongst many professional hoof trimmers, which has made it easier to monitor the prevalence of infectious and non-infectious causes of lameness. If laminitis and its associated claw horn lesions are identified as a major problem, environmental and ruminal acidosis risk factors should be assessed. Environmental risk factors for laminitis include aberrant and excess standing behavior, exposure to concrete and hard floor surfaces and abrupt introduction to confinement systems from pastures or bedded packs. Total daily time spent by cows in holding areas and parlors can be assessed, emphasizing the longest times for the last individual cows to come through the parlor. Stall usage indices are being developed to identify poorly designed or maintained freestalls. The diagnosis of ruminal acidosis is made with a combination of clinical signs, ration evaluation, ruminal fluid analysis, feces examination, or milk fat indicators. Rumenocentesis is a direct measure of rumen pH that can provide diagnostic information, provided that adequate samples are collected. This paper presents a clinical approach to investigations of lameness problem herds and discusses strengths and weaknesses of various tests to identify risk factors for laminitis.

Key Words: (lameness, laminitis, ruminal acidosis, rumenocentesis, stall usage)

Abbreviation Key: **CCQ =** Cow Comfort Quotient, **CCI =** Cow Comfort Index, **SSI =** Stall Standing Index, **SARA** = subacute ruminal acidosis

INTRODUCTION

Lesions of the bovine hoof are common in dairy cows managed in a variety of different management systems. They cause milk production loss (Warnick et al., 2001; Green et al., 2002), reduced fertility (Collick et al., 1989; Hernandez et al., 2001) and increased risk of culling (Collick et al., 1989). In addition to the economic impact, hoof disease is extremely painful (Whay et al., 1998), making lameness in dairy cattle a serious animal welfare issue.

There are many different lesions associated with the bovine hoof, but it is useful to divide them into three primary groups: infectious digital disease, laminitis and associated claw horn lesions, and lesions caused by excessive hoof wear and/or trauma (Guard, 2000). This classification provides a simple, yet useful framework from which to approach lameness problems from a herd perspective.

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 for laminitis. An investigative approach using many of these tools is presented as a flowchart (Figure 1). The paper summarizes field experiences using these tools and suggests modifications of some of them, with the goal of increased efficiency in achieving a herd-based diagnosis of laminitis and recognition of its associated risk factors.

ASSESSING THE SEVERITY OF LAMENESS IN A HERD

Locomotion Scoring and Assessment of Lameness Prevalence

Assessing the prevalence of lameness in a herd is the first step of a lameness investigation. Signs of lameness in dairy cattle include a nodding movement of the head in a vertical plane as the lame foot makes contact with the ground; arching of the spine associated with pain (cows in extreme discomfort may salivate from grinding of the teeth); shortening of the stride length, and sinking of the dew claws of the unaffected contra-lateral hind-limb as it bears weight; and a reduction in the speed of walking, with frequent stops to rest the affected limb.

Table 1. Locomotion scoring system used to determine herd lameness prevalence with suggested targets for proportion of herd at each score.

Locomotion Score	Description	Definition	Herd Target Prevalence
1	Walks rapidly and confidently, making long strides with a level back	Sound	65
2	Walks more slowly, making shorter strides with an arched back. Stands with a level back and does not appear to favor a limb.	Slight Lameness	20
3	Often thin, walks slowly making deliberate short steps, with an arched back, making frequent stops. Encounters difficulty turning. Stands with an arched back and frequently lifts affected foot.	Moderate Lameness	15
4	Usually very thin. Moves very slowly making frequent stops to rest affected limb, which is only partially weight bearing. Frequently salivates and encounters extreme difficulty turning. Stands and walks with a pronounced arched back.	Severe Lameness	0

Using various combinations of these signs, a variety of locomotion scoring systems have been developed for dairy cattle. There are important practical differences between the systems when they are applied in the field. With nine points, the Manson and Leaver (1988) system is difficult to learn and is somewhat cumbersome, especially as the first five scores deal with animals that are not clinically lame. It does, however, have the advantage of stressing the importance of early signs of discomfort. Wells et al. (1993) and Vokey et al. (2001) introduced 4-point systems that score the animal as sound, mild, moderately and severely lame. Sprecher et al. (1997) introduced the shape of the cows' back into a 5-point scoring system. A practical limitation of the Sprecher system is the distinction between the Score 2 cow that arches her back while walking and stands with a flattened back, and the Score 3 cow that maintains an arch both when walking and standing. Most herds are scored as the cows walk between the parlor and the pen. It is unusual for the investigator to be able to view each cow while it is both standing and walking, making it difficult to make the distinction between 2 and 3 scores. Because of this limitation, Cook (In Press) used the scale proposed by Wells et al. (1993), but modified it to utilize observations on the arch of the back (Sprecher et al., 1997). The specific criteria for scoring are shown in Table 1. Cows scoring 3 or 4 in this system are considered to be clinically lame.

Whatever the locomotion scoring system, there are some practices that should be observed to improve the value of the scoring exercise. All of the lactating cows in the herd must be scored. There may be marked differences between pen groups, and it is essential that the sick pen be scored. The cows should be scored while walking on a solid, flat, non-slip, well-lit surface. If repeated observations are made, the same surface should be used. If possible, the herd should be scored with a secondary observer in order to remove some of the subjectivity of the scoring and calculate a mean prevalence from the two scores. It is often beneficial to have the dairy owner or manager present for at least part of the scoring process. Finally, it is useful to keep a clearly defined record system that may be retained for future reference.

Interpretation of lameness prevalence determined by locomotion scoring is somewhat subjective. Benchmarks have been established for confinement Wisconsin dairies using the system described by Cook (In press). In these herds, housed in either tiestall or freestall barns, an average lameness prevalence (Score 3 or 4) of 22% was found. After dividing the herds into quartiles, the soundest 25% of herds had lameness prevalence rates under 15%. Accordingly, a 15% prevalence of locomotion score 3 and 4 cows is an achievable target and lameness rates greater than this are cause for investigation. It should be noted however, that other targets might be appropriate for herds in different management systems such as grazing or dry lot dairies.

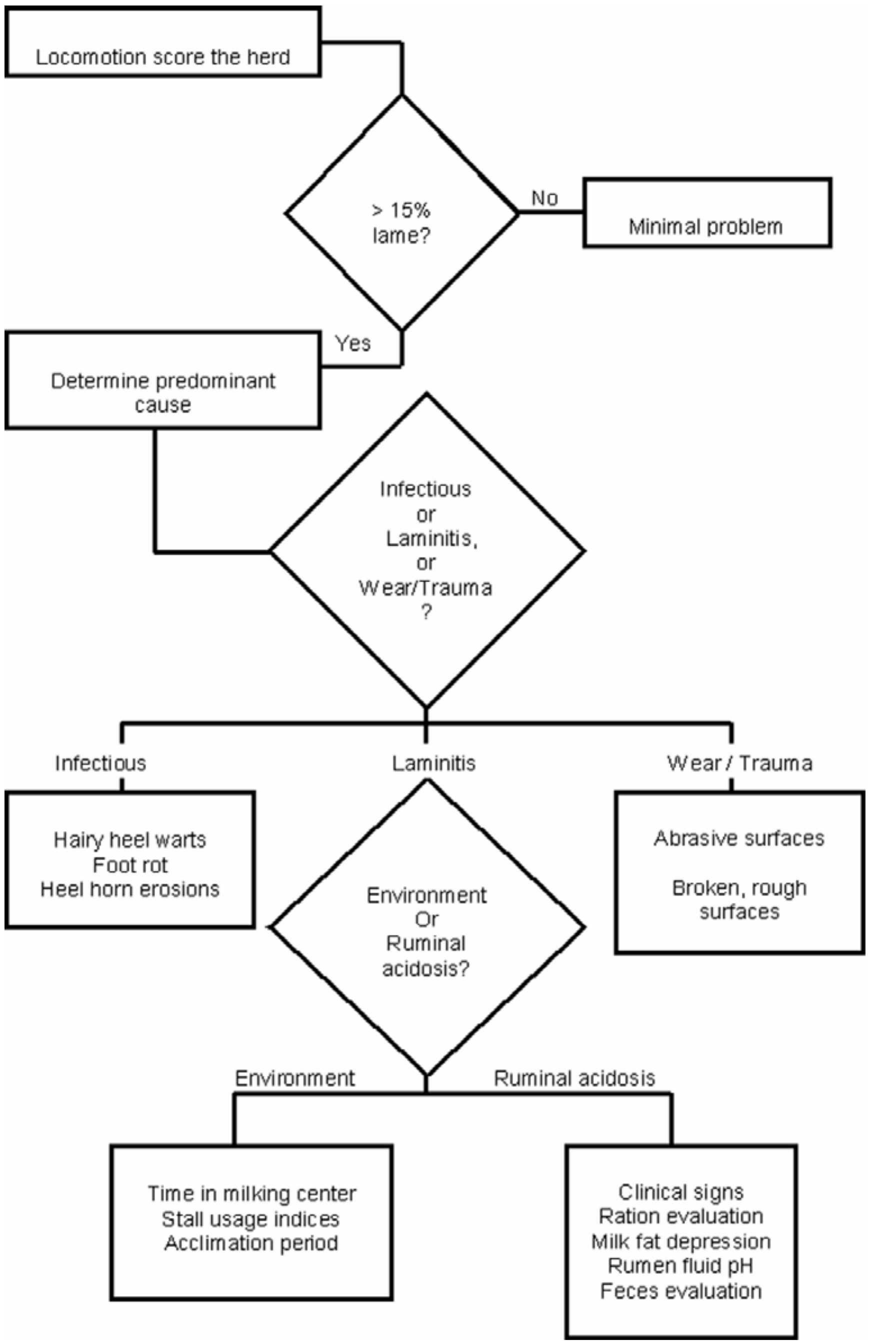
Locomotion scoring has proven to be a useful tool for not only determining the prevalence of lameness on a farm, but also for making farmers more aware of cows with lameness problems. This helps them identify lame cows earlier for attention, preventing some of the more life threatening, severe lesions that may be viewed as a major cow welfare problem.

Incidence of Lameness Treatments

Retrospective examination of herd records for lameness treatments would appear to be a logical source of information to determine lameness incidence. However, lameness treatment records typically do not provide a good source of data from which to estimate incidence. There are several common reasons for the inadequacy. First, dairy operators typically underestimate lameness prevalence within their own herds compared to trained investigators (Wells et al., 1993; Whay et al., 2002), which suggests that some lame cows will not be selected for examination. In practice, lame cows are typically sorted for hoof trimmers along with cows selected for routine trimming. While records may describe the lesions found, it is unusual for the records to indicate whether or not the cow was clinically lame at the time the lesion was found. Finally, many dairies secure the services of a hoof trimmer for fixed periods on a regular time interval. Thus, the number of lame cows examined is determined by the capacity of the hoof trimming service and is not necessarily related to the number of lame cows present on the farm at the time.

While lameness incidence rates based upon treatment records are frequently unreliable, Clarkson et al. (1996) report that annual incidence of lameness can be estimated from the prevalence at one point in time. In that study of 37 dairies, the mean prevalence of lameness was 20.6% and the mean annual incidence rate of lameness episodes was 54.6. These data suggest that the annual lameness incidence can be estimated to be 2.6 times the observed prevalence.

Figure 1. Flowchart for Investigation of a Lameness Problem Herd



ASSESSMENT OF HOOF LESIONS

If locomotion scoring indicated that the herd has a lameness problem, the second step of an investigation is to determine the predominant foot lesions. While treatment records have limitations for retrospective determinations of lameness incidence, they are frequently very useful for determine a ranking of lesion frequency. In recent years, hoof health record systems developed by Bergsten et al. (1998), Burgi (2000), and Shearer et al. (2002) are used by many professional hoof trimmers. These systems use a standardized nomenclature for lesion type, severity and location which has made it easier to monitor the relative importance of the specific hoof diseases.

Whether or not records of lameness treatments are kept on farm, the investigator should plan to examine 10-15 clinically lame cows and cows that have been recently trimmed. Ideally, the examination should take place with the hooftrimmer present so that the classification of lesions can be verified. It also gives the investigator the opportunity to assess the method and skill of the hooftrimmer.

While many specific diagnoses may be recorded, it is useful to group them into the three classes suggested by Guard (2000) of infectious causes, lesions caused by excessive hoof wear and/or trauma, and laminitis and associated claw horn lesions. The predominant causes of lameness should be ranked and appropriate management steps should be taken to minimize the problems.

Infectious Causes of Lameness

Infectious causes of hoof lameness have been reviewed by Bergsten (1997). Cattle housed in wet, manure contaminated conditions are more likely to suffer diseases of the interdigital space and heel. Digital dermatitis (hairy heel warts) is by far the most important of these conditions (Wells et al., 1999), but heel horn erosion and foot rot (interdigital phlegmon, interdigital necrobacillosis) are also significant problems that must be recognized and their risk factors investigated (Collick, 1997).

Excessive Wear and Trauma

Excessive hoof wear may occur in certain housing systems with rough concrete flooring and long distances to and from the milking parlor. This may lead to imbalance between the inner and outer claws of the hind feet (Vokey et al., 2003), creating overloading of the outer claws and thereby predisposing the cow to laminitis and claw horn lesions (Toussaint-Raven, 1985). These problems may be exacerbated by overtrimming – now recognized as a common risk factor for claw horn lesion development and especially for toe ulcers (Kofler, 1999, Van Amstel and Shearer, 2000). It is essential that routine hoof care does not compromise sole thickness or reduce the effective weight-bearing surface of the claws by excessive removal of horn. Assessment of the adequacy of hoof trimming is an essential part of hoof health monitoring on the farm.

Penetration of the sole and other traumatic lesions may result from poorly maintained cows tracks, which are an important risk factor for lameness in grazing herds (Chesterton et al., 1989; Clackson and Ward, 1991). An objective assessment of walking surfaces may be helpful in assessing the degree of risk. Faull et al. (1996) describe a scoring system that was used to assess walking surfaces both indoors and outdoors on farms. The system identifies five surfaces: very smooth (like glass), smooth, satisfactory (good grip without coarse projections), rough, and very rough (broken and exposed very course material). Digital and video photography can provide valuable support to document adverse walking conditions. While it may not clearly identify the causative factors, video is excellent for visually documenting the difficulty cows have walking on some surfaces, and for convincing herd owners that the surface requires improvement.

Laminitis and Associated Claw Horn Lesions

Laminitis presents as a variety of claw horn lesions, which include sole hemorrhage, sole and toe ulceration, double sole, heel fissure, white line disease (hemorrhage, fissure and abscess) and horizontal fissures of the wall (Burgi, 2000). If these lesions emerge as a significant herd problem, further diagnostic work must be undertaken in order to identify significant risk factors for their development.

MONITORING RISK FACTORS FOR LAMINITIS AND ASSOCIATED CLAW HORN LESIONS

While the causes of laminitis and associated claw horn lesions are multi-factorial in nature, our current understanding of the etiology of the disease syndrome focuses our investigations primarily on the environment and diet. Monitoring laminitis risks in the cow environment include assessment of factors that affect the time that cows stand on concrete and lie down in stalls, the quality of walking surfaces, and factors which impact the period of acclimation for heifers first introduced into confinement housing. Dietary risk factors include ration composition, as well as feeding management factors that may be related to ruminal acidosis.

ENVIRONMENTAL RISK FACTORS

Time spent standing in holding areas and parlor

The total time that cows spend in holding areas and parlors each day should be assessed. Smith et al. (2000) recommend that pen sizes in herds with herringbone and parallel parlors should be no greater than 4.5 times the parlor size. Other guidelines for milking center construction suggest limiting total time in the holding area and parlor to 3 hours per cow per day (Vokey et al., 2003). Estimates of time spent for milking are frequently calculated for the average cow in the pen, which would be appropriate if cows enter the parlor in random order at each milking. However, several studies by Dickson et al. (1967) and Rathore (1982) have shown that cows develop a consistent order of parlor entry, which suggests that some proportion of the herd is repeatedly subjected to longer than average sessions in the holding area. It is more accurate to measure the total time elapsed from when a pen of cows is moved to the holding area until the last cows from the pen return from the parlor. We have found individual cows that spend up to 5.7 hours per day in the holding area and parlor in herds that meet the above recommendations for an average cow.

Measuring Stall Comfort

Colam-Ainsworth et al. (1989) and Leonard et al. (1994; 1996) have documented that stall usage behavior, in terms of daily lying and standing times, is a significant risk factor for the development of claw horn lesions. An assessment of stall comfort and use is therefore an essential component of a herd lameness investigation.

Health care consultants have used various indices as predictors of daily lying time and cow comfort. Nelson (1996) described a Cow Comfort Quotient (CCQ), defined as cows lying properly / cows either lying or standing in stalls. Overton et al. (2003) recently summarized the use of three indices of cow comfort: Proportion Lying (number lying / number in pen); Proportion Eligible Lying or Stall Usage Index (number lying / total cows in pen not eating) and Cow Comfort Index (CCI) (number lying / number touching a stall surface). Cook (2002a) has used another index of stall usage, now called the Stall Standing Index (SSI) (cows standing with two or four feet in stalls / number touching a stall) which is essentially the inverse of the CCI or CCQ.

Data to interpret these indices are limited. Nelson (1996) reported a target of 80% for the CCQ, and suggests that a CCQ of 85-90% is usually achieved in the best-managed facilities. The study by Overton et al. (2002) of a herd with sand freestalls, milked three times per day in California, and filmed between 3AM and 10PM, showed peak numbers lying one hour after the return of cows to the pen from the morning milking. Based upon this single herd, it was suggested that the Cow Comfort Index should exceed 85% and the proportion eligible lying should be more than 75%. Unfortunately, data from herds with poor comfort are not currently available to further develop benchmark targets for these indices.

Wagner-Storch et al. (2003) conducted a stall preference study in a 4-row barn with one pen stocked at 100% (one cow per stall) and a second pen at less than 100%. Both pens included six types of stall surface including sand as well as a variety of mattresses. Cows spent similar amounts of time lying in stalls with sand or with mattresses, but cows on mattresses spent more time standing and perching (front feet in the stall and rear feet in the alley) in stalls instead of spending time in the alley. Because cows occupied mattress stalls more than sand stalls, but lying time was similar, it was suggested that indices such as CCQ may unfairly penalize mattress stalls if the goal is to estimate the attractiveness for lying down. It was also suggested that the preferred time for assessing stall use is early morning, before feeding and milking by counting the number of stalls with a cow lying and those stalls that are occupied. At 100% stocking rate, stall usage was considered very good if cows occupied 80-85% of the stalls or were lying down in 55-65% of the total stalls in these early morning hours. These target values will drop by 10-20% as the day progresses and also decline if stocking density is reduced.

Unfortunately, data presented by Overton et al. (2003) and Wagner-Storch et al. (2003) were derived from single herds. Index targets suggested by these studies have not been applied on a wide range of farms with different designs and management systems. However, Cook (2002a, 2002b) determined SSI in 30 herds and found a range from 6 to 35%. The quartile of herds with the greatest proportion of cows lying in stalls has a SSI of less than 15%.

Based on Nelson (1996), Overton et. al. (2002), and the best quartile of herds in the Cook (2002a, 2002b) study, a SSI of less than 15% is suggested as a target for cow comfort. A SSI greater than 15%, determined at a time of one to two hours prior to milking, suggests that stall usage is a potential problem and that stall design and maintenance should be evaluated. Nordlund and Cook (2003) have recently described a five point system for assessing any stall from the perspective of a cow getting into, lying down, rising and exiting the stall. The key points to be assessed are: adequacy of stall surface cushion as measured by a subjective "knee" test, a defined resting area of appropriate size related to the type of animal, adequate room for lunging and an unobstructed "bob zone", adequate height below and behind the neck-rail to rise without hindrance, and a curb height which is high enough to avoid manure contamination from the alleyways, but not so high as to deter heifers from using the stalls.

Acclimation to Confinement Housing

Bergsten and Frank (1996) identified abrupt changes when cattle are moved from relatively soft surfaces such as pasture or bedded packs onto hard surfaces of confinement barns as a risk factor for laminitis. While abrupt changes can occur at a number of stages in the heifer-growing period, they most commonly occur at or near their anticipated calving date. If during the course of an investigation a change is determined to be abrupt, heifers should be introduced to concrete surfaces at feeding areas for several weeks or months prior to calving and they should have access to well-cushioned surfaces after parturition. Straw bedded areas have successfully been used to reduce the severity of claw changes triggered at first parturition (Webster, 2001).

DIETARY RISK FACTORS

Ruminal acidosis is widely viewed as a major risk factor for laminitis (National Research Council, 2001; Nocek, 1997; Ossent et al, 1997). Ruminal acidosis encompasses a wide range of physiological conditions and ranges from peracute acidosis that can result in death to the animal, through acute, subacute, and mild stages (Radostits et al, 2000). Garrett et al. (1997) found that subacute ruminal acidosis (SARA) is a common finding in modern dairy herds. The diagnosis of ruminal acidosis in a herd should be based upon a combination of supporting clinical signs, production records, diet characteristics, and ruminal fluid pH.

Clinical Evaluation of the Herd

A dairy herd with SARA will exhibit a variable syndrome of clinical signs depending on the prevalence, severity, and duration of the acidosis problem. Clinical signs may include depression, diarrhea, multi-focal hepatic and pulmonary abscesses, hemoptysis or epistaxis, and laminitis (Nordlund et. al, 1995). Other diseases can cause any of the individual clinical signs of SARA, so the diagnosis cannot be made without corroborating evidence.

Irregular and reduced DMI is the most consistent feature of SARA in feedlot cattle (Owens et al., 1998). However, changes in DMI due to SARA are extremely difficult to document in group feeding situations in dairy herds. Commercial dairies typically do not intensely monitor DMI, and cattle on commercial dairies are moved frequently enough between pens to make interpretation of group DMI challenging even when it is attempted.

Diet Evaluation

The NRC (2001) has established guidelines for diet formulation that are effective in preventing low ruminal pH under experimental conditions. Low ruminal pH appears to be much more common under field conditions than in experimental trials (Garrett, 1996). It appears that ruminal pH is influenced by much more than the chemical measures of dietary fiber such as ADF, NDF, and non-fiber carbohydrates defined by NRC. Other factors such as high DMI, consumption of large meals, short forage particle length, easily sorted TMR, highly digestible forages, and finely processed concentrates can all increase the risk for SARA (Maekawa et al., 2002; Grant et al., 1990, Oetzel 2000). Allen (1997) noted that measures of diet chemical composition, intake, and digestibility are poorly related to ruminal pH and that interaction among these factors are more significant. As a clinical tool, diet evaluation alone is a poor predictor of the presence or absence of SARA in a herd.

Milk Fat Depression

Herd milk fat depression is commonly used to rule ruminal acidosis in or out as a risk factor for laminitis in a herd. Pennington (1999) suggests that milk fat depression is defined as below 3.2% in Holstein, Ayrshire, and Milking Shorthorn herds, 3.4% for Brown Swiss, 4.0% for Guernsey, and 4.2% in Jersey herds. Milk fat depression was thought to be related to rumen VFA changes of decreased acetate and increased propionate, both of which occur in ruminal acidosis. However, recent research suggests that interference with ruminal biohydrogenation of fatty acids is apparently the cause of milk fat depression, resulting in accumulation and absorption of certain trans fatty acids from the gastrointestinal tract, reducing milk fat synthesis by the mammary gland (Bauman and Griinari, 2001).

Allen (1997) summarized data from several trials to show a relationship between ruminal pH and milk fat percentage where ruminal pH = 4.44 + 0.46 x milk fat percentage ($r^2 = 0.39$). While the relationship was not robust, a ruminal pH of 5.6 was associated with about 2.5% milk fat. In Holstein herds, we view more than 10% of the herd with milk fat percentage below 2.5% as possible (but not confirmatory) evidence for SARA.

Our clinical work also suggests that milk fat depression in dairy herds can be largely independent of SARA. In a field trial, Garrett (1996) found little correlation between herd milk fat percentage and prevalence of low ruminal pH as measured by rumenocentesis or subjective clinical signs of SARA within a herd. Clinical impression of the authors is that low milk fat percentage suggests an increased likelihood of SARA, high milk fat percentage suggests a lower likelihood of SARA, but that normal milk fat percentage gives very little information about the likelihood of SARA within a herd.

Some dairy consultants calculate the ratio of milk fat to milk protein percentages for individual cows and suggest that ratios less than 1.0 indicate ruminal acidosis (Tomaszewski et al., 1993). Because milk fat and milk protein synthesis are independent processes, the calculation of milk fat: protein ratios is probably of even less value in diagnosing SARA than are milk fat percentages alone.

Rumen fluid pH determinations

Rumenocentesis is a direct field test of ruminal pH and has been used in combination with other indicators for herd-based diagnosis of SARA (Nordlund et al., 1995). The test is performed using a needle to aspirate rumen fluid directly from the rumen. Oetzel (2000) has suggested that approximately 12 samples should be collected when ruminal pH is expected to reach the nadir, approximately 2-4 hours after the concentrate meal when diet components are fed separately, and 4-8 hours after a total mixed ration meal. Using the interpretive guidelines, if more than 25% of the samples have a pH less than 5.5, the group is considered to be at risk of subacute ruminal acidosis. These guidelines will characterize groups correctly in situations of either high prevalence or low prevalence of low ruminal pH, but will provide uncertain results in herds where the true prevalence of low ruminal pH is in the range of 10-25% (Garrett et al., 1999).

Obviously, it is important that pH meters are accurate when used for these field tests. The authors recommend that samples should be collected as a batch and the pH determinations made inside at normal room temperatures. The pH meters should be calibrated prior to sample testing, and the readings validated by measuring pH of the standardization solutions upon completion of the tests. Sometimes, pH meters will fail in the field. It is possible to determine the pH of field-collected samples in an office or laboratory instead, because ruminal pH is stable for 8 hours when kept refrigerated in sealed syringes (Nordlund, 2001).

Concerns about the health risks to the cows tested by rumenocentesis have been raised by Wheeler-Aceto et al. (1999) who used ultrasound to diagnose peritonitis in cows that were sampled repeatedly. While there is an obvious potential for peritonitis from a rumen puncture, the authors view the risk as very modest when cows are sampled only once and when cow restraint is satisfactory. In a field trial involving 150 cows on 10 commercial dairy farms, agreements were made with herd owners to reimburse any health damages attributed by the herd veterinarian to rumenocentesis (Garrett, 1996). No claims were made. The authors are aware of reports of two cows that developed mild fevers and were treated without complications from approximately 2,000 rumenocentesis procedures performed during field investigations.

Rumen fluid samples can also be collected by stomach tube or other oro-ruminal probes. These collection techniques present very low risk to the cow. However, oral collection devices are difficult to clean on farms, making them a risk for cow-to-cow or farm-to-farm transmission of infectious organisms (Hancock, 1995). Samples collected by oral routes will likely be contaminated with variable amounts of saliva. Duffield et al., (In Press) compared rumen fluid samples collected by rumenocentesis and by oro-ruminal probes to samples collected through a rumen cannula. Rumenocentesis samples had the lowest pH values and showed the higher correlation with samples obtained by rumen cannulation. Rumenocentesis was evaluated as the more accurate field technique.

Evaluation of feces

Fecal evaluation is of very limited value in monitoring or diagnosing SARA in dairy herds. Ireland-Perry and Stallings (1993) found no effect of dietary fiber on fecal consistency. Fecal pH can be used as an indicator of small intestinal pH (Wheeler and Noller, 1977) but not necessarily ruminal pH.

Visual evaluations of washed screened feces may provide qualitative evidence for SARA (Hall, 1999). Feces from cows may contain many particles greater than 0.5 inches in length, whole pieces of corn stalks, and recognizable undigested feed (green grass, cottonseeds with lint, orange citrus pulp). In addition, foamy manure, diarrhea, and mucin casts may suggest extensive hindgut fermentation, which can be associated with SARA.

CONCLUSIONS

Practical field techniques developed in the past decade have made systematic investigations of dairy herd lameness problems feasible. Scoring systems have been developed to determine lameness prevalence. Improved hoof lesion record systems have been adopted by professional hooftrimmers which facilitates the ranking of predominant problems within a herd. While laminitis and associated claw horn lesions remain a complex disease, tests such as stall usage indices, rumenocentesis, and other monitoring tools are proving helpful in identifying environmental and dietary risk factors within individual dairy herds.

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