

Roles for Veterinary Technicians in Preventing Metabolic Diseases in Dairy Herds

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Abstract

Dairy technicians can play an essential role in preventing and monitoring metabolic diseases in dairy herds. Routine herd-level monitoring of eating space, resting space, pen moves, urinary pH before calving, blood non-esterified fatty acid (NEFA) before calving, blood calcium at calving, and blood ketones after calving can be performed by technicians. The use of technicians in these roles can greatly enhance the partnership between veterinarians, nutritionists, and dairy producers that is needed to prevent metabolic diseases.

Résumé

Les techniciens spécialistes de la santé des élevages laitiers peuvent jouer un rôle essentiel dans la prévention et la surveillance des maladies métaboliques des troupeaux laitiers. En effet, ils et elles peuvent faire le suivi régulier de plusieurs aspects et opérations dans le troupeau : aires d'alimentation et de repos, changements d'enclos, pH urinaire et dosage sanguin des acides gras non estérifiés avant le vêlage, dosage du calcium sanguin au vêlage et des cétones sanguines après le vêlage. Le recours aux techniciens pour ces opérations peut grandement améliorer la prévention des maladies métaboliques car il complèterait et optimiserait le partenariat qui existe déjà entre les vétérinaires, les nutritionnistes et les producteurs laitiers.

Rationale for Using Technicians

Veterinary technicians are well trained in the importance of accurate data collection, blood collection, and proper blood sample handling. They can be scheduled to provide services on a consistent and routine basis. Herd owners often believe that their own staff can acquire the necessary data for monitoring and preventing metabolic diseases. However, assigning the necessary time and labor to tasks that occur infrequently (e.g., weekly or monthly), even if the task is simple, is quite challenging. Designating a technician to regularly perform these tasks usually improves the likelihood that the job will get done on a regular basis. The data collected are simply too critical and too valuable to be left to unintentional or irregular evaluations.

Dry Period Monitoring – Space and Pen Moves

The stage for most metabolic diseases of dairy cattle is set in the dry period. Inadequate eating space, inadequate resting space, and excessive numbers of pen moves are important risk factors for early lactation metabolic disease.⁸ This is particularly true for diseases related to pre-calving negative balance, development of fatty liver, ketosis, and displaced abomasum.

Gathering data about eating and resting space for dry cows is not difficult - it involves counting cows, measuring bunk space, and counting free stalls, or perhaps measuring the area of a bedded pack. Goals for pre-fresh cows are a minimum of 30 inches (76 cm) of bunk space per cow and at least one free stall (or 100 square feet [9.3 sq m] of bedded pack) per cow. Cows can either be counted at the time measurements are made (a good approach with regular monitoring), or the owner's estimate of the maximum number of cows in the pen can be used. Investing in a good laser tape can make measurement-taking faster and is particularly helpful if just one person is taking the measurements.

Pen moves can be estimated by observing current pen populations, consulting the herd record system if pen moves are recorded, or by interviewing the owner. The fewer pen moves before calving, the better. Pen moves between about three to nine days before actual calving appear to have the greatest negative impact on subsequent cow health and productivity.

Pre-fresh Urinary pH Evaluation

Herds that feed low dietary cation-anion difference (DCAD) diets prior to calving should be monitored on a regular basis to see if urinary pH is in the optimal range for milk fever prevention. This is necessary because the DCAD of feed ingredients and diets often changes rapidly and unpredictably. This makes it easy to over-acidify the cows (resulting in poor dry matter intakes and secondary fatty liver and ketosis problems) or to under-acidify the cows (resulting in inadequate milk fever prevention). Herds that do not feed a low DCAD diet prior to calving do not need to be checked for urinary pH - all of the cows will have urinary pH between about 8.0 and 8.5.

Urinary pH evaluations should be done on a weekly (or more frequent) basis. A minimum sample size is

eight cows; testing more cows improves the accuracy of the evaluation but takes more time. A good-quality pH paper or a pH meter can be used for the urinary pH measurements. Entering the pen at a time when most of the cows are lying down can be helpful, because many cows will urinate when they first stand up. Otherwise, it takes patience to stimulate the cows to urinate by rubbing them below the vulva. A clean, midstream sample is necessary for accurate pH testing. Contamination of the urine sample with manure or mucus will falsely elevate its pH.

Urinary pH results are interpreted as a group average, and the optimal range when a low DCAD diet is fed is between about 6.8 and 7.2.² Some cows are expected to be below this range, and others above it. The average is the most important statistic for evaluating the results. The dose of anionic salts should be adjusted whenever the urinary pH becomes too high or too low.

Time relative to feeding has minimal effect on urinary pH, as long as the cows have ample access to feed.⁴ It is a severe problem if feed access during the pre-fresh period is limited; it is crucial that this be fixed before even considering whether urinary pH is in the optimal range or not.

Regular evaluation of urinary pH is not a difficult task. Yet, I have observed that for most dairies it is often neglected in spite of good intentions, probably because it is done only once a week. This makes it difficult for dairies to assign the necessary time and labor for the task. Technicians can be used to provide scheduled and reliable testing. In numerous situations I have investigated major crises in fresh cow health that could have been prevented by regular urinary pH testing.

Pre-fresh Blood NEFA

An evaluation of blood non-esterified fatty acid (NEFA) concentrations can be used to evaluate the presence of negative energy balance prior to calving. Cows should stay in positive energy balance up until the last 24 to 48 hours prior to calving. Elevated NEFA concentrations in pre-fresh cows are associated with high risk for fatty liver, ketosis, and other peri-parturient diseases.⁷ Elevated NEFA concentrations in pre-fresh cows are also associated with increased risk for displaced abomasum after calving.^{1,13}

Pre-fresh NEFA testing is best positioned as a secondary test in a herd already known to have a high incidence of ketosis. NEFA testing is not usually done on a routine or permanent basis. When performed, it helps determine if the postpartum ketosis is due to pre-calving negative energy balance and fatty liver. There is little value in conducting NEFA testing in herds with a low incidence of ketosis, since ketosis is the main problem associated with high NEFA prior to calving.

Pre-fresh blood NEFA testing is difficult. Cows can only be sampled in a very narrow time window (two to 14 days before actual calving). NEFA concentrations normally rise in the last 48 hours prior to calving, so results from cows that calve this soon after the sample was collected are difficult to interpret and should either be discarded or interpreted with caution. NEFA concentrations more than 14 days before actual calving are usually low, and were collected before the cow entered her most critical time period before calving. Adding to the difficulty is the fact that calving date is not known at the time of sample collection. A reasonable estimate is that you will need to collect 50 to 100% more NEFA samples from pre-fresh cows than your final desired sample size. For example, you will likely need to collect 18 to 24 total samples in order to get an adequate sample size of 12 or more cows once calving has occurred.

Samples for NEFA testing should be collected into EDTA tubes and refrigerated as soon as possible.¹⁴ Allowing the sample to stay warm or hot could falsely elevate NEFA concentrations. The plasma can be separated after centrifugation and promptly frozen for later analysis. Frozen plasma samples can be accumulated over time, and submitted together to the laboratory after all of the calving dates for the cows sampled are known and an adequate sample size has been accumulated.

In large dairy herds, the pre-fresh group may be sub-sampled for NEFA screening. In this case, select the cows that appear to be the closest to calving, but avoid cows for whom calving appears to be imminent. I have found it extremely useful in some investigations to collect some plasma samples from cows in the maternity pen as well as the pre-fresh pen, even if the maternity pen cows appear to be very close to calving. Many of these cows will not calve for several more days, which indicates a management error and puts them at risk for elevated NEFA concentrations.

Proposed cut-points for pre-fresh NEFA values range from 0.3 mEq/L¹³ to 0.4 mEq/L.¹⁰ Blood NEFA test results should not be averaged; rather, they should be interpreted as the proportion of cows above the cut-point. More than about 10% of the cows above the cut-point suggests that pre-fresh negative energy balance could be contributing to post-fresh problems.

Blood Calcium in Post-fresh Cows

It is difficult to monitor the incidence of parturient hypocalcemia in dairy herds. The best time to collect blood samples is about 12 to 24 hours after calving. The blood samples must usually be collected by on-farm personnel rather than by a veterinary technician as there won't be enough cows to sample at regularly scheduled herd visits, unless the herd is very large. If the traditional approach of sending serum or plasma samples to

a laboratory for calcium analysis is used, then the farm needs a means of separating the serum (or plasma) and storing it before it is submitted to the laboratory.

An alternative approach to serum or plasma calcium testing at a laboratory is conducting whole blood ionized calcium testing on the farm. Several portable analyzers^{a,b} can analyze whole blood samples for ionized calcium concentration. The sample used is either fresh whole blood or whole blood collected into syringes containing dry lithium heparin. These analyzers cost about \$5,500 to \$7,500 each, and individual cassettes for ionized calcium determinations cost about \$9 to \$16 each.

Cut-points of less than 8.0 mg/dL (2.0 mmol/L) total serum calcium⁹ or less than 4.0 mg/dL (1.0 mmol/L) ionized calcium¹² have been used to define parturient hypocalcemia. Results are interpreted as the proportion of cows below the cut-points. Less than 30% of cows tested, assuming second or greater lactation Holstein cows, should be below the cut-point.¹⁰

Early Lactation Monitoring – Space and Pen Moves

Although dry period eating space, resting space, and pen moves are the biggest determinants of early lactation health, problems in these areas after calving also have negative effects. A routine monitoring program of these factors should include the post-fresh fresh cows as well as the dry cows. Of unique concern to the pre-fresh cows is a short stay in a non-saleable milk pen immediately after calving (often commingled with sick cows) and a short overall stay in the post-fresh pen (i. e., less than 10 days). As for the dry cows, these data are not difficult to acquire and are too important to leave to unintentional monitoring.

Blood BHBA in Post-fresh Cows

Ketosis is now perhaps the most important metabolic disease in dairy cattle. Ketosis has become increasingly prevalent in dairy herds in the upper midwest US. This may be explained by changes from housing cows individually in small tie-stall or stanchion herds to housing cows in groups in larger herds with free stalls and parlors. Overcrowding group pens and the stress of pen moves just before and after calving appear to be the most important risk factors for ketosis in free-stall herds. Early detection of ketosis and accurate monitoring are of critical importance.

The “gold standard” test for ketosis is blood beta-hydroxybutyric acid (BHBA). This ketone body is more stable in blood than acetone or acetoacetate. Suggested cut-points for BHBA in early lactation cows range from 11.7 mg/dl (1.2 mmol/L)¹³ to 14.4 mg/dL (1.4 mmol/L).³ Above this cut-point, cows are at increased risk for

displaced abomasum, clinical ketosis, and decreased milk production. Clinical ketosis generally involves much higher levels of BHBA (above about 29 mg/dL or 3.0 mmol/L).

The alarm level for the proportion of cows above the cut-point has not been well defined. Studies show an average prevalence of about 15% ketosis in early lactation cows. My clinical impression is that we should tolerate no more than about 10% ketosis in early lactation cows. Most herds I test have a 0 to 8% prevalence of ketosis.

The BHBA test can be performed on serum samples sent to a commercial laboratory. However, the recent validation of a hand-held meter^c for rapid cow-side determination of BHBA creates a better option.^{5,11} This meter is sufficiently accurate and is much cheaper and faster than laboratory submissions.

The Precision Xtra[®] meter^c measures either whole blood BHBA or whole blood glucose, depending on the test strip that is inserted into it. It uses a simple and direct electrochemical test for blood BHBA concentration, which may explain why it works well for both human and bovine blood. The ketone test strip contains the enzyme β -hydroxybutyrate dehydrogenase, which oxidizes BHBA to acetoacetate. This conversion generates electrical current, which is measured by the meter and is directly proportional to the BHBA concentration.

These meters retail are available from most veterinary distributors for about \$50. Most human pharmacies also stock the meters, but they typically retail for about \$75 to \$90. Sometimes the meters can be found on sale at human pharmacies. The blood ketone test strips (which measure BHBA) are sold in boxes of 10 strips each. Expect to pay about \$13 to \$15 for a box of 10 strips (\$1.30 to \$1.50 per strip) through a veterinary distributor. Most human pharmacies do not stock the blood ketone strips routinely but can order them. Expect to pay about \$40 to \$75 for a box of 10 strips (\$4.50 to \$7.50 per strip) if purchased through a human pharmacy or online human pharmacy distributor.

Spending \$1.50 per BHBA test is cheaper than sending a blood sample to a lab for BHBA testing, but more expensive than cow-side urine or milk tests. Cow-side urine and milk tests are not nearly as accurate as the blood tests.

The Precision Xtra[®] meter was developed for the human market and thus is very easy to use. Remove a ketone test strip from its foil packet and insert it into the meter with the contact bars on the test strip facing up. The meter will automatically turn itself on, recognize the lot number of the test strip, and prompt you that it is ready for the blood sample to be applied to the end of the test strip. Make sure that the displayed lot number on the meter is the same as the lot number on the test strip. Note that you must put the test strip into the meter before applying blood to it.

You must put the ketone calibrator strip (one of these is provided in each box of 10 strips) into the meter the first time you use a test strip from a new box of 10 test strips. The meter then “remembers” this lot of test strips and recognizes them automatically when they are placed in the meter. No further calibration of the meter is necessary.

Be sure to keep the ketone test strip dry before using it. Moisture on the test strip may falsely lower the BHBA test results.

The meter works on less than a drop of whole blood from the cow. The best way I have found to obtain this sample is from the tail vein using a small needle (20 or 22 gauge) and small syringe (1 mL tuberculin syringe or a 3 mL syringe). You only need a good flash of blood in the syringe (<0.1 mL) and you have the entire sample you need. Cows that are lying down often don't even get up when you insert such a small needle in the tail vein.

After collecting the blood, apply a drop of blood from the syringe to the end of the test strip. The strip will draw the blood into a small sample well, and the meter will indicate when the sample well is full. The amount of blood needed is very small (1.5 microliters). Then wait 10 seconds for the meter to display the results - it will count down the time. BHBA results are displayed as mmol/L (same as millimoles/liter or mM). To convert from mmol/L to mg/dL, multiply the test result by 10.3.

It is not necessary to bring the blood samples inside before applying them to the Precision Xtra® meter. If it is cold outside, be sure to keep the meter and test strips warm in your pocket.

It should be noted that the hand-held meter is not sufficiently accurate for research purposes.⁶ This is particularly true for research studies evaluating small changes in blood BHBA that fall below the ketosis threshold.

The most rewarding use of cow-side blood BHBA testing is for herd-based ketosis monitoring.¹⁰ In summary, the protocol involves testing 12 or more cows in early lactation. If more than 10% of the cows tested have elevated blood BHBA, then the group is considered to have a ketosis problem. An evaluation of early lactation cows for ketosis requires testing most or all of the eligible cows in small to medium-sized herds. In larger herds, a suitable sample size may be obtained on a single herd visit.

Conclusions

Veterinary technicians can be extremely useful in collecting routine data needed for monitoring and preventing metabolic diseases in dairy cattle. The types of

services provided to dairy herds by veterinary technicians depends on the current problems within the herd, relationship of the veterinarian to the herd, ability of the dairy to provide and manage its own labor to collect data, and the cost-consciousness of the dairy owner.

Endnotes

^aVetStat® Electrolyte and Blood Gas Analyzer, IDEXX Laboratories, Inc., Westbrook, ME

^bVetScan i-STAT® Handheld Analyzer, Abaxis®, Union City, CA

^cPrecision Xtra®, Abbott Laboratories, Abbott Park, IL

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