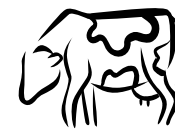


**ODV MEETING
2007**

TRANSITION COWS



Herd-Based Testing for Metabolic and Nutritional Diseases

Garrett R. Oetzel, DVM, MS
Food Animal Production Medicine Section
School of Veterinary Medicine
University of Wisconsin-Madison

Herd-Based Biological Testing Procedures

Metabolic and nutritional diseases typically increase as milk production increases and as dairy herds become larger. These factors favor the use of rigorous, quantitative monitoring of metabolic and nutritional diseases whenever possible. This paper will focus on strategies for testing and monitoring three critical diseases in dairy herds - subacute ruminal acidosis (SARA), ketosis, and parturient hypocalcemia (clinical plus subclinical milk fever). Enough quantitative data about these diseases is available to allow for the development of a herd-based testing scheme. Additionally, these three disorders are gateway conditions for other problems such as laminitis, displaced abomasum, impaired immune function, retained placenta, and cystic ovarian disease. Other metabolic diseases can be important problems in dairies (e.g., hypomagnesemia, udder edema, hypokalemia, etc), but these are less common disorders and there are limited published data available to permit the development of a testing scheme.¹⁵

Sources of Error in Herd-Based Testing. Biological tests can be very useful in supporting other clinical evidence of a metabolic disease problem on a dairy. Veterinarians have tremendous experience in collecting, analyzing, and interpreting the results of biological tests. However, biological test results do not stand alone in making herd-based decisions. Biological test results are subject to errors from inadequate sample size, improper sample handling, inappropriate time of sample collection relative to feeding, and laboratory error. Thus, biological test results should be supported by other herd data. For example, a finding of a high proportion of cows with low ruminal pH collected by rumenocentesis is corroborated by findings of low fiber diets being consumed by the cows, thin cows in the face of high energy diets, a high prevalence of laminitis-related lameness, and/or milk fat test depression. Without supporting evidence, however, the finding of low ruminal pH alone is very suspect and likely is in error (perhaps due to analytical problems in measuring pH of the ruminal fluid).

Interpreting Test Results for Groups vs. Individual Cows. The interpretation of herd-based tests for metabolic and nutritional diseases is very different than interpreting laboratory results for metabolites from individual cows. Test results from individual cows are interpreted by comparing the laboratory result to a normal range established by the laboratory. Normal ranges are often derived by calculating a 95% confidence interval (or a similar statistic) of test results from clinically normal animals. This approach is useful for making decisions about individual sick cows, but is not useful for interpreting herd-based test results. Interpretation of herd-based test results requires an understanding of how the each test affects cow performance (regardless of whether they are within the normal range or not), a statistically-

based approach to determining subsample sizes, and an emphasis on monitoring subclinical disease prevalence instead of clinical disease incidence.

Interpreting Herd Proportions vs. Herd Means. Herd test results for metabolic diseases can be interpreted as either the mean test result of the subgroup sampled, or as the proportion of animals above or below a certain cut-point within the subsample. If a test is associated with disease when it is either above or below a biological threshold (cut-point), then it should be evaluated as a proportional outcome. For example, ruminal pH ≤ 5.5 puts cows at risk for SARA, with subsequent rumenitis and other complications.⁴ High ruminal pH values are not important per se in the herd evaluation, as any value over 5.5 is considered acceptable. Therefore, interpret the proportion of cows with ruminal pH below the cut-point and do not be concerned with the mean value of the group tested.

Ketosis in dairy herds can be monitored by testing for blood β -hydroxybutyric acid (BHBA). Ketosis is also a threshold disease, and cows are affected only when BHBA concentrations are elevated. Lowering BHBA below a threshold concentration is of little to no biological significance to the cow. Therefore, herd-based BHBA test results are interpreted on a proportional basis, and the mean concentration for the group of cows tested is of no concern. Blood BHBA concentration above 14.4 mg/dl (1400 μ mol/L) is the most commonly used cut-point for ketosis. This cut-point is considerably higher than the upper end of the typical laboratory normal reference range for BHBA in individual cows.

Non-esterified fatty acid (NEFA) concentrations in blood can be used to monitor energy balance in pre-fresh cows. Elevated NEFA prior to calving indicate negative energy balance and suggest increased risk for DA, ketosis, and other problems after calving.¹ Low NEFA concentrations are not biologically important. The threshold for NEFA in pre-fresh cows (2 to 14 days before actual calving) is 0.400 mEq/L. In herd testing situations, we evaluate the proportion of cows tested above this cut-point and not the mean.

The incidence of parturient hypocalcemia (clinical plus subclinical milk fever) in a dairy herd is evaluated by measuring serum calcium concentration within 12 to 24 hours of calving. A cut-point of less than 8.0 mg/dl (2.0 mmol/l) total serum calcium has been used to define parturient hypocalcemia.¹³ Blood calcium results from fresh cows are interpreted as the proportion of cows below the cut-point.

Tests for herd-based evaluations of metabolic and nutritional diseases also require well-defined alarm levels for the proportion of animals above (or below) the described cut-point. Because of normal biological variation, a few individual cows are expected to be above (or below) the biological threshold. Alarm levels are established from research results and/or clinical experience with these tests in herd settings. Table 1 lists suggested cut-points and alarm levels for ruminal pH, BHBA, and NEFA test results.

Cows chosen to be sampled must come from the appropriate “eligible” or “at risk” group within the herd. It is of no clinical value to test cows for a condition for which they have little risk. Table 1 also lists the eligible groups for herd-based tests.

Table 1. Cut-points, alarm levels, and defined at-risk groups for subclinical diseases with associated clinical diseases.

Test	Cut-point	Alarm level proportion	At-risk group	Associated disease risk
BHBA	≥ 14.4 mg/dl	>10%	Lactating cows 5 to 50 days in milk	Ketosis, DA
NEFA	≥ 0.400 mEq/l	>10%	Pre-fresh dry cows 2 to 14 days before actual calving	Ketosis, DA, fatty liver
Ruminal pH	≤ 5.5	>25%	Lactating cows 5 to 50 days in milk in herds where concentrate fed separately, 50 to 150 days in milk in TMR fed herds	SARA
Blood calcium	≤ 8.0 mg/dl	>30%	Lactating multiparous cows, 12-24 h after calving	Clinical milk fever

Adapted from Cook NB, Oetzel GR, Nordlund KV: Modern techniques for monitoring the health and productivity of the high producing dairy cow. Part I: General principles of herd level diagnoses. *In Practice*, 28:510, 2006.

Urinary pH in pre-fresh cows fed anionic salts is a useful test for herds that are feeding supplemental anions before calving to help prevent milk fever. Urinary pH is a marker of whether or not the feeding program is achieving the desired acidification. The biological threshold for urinary pH is not one-sided. Rather, the optimal range for urinary pH is about 6.75 to 7.25. Urinary pH values that are either above or below this optimal range have adverse consequences. Therefore, urinary pH testing is evaluated by the mean of the group of cows tested, and the proportion of cows with high or low urinary pH is not calculated.

Appropriate Sample Sizes for Herd-Based Tests. Adequate sample sizes are essential in herd-based testing. We must have reasonable confidence that the results (either a proportion or a mean) truly represent the entire population of eligible cows within the herd. In herd settings, we do not need to sample as many cows as a researcher would sample in order to achieve a 95% confidence ($P < .05$) in the results. Rather, a 75% confidence interval is both acceptable and practical.

The suggested minimum sample size for herd-based tests with proportional outcomes is 12 cows. This minimum sample size gives reasonable confidence (75% or more) that the herd classification from the test results of 12 cows will correctly represent the true classification for the entire group. Figure 1 shows an interpretation guide for ruminal pH testing results based on a sample size of 12 cows, and Table 2 shows interpretation guidelines for all of the proportional tests. Herd-based tests interpreted as means have a lower minimum sample size. For example, as few as 8 cows can be sampled for urinary pH testing.

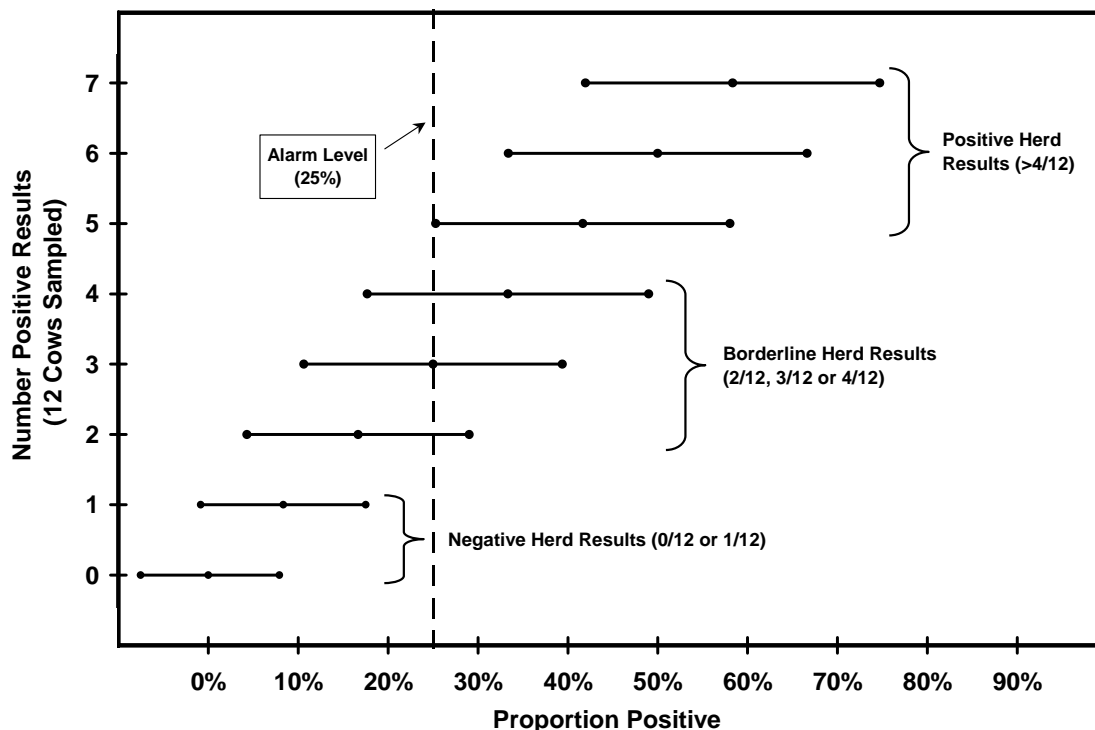


Figure 1. Interpretation of ruminal pH test results using 75% confidence intervals and an alarm level of 25% for test results from 12 cows sampled from within a group 100 cows. Adapted from Oetzel, 2004. Monitoring and testing dairy herds for metabolic disease. *Vet. Clin. Food Anim.* 20:651-674.

Table 2. Herd based test guidelines for interpretation using a 75% confidence level. Note that the interpretation of a negative, borderline and positive herd test varies with the alarm level used for each test.

Herd Test Diagnosis (75 % CI)	Test:			
	BHBA	NEFA	Rumen pH	Calcium
	(number of positive test results from 12 total cows tested)			
Positive	12	12	12	12
	11	11	11	11
	10	10	10	10
	9	9	9	9
	8	8	8	8
	7	7	7	7
	6	6	6	6
Borderline	5	5	5	5
	4	4	4	4
Negative	3	3	3	3
	2	2	2	2
	1	1	1	1
	0	0	0	0
Alarm Level:	>10%	>10%	>25%	>30%

BHBA = blood β -hydroxybutyric acid; NEFA = plasma non-esterified fatty acids.

Adapted from Cook NB, Oetzel GR, Nordlund KV: Modern techniques for monitoring the health and productivity of the high producing dairy cow. Part I: General principles of herd level diagnoses. *In Practice*, 28:510, 2006.

The risk for low ruminal pH appears to follow the cow's natural dry matter intake curve and peak somewhere between 100 and 150 days in milk in TMR-fed herds (Figure 2). Do not focus ruminal pH testing on early lactation cows in TMR-fed herds.

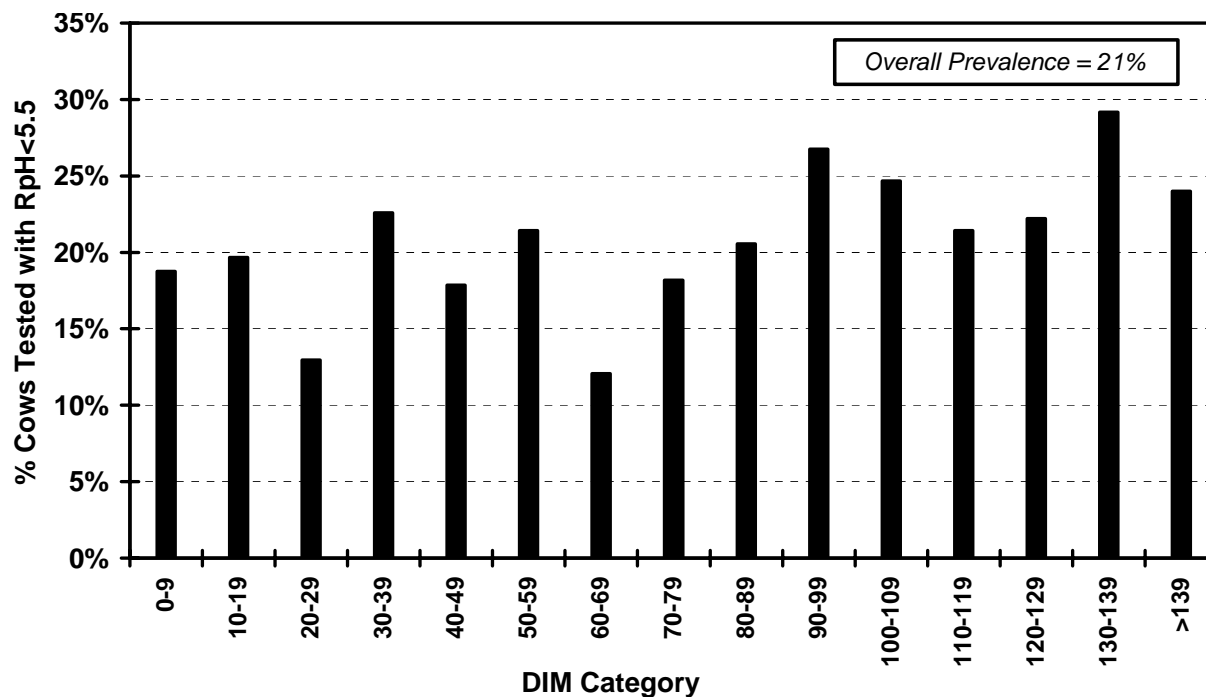


Figure 2. Risk for low ruminal pH (<5.5) by days in milk categories for 766 cows in 61 herds.

More cows than the minimum sample sizes can always be sampled, but value of sampling more cows has to be compared to the time and money required to sample the cows. Sampling additional cows is suggested when the results of a proportional outcome are very close to the alarm level, or when herd test results are not supported by clinical signs observed in the herd.

It is a common misconception that minimum sample sizes are larger for larger herds and smaller for smaller herds. This is incorrect – herd size actually has an inconsequential influence on the necessary minimum sample size.

In smaller herds, it may be possible to test the entire eligible group and still not meet the minimum sample size. This can be particularly true for pre-fresh cow testing (urinary pH and NEFA). For example, there might only be four cows in the pre-fresh group eligible for testing. All four should be tested; however, the sample size is probably too small to yield conclusive results. Additional cows can be tested later, as they enter into eligible group. Group results can be interpreted after test results from about eight (for urinary pH) or twelve (for NEFA) test results have been accumulated. If cows are repeatedly tested for NEFA as they approach calving, only the last test result before actual calving for that cow should be interpreted. Multiple test results from the same cow should not be used to achieve minimum sample size goals.

Herd Monitoring for Subacute Ruminant Acidosis

Subacute ruminant acidosis (SARA) is diagnosed and prevented on a herd basis; there is no practical way to diagnose or treat in on an individual cow basis.¹⁴ Clinical signs in dairy herds affected with SARA may include low or fluctuating dry matter intakes, low body condition scores, diarrhea, nosebleeds, unexplained deaths due to chronic inflammatory diseases, unexplained high cull rates due to vague health problems, milk fat depression, and decreased milk production in the second and greater lactation cows relative to the first lactation cows. None of these signs by themselves are diagnostic for SARA; however, considered together they form the basis for a presumptive herd diagnosis of SARA. It can be extremely useful to support a presumptive diagnosis of SARA in a herd with quantitative ruminal pH data.

Ruminal pH below about 5.5 for prolonged time periods is the apparent cause of the clinical signs observed in herds with SARA problems.⁴ Evaluation of ruminal pH is challenging because it is difficult to obtain a sample for testing, and because ruminal pH varies from day to day within herds and time of day within cow. The methodology for collecting ruminal pH samples has been described in detail.^{10,11}

A potential source of error in ruminal pH measurements is the calibration of the pH meter. A high-quality pH meter is recommended – pH paper is not sufficiently accurate and is influenced by the green color of the ruminal fluid. Field pH meters do not work well when operated at cold temperatures. It is best to conduct the pH determinations in a warm milking parlor or office during cold weather. The ruminal fluid samples can be capped in their syringe (with the air excluded) prior to determining their pH. Also, pH electrodes may become dry between uses and lose accuracy; soaking the electrode in a buffer solution prior to calibration can prevent this. It is good practice to calibrate the meter twice (or more) before pH testing. After the last calibration, put the pH 7 and pH 4 buffers back on the meter to verify the correct calibrations.

The testing scheme for SARA works very well for herds with high (>30%) or low (<15%) prevalences of cows with low ruminal pH. It is not intended as a means of ‘fine-tuning’ diets for optimal ruminal pH - this would require much larger sample sizes and quite frequent testing. Herds with intermediate (16.7 to 33.3%) prevalences of low ruminal pH may require additional testing. Immediate dietary intervention is probably not critical in herds with intermediate prevalences, so it is not unreasonable to take some additional time to test more cows.

Ruminal pH sampling should be done around the time of the expected lowest point (nadir) in daily ruminal pH. In component-fed herds, the nadir in ruminal pH occurs about 2 to 4 hours after a grain feeding and is probably the lowest after the last grain feeding of the day. In TMR-fed herds, the nadir in ruminal pH occurs about 6 to 10 hours after the first TMR feeding of the morning. Ruminal pH nadir occurs later in the day when dry matter intake is higher.

Figure 3 shows a distribution of herds I have categorized for SARA based on ruminal pH testing. With borderline herds, you either need to test more cows or use other herd information in order to make a diagnosis.

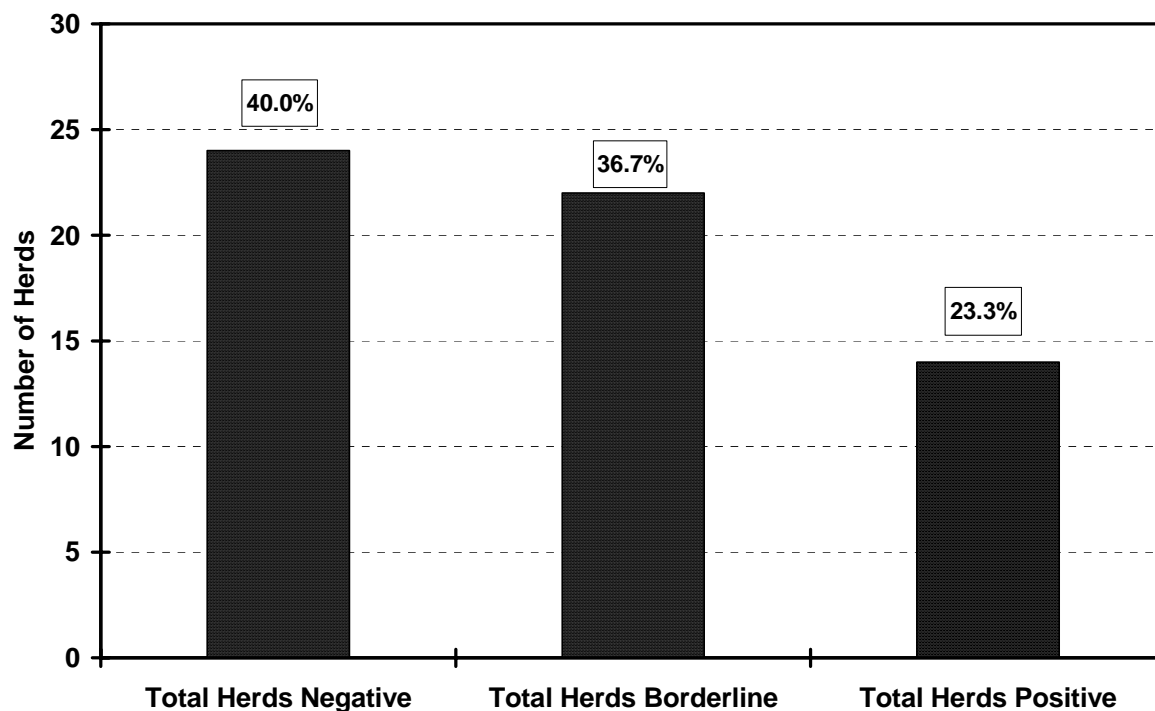


Figure 3. Distribution of SARA classification for 60 herds.

Herd Monitoring for Ketosis

It is difficult to assess the degree of ketosis problems that a herd may be experiencing without doing herd testing. Clinical ketosis rates (as determined by dairy producers) have very limited value in assessing the true ketosis status of a herd. Producers have dramatically different definitions for clinical ketosis, and also have dramatically different abilities to detect ketotic cows. Producers in smaller herds tend to overestimate the incidence of clinical ketosis, and producers in larger herds tend to underestimate the incidence of clinical ketosis.

Herds with ketosis problems in early lactation cows will typically have increased incidence of displaced abomasum and increased herd removals in the first 60 days in milk. High ketosis herds may also have a higher proportion (>40%) of cows with milk fat to true protein percentages above 1.4 at first test after calving.² These clinical findings by themselves are not sufficient evidence to make a definitive diagnosis of a ketosis problem in a herd. Herd-based testing is required before a definitive diagnosis can be made.

The “gold standard” test for ketosis is blood BHBA ≥ 14.4 mg/dl (1400 $\mu\text{mol/l}$). Clinical ketosis generally involves much higher levels of BHBA (25 mg/dl or more). The alarm level for the proportion of cows above the cut-point of 14.4 mg/dl has not been well defined. Published research studies show an average ketosis prevalence of about 15%, and I suggest using 10% as the alarm level for herd-based ketosis testing. Figure 4 shows an example interpretation guide for BHBA testing based on this alarm level. Figure 5 shows the distribution of herd test results for ketosis. As for SARA testing, we should expect to have many borderline results.

As for SARA testing, the ketosis testing strategy described here is designed to identify herds with either very high or very low prevalence of ketosis. It is not intended to ‘fine tune’ or optimize a transition cow feeding and management program for ketosis prevention.

The BHBA test is performed on serum samples, and there are no special sample handling requirements. Blood samples for BHBA testing should not be collected from the mammary vein. Mammary vein blood is lower in BHBA because the udder extracts BHBA during milk synthesis.⁸

Blood BHBA concentrations do exhibit post-feeding patterns and typically increase after feeding.^{9,3} Sampling times should be consistent and preferably about 4 to 5 hours after the first feeding of the days in order to capture peak BHBA concentrations.³ The post-feeding peak in serum BHBA concentrations is caused by ruminal production of butyric acid. Surpluses of ruminal butyric acid (either from ruminal production or from silage) are mostly converted to BHBA in the wall of the rumen.

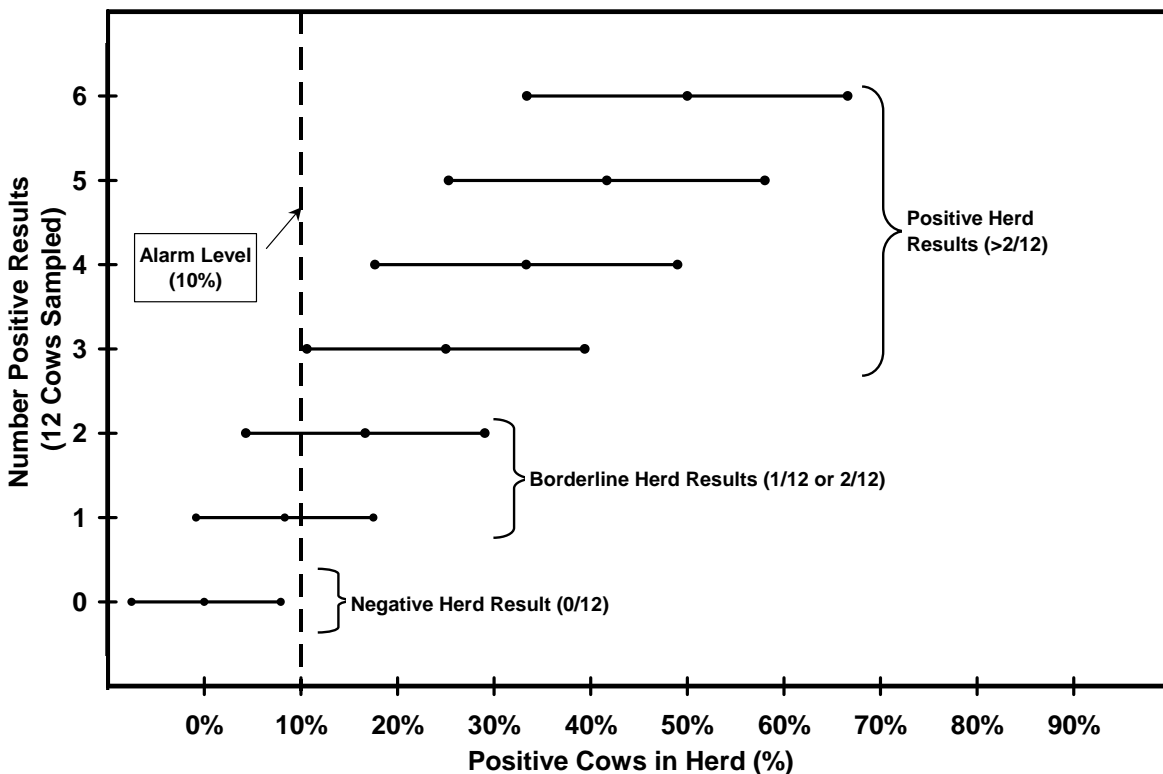


Figure 4. Interpretation of blood β -hydroxybutyric acid test results using 75% confidence intervals and an alarm level of 10% for test results from 12 cows sampled from within a group 50 cows. Adapted from Oetzel, GR: Monitoring and testing dairy herds for metabolic disease. *Vet. Clin. Food Anim.* 20:651-674, 2004.

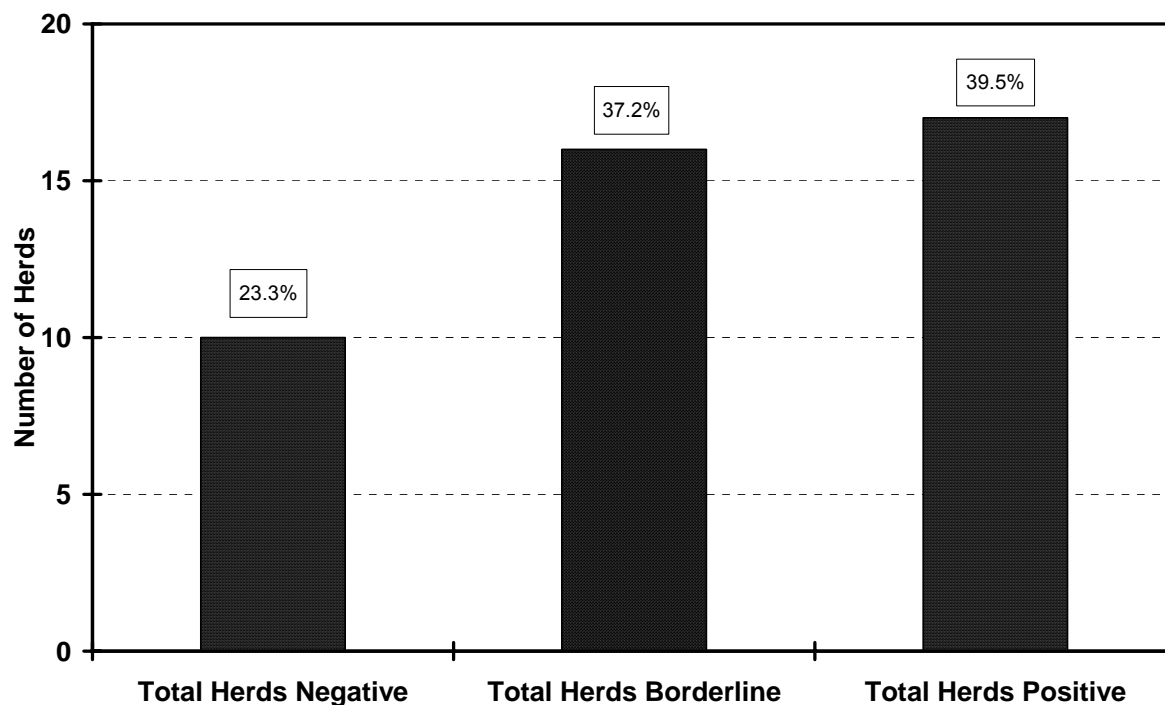


Figure 5. Distribution of 43 herds classified for ketosis.

A variety of cowside tests are available for ketosis testing of individual cows. However, no cowside test has perfect sensitivity and specificity compared to blood BHBA. It is best to use the gold standard ketosis test (blood BHBA) for herd-level diagnosis and monitoring. Cowside ketosis tests have lower costs, require less labor, and provide immediate results. This makes them useful for diagnosing clinical ketosis in individual, sick cows.

The blood NEFA test is used to evaluate energy balance prior to calving.⁶ Dry cows should be in positive energy balance up until the last 24 to 48 hours prior to calving. Negative energy balance is expected in milking cows, so blood NEFA concentrations are high after calving and can be difficult to evaluate. The ketosis test of choice for post-fresh cows is blood BHBA.¹

The NEFA test is best positioned as a secondary test in herds already known to have a high incidence of ketosis. The NEFA testing helps determine whether the post-partum ketosis is caused by negative energy balance prior to calving.

The most commonly used cut-point for NEFA is ≥ 0.400 mEq/L in pre-fresh cows between 2 and 14 days from actual calving. NEFA concentrations normally rise in the 48 hours prior to calving, so results from cows that calve this soon after the sample was collected are difficult to interpret. They are usually discarded or interpreted with caution (values below .400 mEq/l are definitely negative, but higher values are not necessarily proof of a problem).

The alarm level for the proportion of cows with elevated NEFA concentrations within a group is not clearly known. I suggest using 10% as a reasonable alarm level. Because this is the same alarm level as for blood BHBA in post-fresh cows (10%), the interpretation of NEFA results is the same as previously outlined for blood BHBA (Figure 2).

The window of eligibility for NEFA testing is very small – only about 12 days, and you cannot know whether a cow will fit in the window until after she calves. In small dairy herds it may be difficult to sample enough pre-fresh cows to meet the minimum sample size required. Samples can be collected, frozen, and later submitted as a group for NEFA analysis when actual calving dates are known and about twelve samples have been accumulated.

In large dairy herds, only a portion of the pre-fresh group needed may be sub-sampled for NEFA testing. In large pre-fresh groups, select cows that appear to be the closest to calving (based on due dates and visual observation), but avoid those cows in which calving appears to be imminent. In my experience, only about 75% of cows identified for NEFA testing using these criteria will actually calve 2 to 14 days later. Thus, expect to have to sample at least 16 cows in order to have 12 or more valid samples once actual calving dates are known.

Some pre-fresh cows may be in a maternity pen instead of the main pre-fresh pen(s). Do not avoid sampling cows in the maternity pen, as long as they do not appear to be imminently close to calving. Many of the cows in a maternity pen will not calve for several more days, and they are at very high risk for elevated NEFA concentrations because of the move to a new pen.

Concentrations of NEFA reach their nadir about 4 to 5 hours after the first feeding of the day³ and peak just prior to the next major feeding. It is best to sample just prior to feeding in order to capture the peak NEFA value. It is acceptable to sample cows immediately after they have been locked up to new feed.

It is important to keep the plasma samples for NEFA testing cool or frozen from the time they are collected from the cow until the time they are received at the laboratory for analysis. At room temperatures some of the triglycerides normally present in blood may degrade to NEFA and falsely (but slightly) elevate the test results.

Herd Monitoring for Parturient Hypocalcemia

Both clinical milk fever and parturient hypocalcemia can be monitored in dairy herds. Limited data are available to assist in determining an alarm level for parturient hypocalcemia. Two studies with multiparous Holstein cows^{16,7} record the incidence of both clinical milk fever and parturient hypocalcemia. In both studies, cows were fed control diets with and without anionic salts added. Feeding anionic salts reduced the incidence of clinical milk fever from 18.5% to 7.7% and the incidence of parturient hypocalcemia from 50.0% to 28.2%. I suggest alarm levels of $\geq 30\%$ for parturient hypocalcemia and $\geq 8\%$ for clinical milk fever in multiparous Holstein cows. Primiparous cows are at

very low risk for low blood calcium around calving and probably should not be included in the monitoring program.

Using an alarm level of 30% for parturient hypocalcemia in multiparous cows and a minimum sample size of 12 cows, the interpretation scheme would be 0, 1 or 2/12 is negative; 3, 4, or 5/12 is borderline, and 6/12 or more is positive. Herds that do not feed acidogenic diets are unlikely to be classified as negative for parturient hypocalcemia.

The best time to collect blood samples for monitoring hypocalcemia is about 12 to 24 hours after calving. In most situations the blood samples must be collected by on-farm personnel rather than by a veterinarian or technician. The farm then needs a means of separating the serum (or plasma) and storing it. Samples should be promptly picked up from the farm, processed, and submitted to an analytical laboratory for calcium analysis.

Urinary pH for Monitoring Anion Dose

Dietary acidification by feeding supplemental anions is a means of reducing both clinical and subclinical hypocalcemia.¹² Urinary pH is a good monitor of systemic acidification and should be about 7.0. Urinary pH is interpreted as a mean value, and the suggested minimum sample size is 8 cows. Testing should be done weekly, or even more frequently if urinary pH results are unstable or if monitoring for parturient hypocalcemia reveals a problem.

Urinary pH can be determined satisfactorily with pH paper – a calibrated pH meter is not required. On-farm personnel can conduct urinary pH testing (it is not technically difficult), but they actually tend to be very poor at doing this because they are often busy with other, more urgent tasks. Having a veterinary technician check urinary pH values once a week helps assure that the task actually gets done.

The effect of time post-feeding on urinary pH is small when cows have access to feed throughout the day.⁵ If feed access is not good throughout the day for pre-fresh cows, then the problem of inadequate feed availability is much more important than monitoring urinary pH.

Urea Nitrogen Testing to Evaluate Protein and Energy Nutrition

Blood UN (BUN) or milk UN (MUN) are indirect measures of protein and energy nutrition in lactating cows. High UN's may be caused by either high dietary crude protein (especially soluble protein) and/or low dietary NFC. High UN's are a risk factor for infertility and body condition score loss due to the energy cost of detoxifying excessive ruminal ammonia into urea by the liver.

The effect of time relative to feeding on UN concentrations is great, particularly if the protein is fed as a separate component of the diet two or three times a day (see Figure 6). Lack of control of the time of UN sampling relative to feeding has greatly hindered the effectiveness of this test in the past. Sampling at about 3 hours after a major protein feeding should assist in determining peak daily UN concentrations. Consistent time of sampling relative to feeding is necessary when monitoring a herd over time.

Milk UN concentrations are closely related to BUN concentrations (Figure 6). Therefore, either BUN or MUN samples are acceptable for evaluating herd UN. Bulk tank MUN is particularly attractive because it provides a mean value for a large group of lactating cows with a single test, without concerns of getting an adequate sample size. Wet chemistry procedures for MUN are preferred over NIRS tests (e.g., MUN testing provided through DHI) because of they are more accurate. Because bulk tank MUN testing is inexpensive and accurate (as long as a wet chemistry analysis is used), and because UN is evaluated on a basis of the group mean, bulk tank MUN screening it is a reasonable procedure to conduct on a routine basis. Individual cows (or milking strings) could then be evaluated for UN if the bulk tank MUN value falls outside the normal range for a group of animals.

In general, I have found UN testing to be the least useful of all of the herd-based tests described in this paper. Whenever I have found a UN problem in a herd, I already knew what the ration problem was that caused it. Other tests have been more useful in that they described problems that were more subtle or difficult to diagnose based on the ration evaluation.

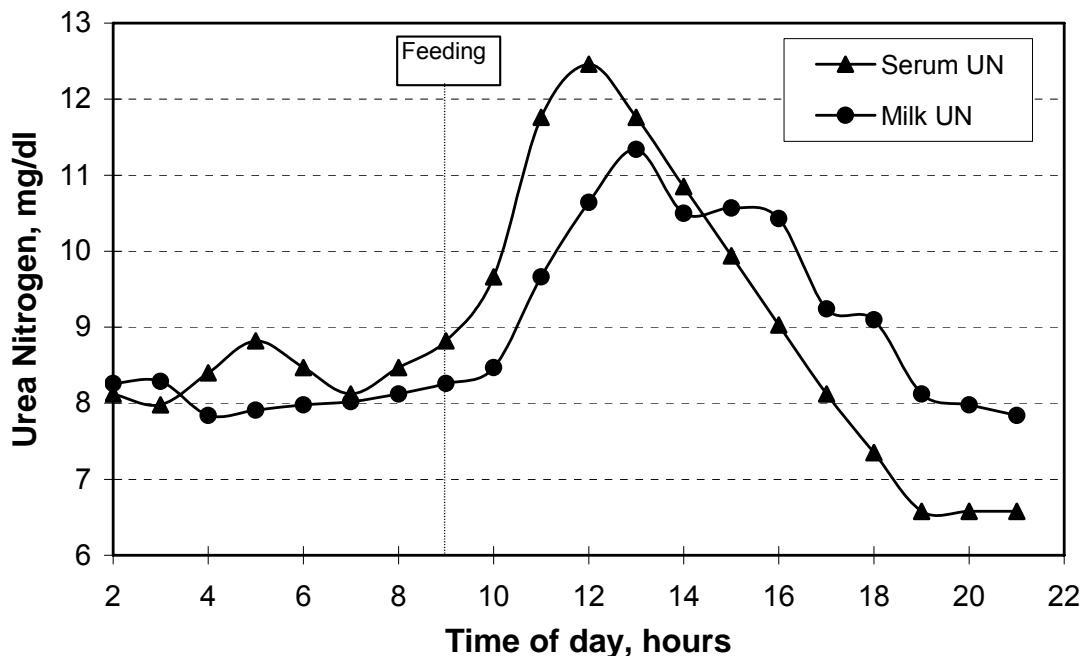


Figure 6. BUN and MUN variations after feeding. Adapted from Gustafsson, A. H., and D. L. Palmquist. Diurnal variation of rumen ammonia, serum urea, and milk urea in dairy cows at high and low yields. *J. Dairy Sci.* 76:475-484, 1993.

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Appendix 1 - Using Dairy Comp 305 Records for Herd-Level Health Evaluation

I. On-Farm Review of Dairy Comp Records

A. Display and Print Events Table by Month

Command: EVENTS FOR LACT>0 \5

LACT>0 excludes calves and replacement heifers from the table

\5 selects the “Events Table by Month” option automatically

Note: EVENTS commands automatically include both live and dead cows

Note: dead cows in Dairy Comp 305 means any cow no longer in the herd (i.e., includes both SOLD and DIED cows)

Note: this table automatically includes events for the last year only

Evaluation: look at the events table to see the EVENTS that are defined for this herd (note that events are not necessarily disease diagnoses)

Evaluation: check the number of fresh cows, both for the entire year and by month (note that the months are always arranged from Jan through Dec – not chronologically; the column for the current month includes data from both this and the previous year)

Evaluation: check the number of SOLD cows by month (there should be some cows SOLD for each month – if not, then an archive file is probably missing or is not being read by Dairy Comp)

B. Calculate Baseline Herd Health Data from the Events Table

Calculate Average Herd Size for the Last Year

(needed for the denominator of subsequent calculations)

Note: average herd size (milking plus dry cows) for the last year is not usually calculated by Dairy Comp 305, and is not presented in the events table. There are four options for getting an estimate of average herd size for the last year:

1. If the herd is on DHI, the herd summary sheet will display the rolling average herd size (see the “No. Cows” column to the left of the rolling herd average; use the value for the most recent month).
2. Check the herd monitor (type MONITOR from the command line) and see if total herd size (milking plus dry cows) is included in the monitor. You can look at the configuration of the monitor to see how this number was determined. The herd size you are looking for is calculated by the Dairy Comp command COUNT LACT>0. If this calculation has been done, you can compute the average herd size from the monthly data presented in the monitor.
3. If the herd is not on DHI and historical herd size information is not available in the Dairy Comp 305 monitor routine, you can determine the current herd size (milking plus dry cows) using the Dairy Comp command COUNT LACT>0. If herd size has been stable over the last year, then the current herd size is a reasonable estimate of average herd size for the last year.
4. Another option for estimating average herd size over the last year is to multiply the number of cows fresh in the last year (from the Dairy Comp 305 events table) by .93. If herd size has been stable and the turnover rate is not very high or low, this estimate works fairly well. It

could be useful to compare or average the results from this calculation and the current herd size when these are the only methods available for estimating average herd size for the last year.

Calculate Turnover Rate: $(\text{Cows SOLD} + \text{Cows DIED}) / \text{Average Herd Size}$

Goal is <30% annual turnover rate, with adjustments for herds that are expanding or for herds that sell some fresh cows to be dairy cows in other herd.

Calculate Turnover Rate for the First 30 Days in Milk:

Enter the command `EVENTS FOR LACT>0 DIM<31 \2SI`

LACT>0 excludes calves and replacement heifers from the table

\2 selects the “List Cows and Events” option automatically

\S allows you to select the date range for events to be included on the list (you will be prompted to select the date range – the last year is the default)

\I inquires as to which event(s) you will select for the list (you will select SOLD and DIED when prompted)

This command will generate a list of all the cows removed from the herd (SOLD or DIED) before 30 days in milk. Calculate the removal rate between 0 and 30 days in milk by dividing the total number of cows on the list by the average herd size.

The goal for herd removals in the first 30 days in milk is <4%. Higher removal rates suggest problems with fresh cow health. An exception would be herds that sell recently fresh cows for dairy purposes; they would have a high herd removal rate in the first 30 days in milk that is not indicative of a fresh cow health problem.

Calculate Turnover Rate for 31 to 60 Days in Milk:

Enter the command `EVENTS FOR LACT>0 DIM>30 DIM<61 \2SI`

This command will generate a list of all the cows removed from the herd (SOLD or DIED) between 31 and 60 days in milk. Calculate the removal rate between 31 and 60 days in milk by dividing the total number of cows on the list by the average herd size.

The goal for herd removals between 31 and 60 days in milk is <2%. Higher removal rates suggest problems with fresh cow health, as described above.

Calculate Turnover Rate for the first 60 Days in Milk:

Sum the number of cows SOLD and DIED between 0 and 60 days in milk (as done in the two steps above) and divide by the average herd size,

The goal for herd removals between 0 and 60 days in milk is <6%. Higher removal rates suggest problems with fresh cow health, as described above.

Determine the Number of Cows Fresh in the Last Year:

(needed for the denominator of subsequent calculations)

The best way to get the number of cows fresh in the last year is from the Dairy Comp 305 events table (as described above). If you have only DHI records and know the average herd size in the last year but not the number of fresh cows in the last year, You can estimate the number of fresh cows by dividing the average herd size by .93. If herd size has been stable and the turnover rate is not very high or low, this estimate works fairly well.

Calculate Death Loss Rate: Cows DIED / Cows FRESH in Last Year

Goal is <4% annual death loss rate. Unfortunately, average death loss in medium to large dairies is now about 8%. If death loss is a problem in a herd, an optional exercise is to evaluate death loss by days in milk (see later for details).

C. List All of the SOLD and DIED Cows for the Last Year

Command: `EVENTS ID LACT ME305 FOR LACT>0 \2SI`

ID, LACT AND ME305 adds useful items to the list for later analyses
(be careful – some herd setups do not use ME305 as an item)

Once the list is displayed, you can print it (unless the herd is very large and the list is very long). The list will include the DIM when the event occurred, and the reason(s) that the producer entered for why the cow was sold or died. The REM (remark) column is limited to eight characters, so these are often cryptic and inconsistent from cow to cow. Remarks cannot usually be interpreted unless the dairy producer first explains them to you.

Back in the office, you can export the sold and died list out of Dairy Comp 305 and import it into Excel for more detailed analysis and better graphical display. To export the list, hit the “diskette” icon on the Dairy Comp 305 taskbar and save the file as a text file in the desired subdirectory. You can then import the text file into Excel. Once in Excel, you can sort, analyze, and chart the list as needed.

D. Optional - Plot the SOLD and DIED Cows for the Last Year by Days in Milk

(only necessary if the herd is not on AgSource DHI, doesn't have WiscGraph, and/or you don't want to export and plot the data in Excel)

Command: `PLOT EC \W60D`

EC (event code) allows you to select which events you want to plot. When prompted, select SOLD and DIED. You can specify the starting and ending dates here (the default is the last year). You should then specify graphing by “days in milk.” The number of sold and died cows will then be plotted as separate bars for each 60-day time period.

\W60D sets the time interval for each plotted bar (60 days in this case).

Note: This plot is similar to a WiscGraph plot, except that the WiscGraph plot includes sold and died cows together for each 30-day interval. You can replicate the WiscGraph plot in Excel after by exporting the Dairy Comp data to Excel (as described above) and then manipulating the data using various Excel functions.

E. Determine the Number of Cases of DA in the Last Year and Calculate DA Rate

Command: `EVENTS ID LACT ME305 FOR LACT>0 \2SI`

\I inquires as to which event(s) you will select for the list
(you will select DA, or perhaps LDA and RDA, when prompted)

Cows with repeat DA events should be considered as only one DA case. So, look at the list and record only the number of cows with DA, not the number of DA events.

DA's may be subdivided into LDA and RDA for some herds; in this case, add them up to get the total number of DA's.

Many herds do not enter DA as an event for cows that are diagnosed with a DA but are sold (or die) instead of receiving treatment or surgery. Producers often (incorrectly) enter only SOLD or

DIED as the event, then enter “DA” somewhere in the REM column. So, check the REM column to find these additional cases of DA. Add these to your total number of DA events.

Back in the office, you can export the DA list out of Dairy Comp 305 and import it into Excel for more detailed analysis and better graphical display. To export the list, hit the “diskette” icon on the Dairy Comp 305 taskbar and save the file as a text file in the desired subdirectory. You can then import the text file into Excel. Once in Excel, you can sort, analyze, and chart the list as needed. It is particularly useful to calculate the median days in milk at DA event (expected range of 10 to 12 days in milk).

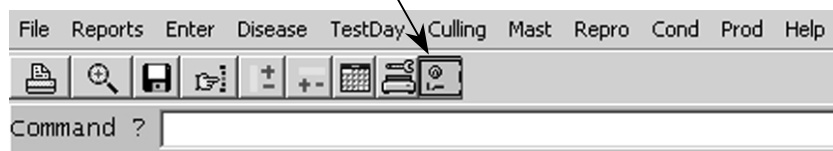
Calculate Displaced Abomasum Rate: Cows DA / Cows FRESH in Last Year

Goal is <4% annual DA rate

Note: Displaced abomasum is the easiest disease to diagnose and monitor on a herd-level basis. We usually do not specifically evaluate the rates of other diseases, because either the disease diagnostic criteria are inconsistent and/or the disease is not usually recorded. If a herd does correctly diagnose and record other disease events, then feel free to evaluate these diseases using the same pattern as described above for DA events.

II. Downloading Dairy Comp Files to Bring Back to Office

- A. Do not use the “Daily Backup” option from the Dairy Comp menu for this purpose! The necessary herd archive files will probably not be included in this backup (due to file size / floppy disk size limitations), unless the herd is small. Without all of the necessary archive files, you will have missing data from any cows sold or died since the last herd cleanup.
- B. Click on the backup (“safe”) icon on the Dairy Comp main menu (see picture below)



Then follow the Dairy Comp prompts. It usually works best to have the backup files copied to a USB drive. Select the “consultant backup” from the menu options. This will create a zip file of all the needed files, archives, etc. You will have to unzip it to your computer.

- C. If the backup menu option does not work, you can hand copy all “dat” (data) and “arc” (archive) files to your computer media. This can be difficult at times, and you need to bring a variety of media with you to the farm. Follow this protocol:

Exit Dairy Comp 305

Go to “My Computer” (or the Command Prompt) and find the subdirectory containing the Dairy Comp program and data files (usually C:\DC305).

Find all of the herd data files (cowfile*.dat) and herd archive files (cowfile*.arc), where * is a number between 1 and 9. If the computer is set up so that filename extensions are not displayed, you can view the ‘file type’ column to determine the filename extension (‘dat’ files are displayed as ‘DAT’ file type, and ‘arc’ files are usually displayed as ‘WinZip’ file type, even though they are not zipped files).

Copy all of these files to your disk media. If you copy the files into a subdirectory on your disk media, give the subdirectory a name that is less than eight characters long. Dairy Comp 305 cannot read files that are contained in a subdirectory name with more than eight characters.

The media you use depends on the type of computer, disk drives available, USB ports available, etc. Follow this flowchart for choosing which media to use:

1. If a USB port is present and open, insert a USB external disk drive and then copy the cowfile*.dat and cowfile*.arc files directly to the USB drive. This is the fastest and best option, and usually works on later model computers. If the on-farm computer uses Windows 98 or Windows 95, you may need to first install the driver for the USB drive on the computer. So, it is a good idea to bring along a floppy disk that contains the necessary driver for the USB drive you are using. This file should have been provided by the manufacturer of the USB drive. Alternatively, you may be able to download the necessary driver from the web site of the USB drive's manufacturer. Windows 2000 and higher systems usually recognize USB drives and automatically install the necessary drivers for them.
2. If #1 doesn't work, then check for a zip drive (internal or external) on the computer. If a zip drive is available, then copy the cowfile*.dat and cowfile*.arc files directly to the zip drive.
3. If neither #1 nor #2 work, then check for a CD writer drive on the computer. If one is present, then use the computer's software (varies by machine!) to burn the cowfile*.dat and cowfile*.arc files directly to a blank CDR.
4. If none of the above work, then your last option is to use the floppy disk drive. This is often the case for older on-farm computers. Unfortunately, most dat and arc files are >1.44 MB in size and must be compressed before they will fit on a floppy drive.

Some newer computers may already contain the Windows-based WINZIP program, which can be used to compress the files to floppy disks. But older computers do not have this program. On these machines, you must use the DOS-based "PKZIP.EXE" utility program to compress the files and copy them to the floppy disk drive. This program is usually included with the Dairy Comp 305 software files and resides wherever the Dairy Comp 305 program files are located (typically C:\DC305). Go to the command prompt (or DOS mode) and find the subdirectory containing this file. Then zip the needed files to your floppy disk(s). The syntax for using PKZIP.EXE is:

PKZIP destination file name source file name

Example commands to zip the needed data and archive files could be:

PKZIP A:\herd-name-1.zip C:\DC305\COWFILE*.DAT

(this puts all of the data files into one zipped file) and

PKZIP A:\herd-name-2.zip C:\DC305\COWFILE*.ARC

(this puts all of the archive files into one zipped file)

If the data and archive files are very large, you may need to zip each one individually to a single floppy disk for each cowfile. For example:

PKZIP A:\herd-name-1.zip C:\DC305\COWFILE1.DAT

(this puts cowfile1.dat into a single zipped file, which should be <1.44 MB in size)

Sometimes it takes four or more floppy disks to get one herd's files downloaded, so take plenty of floppies along in case you need them.

- C. If you copied the herd files to a USB drive, zip drive, or a CD, you can logon to the file copies you just made to verify that you indeed have all of the correct files. If you copied the herd files to floppies as zip files, then you cannot do this extra check.

Follow this protocol for checking the files you copied onto a USB drive, zip drive, or CD:

1. Leave your USB drive, zip drive or CD in the on-farm computer.
2. Invoke Dairy Comp 305 on the computer. There is usually an icon on the desktop for this purpose. Otherwise, you should be able to find Dairy Comp 305 via the “Start” and “Programs” menu options on the computer’s desktop.
3. Dairy Comp 305 will likely open with the current, on-farm cowfile (from the computer’s hard disk drive). You now need to manually ask the program to logon to the cowfile you just copied onto your computer media.

Command : LOGON - a pop-up window should appear next

click on the BROWSE button that should appear on the right side of the window

navigate through the dialog box to find the herd files you just copied
(for example, the path to a USB drive file might be E:\Herdx)

click to highlight the file named cowfile1.dat, then click ‘open’

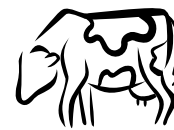
the cowfile should open and the date dialog box should appear

the date displayed should be today’s date; press OK. This is one check that you have copied the right file

Command: EVENTS FOR LACT>0 \5 – this should generate the exact same table that you created earlier from the on-farm version of the cowfile.

Command: EXIT - then click on ‘Exit Immediately’ to leave Dairy Comp 305; do not make a daily backup (as mentioned above, this backup is usually incomplete)

remove you media from the on-farm computer and bring it back to the office.



Categorizing Ketosis Problems in Dairy Herds

Garrett R. Oetzel, DVM, MS
Food Animal Production Medicine Section
School of Veterinary Medicine
University of Wisconsin-Madison

Defining Ketosis

Ketosis is often poorly defined in dairy herds. There are many different tests and criteria for establishing the amount of ketosis in a dairy herd. Each herd (and each research study) probably defines ketosis a little bit differently, which makes it difficult to compare the incidence and prevalence of ketosis in different settings.

It is best to simply define ketosis as increased levels of circulating ketone bodies and not to try to distinguish between its clinical and subclinical forms. Ketosis causes economic losses in dairy herds directly by decreasing milk production and indirectly by increasing the risk for displaced abomasum and other periparturient diseases.

The gold standard test for ketosis is blood β -hydroxybutyric acid (BHBA). A threshold concentration of 1400 $\mu\text{mol/l}$ (14.4 mg/dl) BHBA defines ketosis. (To convert BHBA concentrations from $\mu\text{mol/l}$ to mg/dl, multiply by 0.0103). Early lactation cows with blood BHBA concentrations above this cut point are at threefold greater risk for developing clinical ketosis or displaced abomasum compared to cows with lower blood BHBA concentrations (Duffield, 1997).

Acetoacetate (AcAc) is also one of the major ketone bodies found in the blood, milk, and urine. Blood concentrations above about 360 $\mu\text{mol/l}$ represent subclinical ketosis, and over about 500 $\mu\text{mol/l}$ represents clinical ketosis. These cut-points are not very well defined, and AcAc is not the best ketone body to use for ketosis testing because of its instability (it readily decomposes to acetone and carbon dioxide) and relatively lower concentrations compared to BHBA (about 4- to 8-fold less). However, many of the older ketosis studies use AcAc as their sole biochemical measure of ketosis. The proportion of AcAc relative to BHBA rises as total ketone body concentrations rise during ketosis. A sum concentration of AcAc plus BHBA of greater than about 9 mg/dl represents ketosis.

Clinical ketosis is difficult to define. It is usually described subjectively as early lactation cows with diminished appetite, hard or dry feces, decreased milk yield, rapid weight loss, and some elevated ketosis test result (urine, blood, milk, or breath). Different herds diagnose clinical ketosis very differently. Herds that have personnel who can smell ketosis on a cow's breath or herds willing to check urine ketones tend to report high incidence of clinical ketosis. Herds with minimal intensity of ketosis detection usually report low incidence rates.

Smaller, component-fed herds typically watch for cows who refuse their concentrates (grain or protein) and then check these cows for ketosis. In contrast, larger, TMR-fed herds in free-stall barns often do not observe individual cows for appetite. They tend to diagnose clinical ketosis by much less reliable criteria, such as an unexplained drop in milk production. As a result, free-stall herds often completely miss cases of clinical ketosis and only report that they find “sudden” deaths in early lactation cows. Or, they may not discover the clinical ketosis until the cow is extremely depressed.

Blood BHBA concentrations in early lactation cows with clinical ketosis typically range from 2600 $\mu\text{mol/l}$ (26.8 mg/dl) to 6000 $\mu\text{mol/l}$ (61.8 mg/dl). I often find individual cows with blood BHBA concentrations in this range when I randomly sample post-fresh pens in TMR-fed, free-stall herds. These cows were not identified as sick by the dairy producer and had not been pulled for treatment. When I identify such cows, I call the dairy’s veterinarian immediately and have the cows examined and treated. Many of them have a displaced abomasum, which might have been averted if the cow had been diagnosed and treated for clinical ketosis earlier.

Because of the difficulties in consistently diagnosing clinical ketosis, I do not attempt to quantitatively monitor it in dairy herds. I do ask about treatment rates for clinical ketosis, but do not regard this as a true incidence rate. Instead, I monitor the prevalence of ketosis, which is objectively defined and repeatable. I am also very interested in evaluating the diagnostic criteria used for clinical ketosis and the treatment protocols used on the dairy (this will be discussed in detail in a later presentation). Dramatic improvements can often be made in this area..

Types of Ketosis in Dairy Herds

I have found it extremely useful in clinical investigations of herd ketosis problems to categorize the ketosis into three general types (Table 1). Each type has a different etiology and therefore a different prevention strategy. There is overlap between the categories, and herds may have a combination of the types. Much of this classification scheme is adapted from Swedish work (Holtenius and Holtenius, 1996) and is described in detail in an excellent review article (Herdt, 2000).

Type I Ketosis

Type I ketosis is classic, underfeeding ketosis in cows that are 3 to 6 weeks post-calving. They are at their highest milk energy outflow, and they simply cannot keep up with energy demand because of some deficiency in nutritional management. These cows typically did not have difficulties in the pre-fresh period, calved normally, and started their lactation by milking well.

Cows with type I ketosis can effectively make glucose from precursors (mostly propionate from the rumen and amino acids from the small intestine). The limiting factor is the supply of glucose precursors. Blood ketone concentrations may become very high and blood glucose concentrations very low under these conditions (Figures 1 and 2).

Table 1. Summary of Dairy Herd Ketosis Types

Outcome	Ketosis Type:		
	Type I	Type II	Butyric Acid Silage
Description	Spontaneous Underfeeding	Fat Cows Fatty Liver	Wet silages
Blood BHBA	Very high	High	High
Blood NEFA	High	High	Normal or High
Blood glucose	Low	High	Variable
Blood insulin	Low	High	Variable
Insulin status	Insulin-dependent (Type I diabetes mellitus)	Insulin-resistant (Type II diabetes mellitus)	Variable
Body condition	Probably thin	Probably fat (may have lost fat)	Variable
Fate of NEFA	Ketone bodies	Liver triglycerides	Variable
Liver gluconeogenesis	High	Low	Variable
Liver pathology	None	Fatty liver	Variable
Highest risk period	3 to 6 weeks	1 to 2 weeks	Variable
Prognosis	Excellent	Poor	Good
Key diagnostic test	Post-fresh BHBA	Pre-fresh NEFA	Silage VFA analysis
Key intervention	Post-fresh feeding	Pre-fresh feeding	Destroy, dilute or divert the silage

Type I ketosis is named for its related metabolic disorder, type I diabetes mellitus. In both conditions, blood insulin concentrations are low, although for different reasons. Insulin is low in type I diabetes because of a pancreatic defect, and is low in type I ketosis because of chronic hypoglycemia due to a shortage of glucose precursors.

Cows with type I ketosis generally respond well to a variety of ketosis treatments. All they need is a small boost in their battle to keep up with energy demands, and they are back on track again.

The key to preventing type I ketosis is to maximize energy intake in early lactation. In some herds, this might be as simple as feeding a little more grain in early lactation. Alternatively, a little less grain might be the correct solution if the cows simultaneously have subacute ruminal acidosis (SARA) causing depressed dry matter intake. Early lactation SARA is particularly commonly in component-fed herds.

Fat supplementation in early lactation does increase energy density of the ration, but is ineffective and contra-indicated for ketosis prevention. Fat supplementation does not provide the glucose precursors needed to fuel gluconeogenesis, but rather floods the liver with more of the fatty acids it is already struggling to oxidize completely.

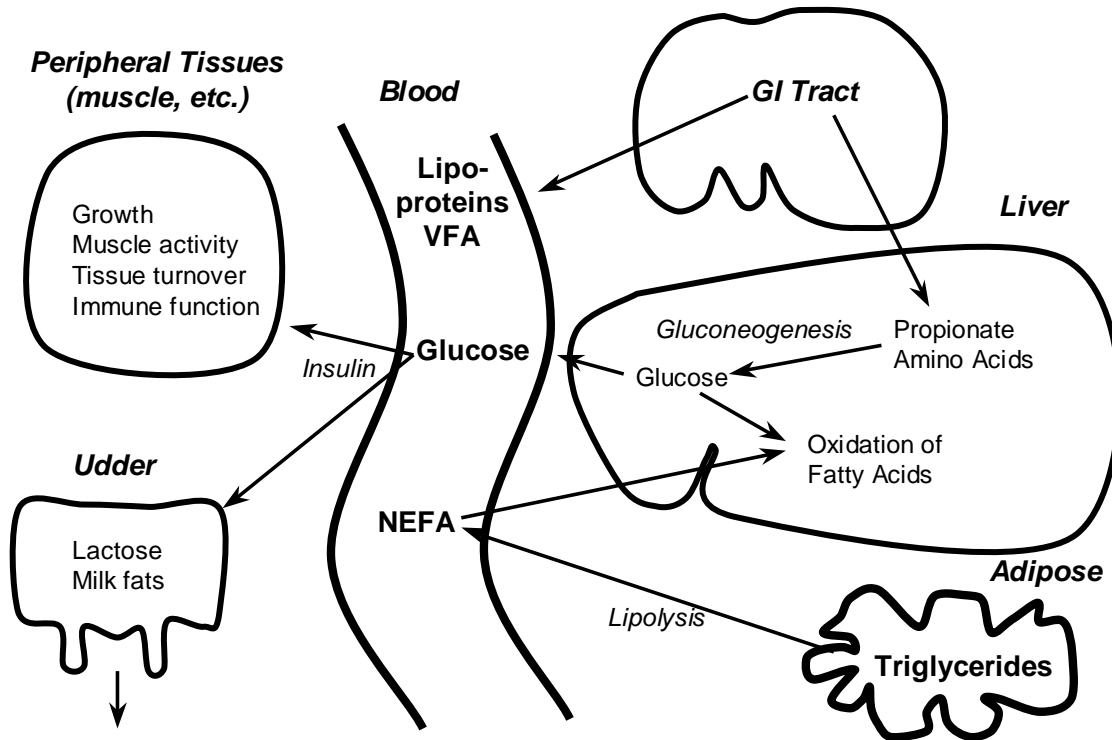


Figure 1. Schematic of glucose metabolism in a normal cow.

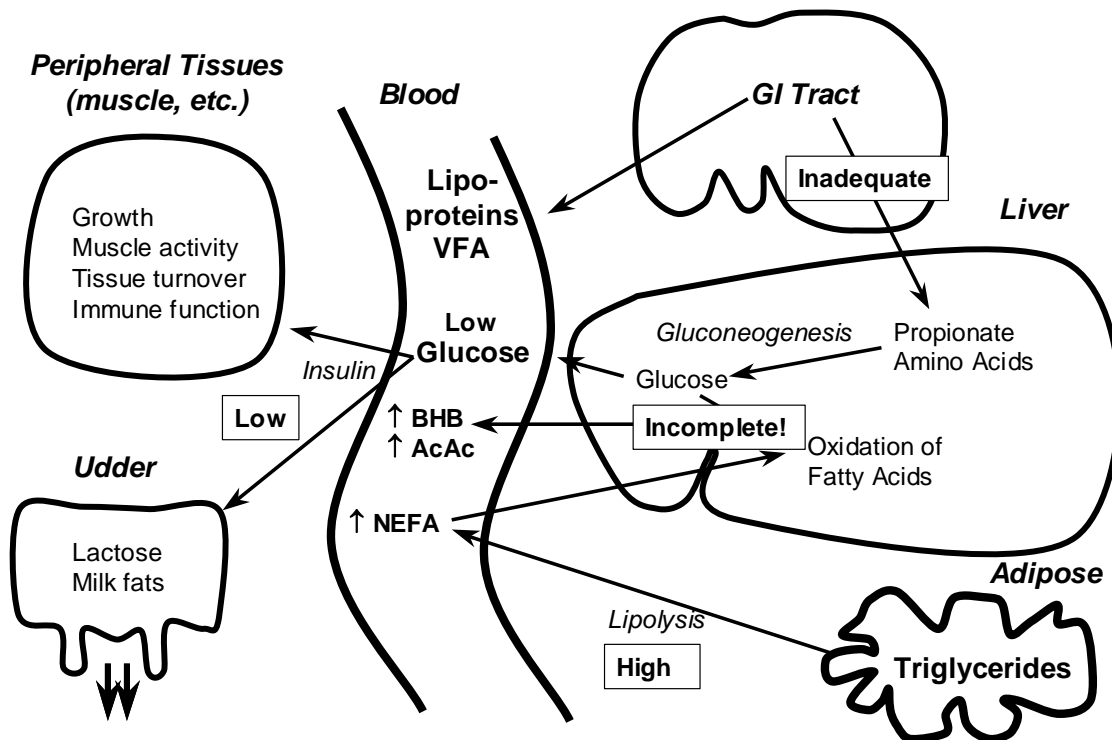


Figure 2. Schematic of glucose metabolism in a cow with Type I ketosis.

Instead of energy from fat, post-fresh cows need as much energy as they can reasonably obtain from grains. Grains are fermented to propionate and metabolized by the liver to glucose. Fat supplementation also tends to depress dry matter intake, particularly in early lactation. Keep in mind that total energy intake is a combination of both energy density *and* dry matter intake (Table 2). For example, an extra 3 lbs of dry matter intake is worth more energy to an early lactation cow than an increase of .04 Mcal/lb in energy density.

Table 2. Combinations of dry matter intake and energy density to meet energy requirements

Feeding Situation	Diet energy density, Mcal NEL/lb							
	.66	.68	.70	.72	.74	.76	.78	.80
Pre-fresh dry cows, NEL requirement of 18 Mcal NEL/day								
Dry matter needed, lbs/day	27.3	26.5	25.7	25.0	24.3	---	---	---
Early lactation cow, NEL requirement of 40 Mcal NEL/day (after allowing for body weight loss)								
Dry matter needed, lbs/day	---	---	---	55.5	54.1	52.6	51.3	50.0

Over-crowding and/or lack of bunk space can be another cause of insufficient energy intake in early lactation cows. Early lactation cows appear to be especially sensitive to over-crowding; timid or even mildly sick cows in early lactation can have great difficulty getting up to the bunk to eat if they have to fight their way there. Thus, what should be a mild, self-limiting illness for any cause can become clinical ketosis or a displaced abomasum when the post-fresh pen is over-crowded. I recommend a full 2.5 feet of bunk space per cow during early lactation. This applies even when 2.0 foot headlocks are used; cows still need 2.5 feet per cow. Thus, pens with 2.0 foot headlocks should only be stocked to 80% of the number of headlocks available. Other pens on the farm can be over-stocked or have restricted bunk space with milder consequences, but over-crowding or restricting bunk space in a post-fresh pen is courting disaster. Six-row barns (with 3-row pens) for post-fresh groups can be stocked to only about 60% of stall capacity to meet these criteria.

Type I ketosis may be caused by over-feeding protein and under-feeding energy in post-fresh groups in TMR-fed herds. Some post-fresh diets are overly conservative for fiber (because of concerns about SARA) and overly aggressive for protein (in an attempt to get cows to peak higher and faster). Adding baled hay to the post-fresh group TMR often makes these problems worse, and especially if the added hay is sortable. I see problems start when post-fresh NEL is less than about .76 Mcal/lb in combination with crude protein above about 19%. Neither factor by itself causes problems, but the combination does. The main problem with high crude protein content is the energy required to detoxify the extra ammonia that is absorbed from the rumen (i.e., the urea cost). It is not necessary to be overly concerned about SARA in the post-fresh group in TMR-fed herds, because their dry matter intakes are still relatively low. The highest risk period for SARA in TMR-fed herds is around peak dry matter intake (90 to 120 days in milk).

Type II Ketosis

Type II ketosis includes the older designation of “fat cow syndrome,” but encompasses more than just overly fat dry cows. It includes any cows that develop negative energy balance and begin mobilizing body fat prior to calving. Fat cows are at the highest risk for this problem because they are prone to dry matter intake depression around calving (Treacher, Reid, and Roberts, 1986), but thinner cows are also at risk if pre-fresh nutritional management is poor.

Maintaining positive energy balance up to the time of calving can be difficult, since dry matter intake is naturally depressed for about the five days prior to parturition (Bertics and others, 1992). As for post-fresh cows, maintaining energy intake is a matter of both energy density and dry matter intake. Nutrient densities for pre-fresh groups have to be set with the lowest expected dry matter intakes (i.e., just prior to calving) in mind. Formulating pre-fresh diets for the average intake of the group will result in negative energy balance in those cows approaching calving.

Moving cows to a different pen just prior to calving, over-crowding cows prior to calving, moving cows to different pens frequently after calving, and over-crowding after calving are important risk factors for type II ketosis. These issues are discussed in detail in another paper by Dr. Nordlund in these seminar proceedings.

Inadequate maternity pen management also increases the risk for type II ketosis. I often find maternity areas to be over-crowded, dirty, and extremely short of bunk space. Cows need at least 125 square feet per cow in a maternity pen and generous access to good feed and clean water. Many maternity pens provide no water and/or have very poorly-designed feed bunks (often with a surface lower than the standing surface). It is common to find maternity pen bunks are out of feed for much of the day. If cows spend more than a few hours in a severely compromised maternity pen, all of the effort spent on preventing type II ketosis in the pre-fresh period is wasted.

The fundamental lesion of type II ketosis is fatty liver (Figure 3). Fatty infiltration of the liver is largely complete by calving, but waits to manifest itself clinically after until calving. It impairs the liver’s gluconeogenic capacity, which greatly increases a cow’s risk for ketosis once lactation starts. Affected cows develop ketosis in the first week or two after calving. The quality of their post-fresh management has some but little bearing on the risk for type II ketosis; affected cows were programmed to get ketosis by calving time.

Type II ketosis is named for type II diabetes mellitus, its metabolic counterpart. In both conditions blood insulin concentrations are high and blood glucose concentrations are high (although probably only transiently so in type II ketosis cows). Insulin resistance may also characterize both conditions. Obesity is a particularly important factor in the development of insulin resistance. Further accumulation of body fat is restricted when tissues are insulin resistant; however, insulin resistance has grave consequences once the cow faces an energy crisis in early lactation and desperately needs to move glucose into her cells.

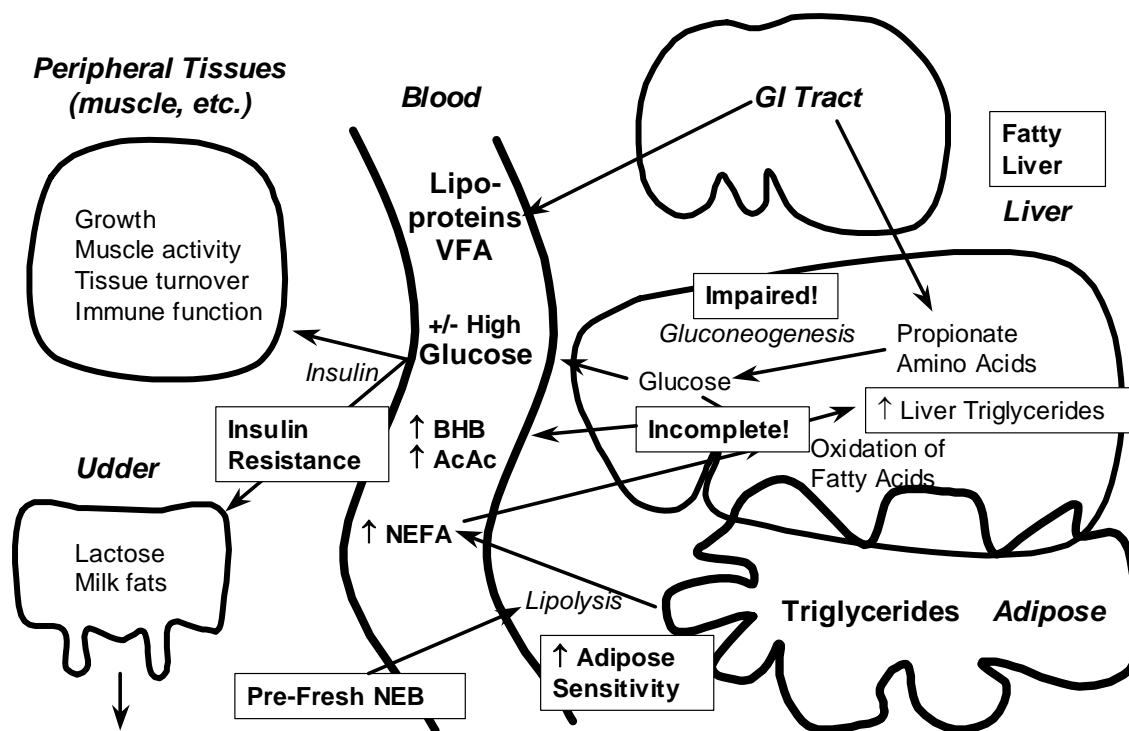


Figure 3. Schematic of glucose metabolism in a cow with Type II ketosis.

Obese cows are also prone to increased adipose sensitivity, which is the tendency to mobilize body fat very rapidly under conditions of stress or negative energy balance. This further exacerbates the cow's problems, because excessive mobilization of body fat increases fatty liver infiltration, drives ketone production, and depresses appetite even more. Very fat cows fall into a downward metabolic spiral soon after calving that leads to high mortality.

Obesity in replacement heifers often results in the worst possible cases of type II ketosis in dairy herds. This probably happens because the heifers have more difficulty than cows getting access to feed when they begin to feel sick. Obese heifers are also more prone to dystocia, retained placenta, and metritis than older cows. Mortality in replacement heifers can be high when they are obese and when transition cow management is not excellent.

Blood ketone concentrations are not as high in type II ketosis as for type I. Yet, the prognosis for recovery in type II cases following treatment is poor, because treatment does little to improve the cow's underlying lesion of fatty liver infiltration and loss of gluconeogenic capacity.

Fatty liver infiltration impairs both gluconeogenic potential and immune function by hepatocytes. Severe negative energy balance also suppresses immune function by itself (immune cells are voracious consumers of energy). The net result is a cow that is not only persistently ketotic, but also immune

suppressed. Many cows with type II ketosis die from infections (metritis, mastitis, pneumonia) that their immune systems would normally have been able to combat.

Type II ketosis is diagnosed in a dairy herd by finding a high incidence of ketosis in cows in the first two weeks of lactation, combined with finding a high prevalence of elevated blood NEFA concentrations in the pre-fresh cows. Other factors help substantiate the diagnosis, including obesity, very persistent ketosis, high rates of displaced abomasum, and high mortality rates in early lactation.

Type II ketosis is prevented by excellent pre-fresh nutritional management combined with prevention of obesity in dry cows. Preventing negative energy balance prior to calving requires good dry matter intakes as well as proper energy density of the pre-fresh diet (Table 2). Getting the cows to eat 3 extra pounds of dry matter is of as much benefit as increasing energy density from .66 to .74 Mcal/lb NEL. As for the post-fresh cows, issues that increase dry matter intake are of more practical importance than increasing diet energy density. Over-crowding pre-fresh pens or restricting bunk space for pre-fresh cows has the same dire consequences as it does for post-fresh cows.

Butyric Acid Silage Ketosis

Dairy cattle consuming silages containing butyric acid may have persistent ketosis problems. These silages have been described as “ketogenic” silages (Tveit and others, 1992). Hay crop silages that are chopped too wet (insufficient wilting or direct-cut silages) tend to favor growth of *Clostridium sp.* bacteria, which ferment some carbohydrates to butyric acid instead the desired lactic acid. Corn silage or ensiled corn grain rarely supports clostridial growth, presumably because of their relatively high water-soluble carbohydrate content. Some grass silages (particularly ryegrass) are also resistant to clostridial fermentation because of their abundance of water-soluble carbohydrates. Time of day at cutting affects water-soluble carbohydrate content as well, but is somewhat impractical to control.

Silages that have undergone a clostridial fermentation are easy to recognize because of the distinctive odor of butyric acid and protein degradation products that accompany this fermentation pattern. A silage fermentation (VFA) analysis can confirm the presence of and the amount of butyric acid present in the silage.

A review of the papers published on silage butyric acid suggests that daily doses of over 50 to 100 g of butyric acid can cause ketosis, and that doses over about 200 g of butyric acid may induce clinical ketosis. About 450 to 950 g of butyric acid will reliably induce clinical ketosis in nearly any early lactation cow. High-producing cows in early lactation in modern dairy herds are probably at inherently higher risk for ketosis than the cows used in these older experiments. Thus, be conservative in recommending how much dietary butyric acid a cow can “handle.”

Cows are equipped to metabolize the butyric acid produced by ruminal fermentation (about 750 g/day), mostly by using it as metabolic fuel for the ruminal musculature. About 75% of the additional ruminal butyric acid is converted to blood BHBA, the direct cause of ketosis (Figure 4). The liver then can

convert BHBA to AcAc (and vice versa). Thus, there is no “safe” dose of dietary butyric acid for dairy cows. Whether or not dietary butyric acid causes ketosis depends on the dose of butyric acid consumed and on whether other risk factors for ketosis (early lactation, high production, low dietary energy, high dietary protein, ruminal acidosis, etc.) are also present. *Any* amount of additional dietary butyric acid increases a cow’s risk for ketosis.

Dairies with large amounts of high butyric acid forage already in inventory have three options to deal with it - destroy, divert, or dilute. The best option is to destroy the feed, i.e., haul it away in a manure spreader to be spread on the fields (it is good fertilizer). Second, this forage could be diverted away from the pre- and post-fresh cows and fed only to replacement heifers, late lactation cows, and/or far-off dry cows. In any case, the concentration of butyric acid in the forage should be monitored frequently and the daily dose of butyric acid kept below 50 g/cow/day. Feeding these silages could compromise dry matter intake, even if ketosis does not result. “Aerating” the forage prior to feeding it could volatilize some of the butyric acid and make it safer to feed. Still, the butyric acid content of the silage should be monitored after aeration, and the aerated silage should be watched for heating, although this is unlikely. Third (and only under the most extenuating circumstances), the forage can be diluted and fed to close-up dry cows and/or early lactation cows. Again, the dose should be kept below about 50 g/cow/day. Early lactation cows should be intensively monitored for ketosis and promptly treated if the cows go off feed or show signs of ketosis.

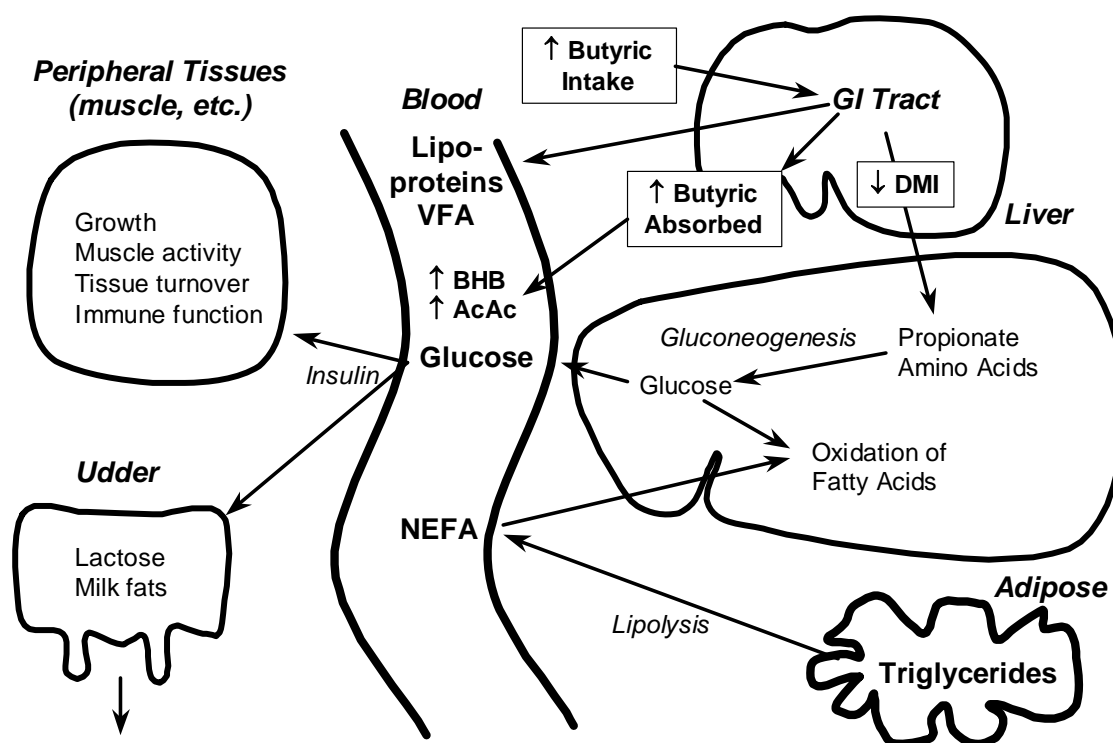


Figure 4. Schematic of glucose metabolism in a cow with butyric acid silage ketosis.

Harvesting practices must then prevent ensiling overly wet forages in the future. This requires adequate wilting time in the field after cutting and prompt covering of bunker silos if it rains during the filling and packing process. It is useful to recognize that clostridial fermentation of silages does not drop pH below 5.0, which means that the fermentation bacteria continue to grow and produce butyric acid indefinitely. In contrast, a normal fermentation by lactic acid bacteria drops the silage pH to well below 5.0, which kills the bacteria and stabilizes the silage mass. If a producer has already harvested a very wet hay crop silage, that feed should be fed out (or discarded) sooner rather than later. Be especially vigilant for high butyric acid silages in the late winter and early spring months, because hay crop silage that has been in storage the longest time period is often fed at this time of year.

In order to stay below 50 g/day of butyric acid with hay-crop silage as the sole forage (22 lbs forage dry matter/cow/day), the butyric acid content of the hay crop silage cannot exceed .50% on a dry matter basis. If the hay-crop silage makes up half of the forage dry matter (11 lbs/day) and the other half of the forage contains no butyric acid (corn silage or dry hay), then the hay crop silage should not exceed 1.00% butyric acid on a dry matter basis.

Clinical Data - Types of Ketosis in Dairy Herds

Our clinical experience with BHBA testing in problem dairy herd investigations supports the theory that these three different types of ketosis are present and can be diagnosed in dairy herds. Days in milk at the time of elevated BHBA concentration is especially helpful in making this determination. Examples of herds with elevated BHBA values typical of either Type I or Type II ketosis are presented in Table 3. Cows with high BHBA concentrations within the first 14 days in milk are most likely to have Type II ketosis. Thus, focus your attention on pre-fresh and maternity pen management in these herds. Cows whose BHBA concentrations first rise later than 14 to 21 days after calving probably have Type I ketosis. Focus your attention on post-fresh nutritional management in these herds. Clinical data from our problem herd investigations illustrates a biphasic distribution of ketosis by days in milk (Figure 5). It is possible that there is a time of reduced risk for ketosis between about 20 to 30 days in milk.

Herds with butyric acid silage ketosis appear to have increased risk for ketosis at any time before 50 about days in milk. This type of ketosis probably interacts with Type II and or Type I problems in the same herd. Cows with Type II ketosis may have lingering ketosis past 30 days in milk, but the onset of their ketosis is typically in the first 14 days after calving.

Table 3. Examples of dairy herds with days in milk of cows with high blood β -hydroxybutyrate concentrations (cut-point of $\geq 1400 \mu\text{mol/L}$) suggestive of either Type II or Type I ketosis.

Type II Ketosis Example Herd:			Type I Ketosis Example Herd:		
Cow	Days in Milk	BHBA (mg/dl)	Cow	Days in Milk	BHBA (mg/dl)
1902	5	14.5	Sheila	5	7.4
2910	5	25.6	Susan	5	8.9
4176	8	43.2	Lynn	6	4.6
3503	9	6.9	Sparkle	6	7.9
5293	9	17.8	Swish	7	9.8
6576	10	19.9	Dimples	8	5.5
6624	11	11.3	Gracie	10	4.0
3548	13	11.0	Marcy	10	12.2
3553	13	7.2	Diane	11	8.4
4019	13	4.1	Tootsie	11	8.5
1709	14	26.0	Sasha	15	10.0
4081	14	6.7	Olive	19	23.2
6662	14	16.3	Merry	20	17.6
6476	19	13.5	Kristyn	24	25.9
6681	23	18.7	Morgan	25	30.5
4040	26	9.5	April	31	22.8
3579	31	8.2	Twinkle	35	4.6
4109	32	6.8	Sarah	38	22.9
Group Summary:		8/18	Group Summary:		6/18

Incidence of Ketosis by Days in Milk
(906 cows in 63 herds)

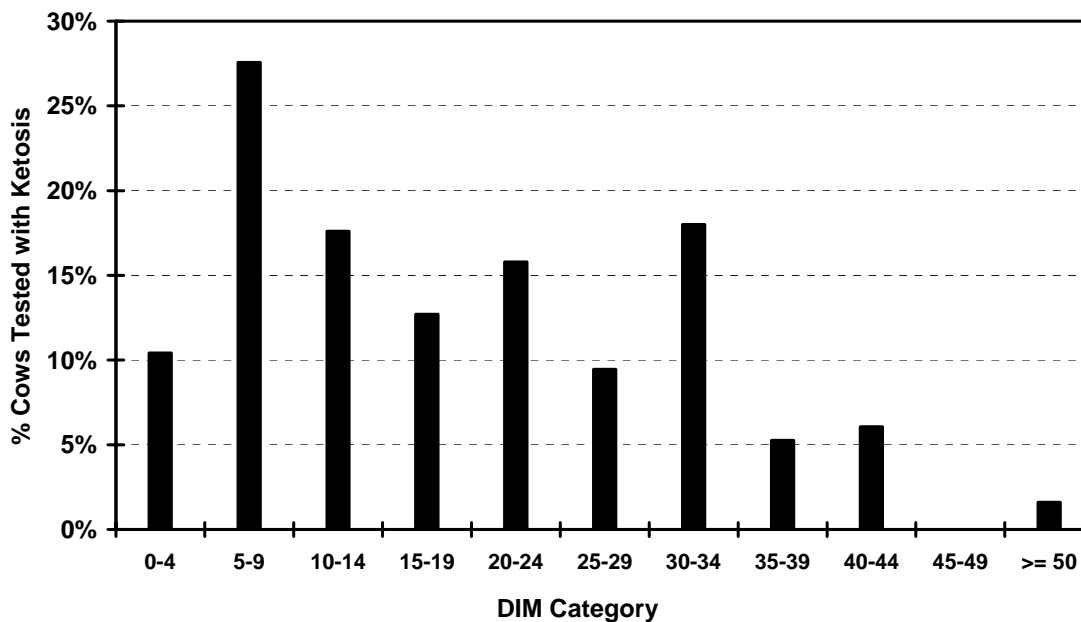
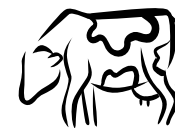


Figure 5. Incidence of ketosis by days in milk. Data are from 906 cows in 63 herds.

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Update on Dairy Cow Behavior, Facilities Design, Pen Moves, and Stocking Densities for Transition Cows

Nigel B. Cook, Kenneth V. Nordlund, and Garrett R. Oetzel
Food Animal Production Medicine Section
School of Veterinary Medicine
University of Wisconsin-Madison

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Summary

Knowledge of the complex behavioral needs of the dairy cow is essential if we are to provide adequate housing during the transition period. Cow flow through the transition period often necessitates many pen changes, which are disruptive to the social organization of cow groups. Stocking rates which exceed stall and feed bunk capacity place even greater challenges on the dairy cow at this time. Alternative strategies for cow grouping and improvements in pen and stall design are discussed which provide greater behavioral freedom for the dairy cow, and improvements in health and productivity.

Introduction

The purpose of this chapter is not to provide an all-encompassing guide to the building of a new dairy facility as other sources can provide much more detailed information on engineering matters related to flooring, roof designs, insulation requirements, barn location and manure handling. Rather, we take this opportunity to discuss matters of building design that immediately impact the health and welfare of the transition cow, areas that fall within the domain of the veterinarian. During the planning and management of transition cow facilities, we believe that it is the responsibility of the veterinarian to serve as the advocate for the needs of the dairy cow. Central to any discussion of housing requirements for dairy cows is an understanding of their social behavior. Before examining specific facility requirements in detail, we will therefore start by considering the behavioral stresses encountered by dairy cows in modern free stall barns, the challenge of pen moves to different management groups, and the effects of overstocking within these groups.

Behavioral Needs of the Individual Cow

Much research has examined the effect of different environments on milk production and dry matter intake (DMI) of small groups of cattle over relatively short periods of time. It is our view that many of these studies have inadequately demonstrated the true impact of environmental factors on cow health by failing to monitor low rank sub-groups of the population. In simple terms, compromised environments do not affect all animals equally. Ill health does not affect all of the individuals in a pen at the same time; rather, some cows are unaffected and perform well, while a few succumb to disease and perform poorly. Monitors based upon group mean DMI and milk production are likely to miss the adverse effects on outlier cows that are unable to compensate in a compromised environment. We believe that to improve

the health and well-being of dairy cattle in modern free stall facilities, we must provide for the needs of each cow so that she can behave as a herding animal, eating with the herd, resting with the herd, and socializing without fear.

Grouping Cows

The replacement of old tie-stall barns with free stall housing has brought with it a change in the life style of the dairy cow. Traditionally, the tie-stall cow was milked in the stall, fed in the stall, drank water from a cup in the stall, and stood and lay down in the stall as she required. In most situations, cows were allowed outside of the barn for 2-4 hours per day for exercise and to display signs of heat. Her production level and ration might change, her pregnancy status would change, and she might receive treatment for injury or disease, but she would remain in the same stall with her herd-mates in place on each side. In essence, management was brought to the cow in her tie-stall.

In contrast, the cow in the large free stall barn moves to management groups. She is moved to different pens for special rations, breeding, dry off, treatment, and other management practices. Smith et al. (1) have described the use of the groupings, outlined in Figure 1 under the “Traditional” column, for the management of transition cows. From the far-off dry cow group, a cow is typically transferred to the close-up dry cow group at 14-21 days prior to the expected calving date. From here, she is often moved to a bedded pack maternity pen at around three days before the expected calving. After calving, she is moved to a pen for cows with non-saleable milk to stay for two days, then to a fresh cow pen for 14 days, and then to a high group pen. This plan completes five pen moves in a period of less than 5 weeks. Essentially, the cow moves to management and finds herself in a different space, surrounded by different herd-mates, and subject to the management change for which she was moved. As investigators of problem herds, we have become increasingly concerned about the frequency and character of these pen moves on the well-being of the transition cow.

Pen Moves

Effect of pen move on the group mean. Moving cattle between groups brings about a period of increased social interactions, many agonistic, before stabilization and development of a social hierarchy (2). For lactating cows, Grant and Albright (3) report that social impacts of moves last around 3 days and almost always less than seven days.

Kondo and Hurnik (2) conducted a study on the behavior of lactating dairy cows after pen changes where two groups of 16 lactating dairy cows each were assembled in free stall pens and monitored for 5 weeks, after which half of each group were randomly selected and reassembled into a third group. Agonistic interactions between cows were characterized as physical, which included bunting, pushing, and fighting, or non-physical interactions which included threatening and avoidance behaviors. The frequency of agonistic interactions was high for the first 48 hours after grouping, averaging over 300 events per 2 hour recording session. After 48 hours, the frequency had stabilized at about 100 events per session. During the first 48 h, approximately 65% of interactions were physical and 35% non-physical. After the second day, this ratio had reversed to around 40% physical and 60% non-physical. When cows are moved into

stable groups, the moved cows are involved in more agonistic interactions than the stable cows. Brakel and Leis (4) showed that during the first day after regrouping, the average moved cow was involved in 9.6 interactions per hour, approximately double the rate of the other cows in the pen. Obviously this increase in physical interactions during the first 48 h of joining a new group may have an effect on other behaviors performed during the day – feeding and resting time in particular, which may in turn influence milk production.

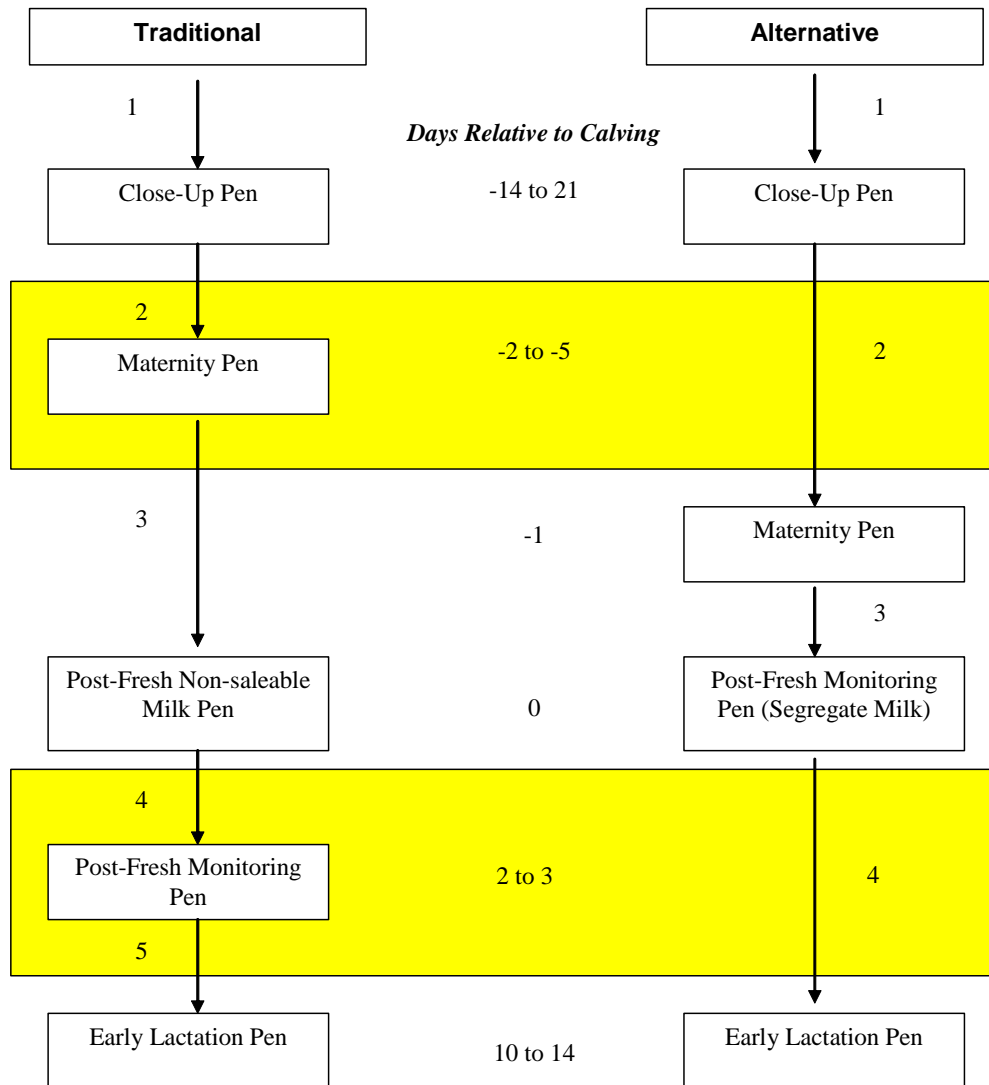


Figure 1. A pen move comparison for the traditional grouping strategy for transition cows, compared to an alternative strategy aimed at avoiding moves between 2 and 5 days before calving and 2-3 days after calving – highlighted in the shaded areas.

Research on the milk production effect of pen moves on the average cow in the group has found mixed results. Generally, a pen move has a negative effect on milk yield of the transferred cows of the order of

2-5% for a short period (4, 5, 6), but not in all situations (7, 8). For example, Brakel and Leis (4) found a 3% decrease in fat corrected milk yield of the transferred cows on day one of the move. It should be noted that many of these studies were conducted with mature cows in mid-lactation and not with cows in the transition period.

Studies on the effect of the number of cows moved at one time have generally found that movement of single animals should be avoided as it is believed that familiarity and social bonds between 3 to 5 moved animals may reduce the social stress of integrating within a larger group (9). Sowerby and Polan (5) did not find significant production differences between groups where between 2 and 14% of the cows were transferred at one time. Studies on the effect of the size of groups moved into large pens of 100 to 300 cows have not been reported.

Effect of Pen Moves on Individual Cows

While the effect of pen moves on the average cow appears to be modest, the effect appears to be more significant on low rank cows. The subject of rank and social dominance is complex. Lamb (10) describes three different ranking orders in cow herds, dominance, leadership, and parlor entrance order, and reports that the rankings for each are not the same. For example, the “leader” cow is not likely to be the most dominant cow. Dickson (11) reported that cows form dominance hierarchies strongly associated with age, body size, and seniority in herd. Changing conditions for individual cows such as weight gain or loss result in rank changes. Arave (12) reports a trial of individually-fed primiparous cows, some receiving a ration that exceeded energy requirements and others receiving an energy deficient diet. Rank within the group changed continually as some cows gained weight, strength, and social dominance, while cows on the low energy diet lost weight, strength, and rank. Pen moves are also responsible for changes in rank. Dominance relationships between pairs of cows are gradually learned, but once formed, they tend to last for a long time (13). Cattle moved to a new pen will tend to maintain their rank relative to the cows that were moved (14), but occupy a low rank with respect to the other cows, even first-lactation, that already occupy the pen. However, the situation may become more complex. Hook (15) observed a complete reversal of the social rank of a group of six heifers with the removal of the high rank individual and the simultaneous introduction of a new heifer.

Primiparous cows are usually subordinate to multiparous cows. Phillips and Rind (16) studied behavior and milk production of mixed and unmixed parity groups on pasture after assembly of the groups. Unmixed groups of either primiparous cows or multiparous cows produced 3% more milk in the first week than equivalent cows in the mixed group. Both primiparous and multiparous cows spent more time standing and less time grazing in the mixed group. The primiparous cows spent more time grooming, a submissive action, while the multiparous cows increased pasture biting rates, an aggressive action, compared to their contemporaries in unmixed groups.

Hasegawa et al. (6) described the effect of pen moves on dominant, middle rank, and subordinate primiparous cows. Dominant animals showed little change in behavior and production, but middle-rank and subordinate cows produced 3.8 and 5.5% less milk in the second week after movement to a new pen.

Subordinate individuals spent more time eating than dominant cows, spent more time standing – especially on day two after the move, and had a greater frequency of short lying bouts of less than 15 minutes in duration, suggestive of disrupted lying behavior.

Robinson et al. (17) found no difference in subsequent early lactation milk production following exposure to either 11.7% or 14.4% crude protein pre-fresh rations. However, the time for which primiparous cows had access to the diets was significant. Close-up primiparous cows that spent 9 or more days on the control ration produced significantly more milk in the subsequent lactation than those that spent 8 or fewer days on either ration. In contrast, there were no significant differences in response of multiparous cows to either ration or duration of exposure. We are therefore starting to question the need for multiple dry cow diets and suggest that the requirement for the cow and the rumen to adapt to a new diet in dairy herds feeding predominantly TMR based rations has been over-stressed. Indeed, some progressive dairy owners are now feeding high fiber lower energy straw-based diets throughout the dry period with apparent success. Our focus has shifted from concern over rumen adaptation to concern over social disturbances around calving time. Think for a moment about how close-up pens and maternity pens are managed. The close-up pen consists of a group of cows which spend about 2-3 weeks together. Additions to the pens are made usually on a weekly basis, which means that there will be social turmoil for 2-3 days followed by 4-5 days of stability. We would suggest that sub-ordinate animals – first lactation heifers for example, would be affected greater by these social challenges. Thus, when we look at the data from Robinson et al. (17), we might suggest that there is an alternative point of view. Benefits to heifers of a longer exposure to the close-up ration and pen may be due as much to stabilization of rank and social order as to the acclimation to the ration. Stays of 4 days or less will be characterized by social disruption through most of the entire stay, whereas longer stays allow for acclimation to both rations and herd-mates.

Effects of Confinement

Normal stocking density. Confinement appears to increase levels of conflict, even in established groups of cows. Miller and Wood-Gush (18) monitored conflict interactions in a herd of 190 high-yielding cows on pasture during a grazing season and through the following winter confinement in a freestall barn. Agonistic interactions averaged 1.1 per cow per hour on pasture, but increased to 9.5 per hour in a confinement barn stocked at a rate of 0.9 cows per stall. Low rank cows spent approximately 15% of their time in submissive or avoidance behavior in confinement and their movements were frequently blocked by dominant cows in their paths.

Galindo and Broom (19) observed three dairy herds through a five-month study of social rank, behavior, and lameness. In all herds, the stocking density was 1 cow per stall. Low rank cows spent less time lying and more time standing still and standing half in the freestalls than middle and high-rank cows. By 25 weeks into their lactations, more than 60% of the low rank cows had become lame compared to 18% of the high rank cows, suggesting a link between social rank and health in confinement conditions.

Overstocked Conditions

When confinement barns are overstocked, social tension increases. Primiparous cows spent more time walking and lying outside of freestalls, and showed a greater cortisol response to adrenocorticotrophic hormone (ACTH) challenge than multiparous cows in a mixed group stocked at 2 cows:1 stall (20), indicating an elevated level of stress in these animals. Overstocking can also refer to situations where the number of cows exceeds the number of eating spaces. Ethologists describe cattle as allelomimetic, meaning that they like to perform the same activity at the same time (18), which can apply to resting behavior, eating, drinking, and other activities. Overstocking, by definition, frustrates allelomimetic behavior.

Most modern free stall pens are constructed with either two or three rows of stalls. Stalls are approximately 48 inches wide, while headlocks are located 24 inches on center. Thus in a two row configuration there are two feeding spaces for every two stalls. In contrast, in three row pens, feeding space per cow is reduced by one third. Studies of the effect of limiting feed-bunk space have produced mixed results. Using 24-hour video monitoring of high-producing cows in 3-row barns, Menzi and Chase (21) showed that periods when the feed-bunk was occupied to capacity were few and of short duration, suggesting that there was much alternative time available when other cows could gain access to the feed. However, recent work has demonstrated changes in feeding behavior following fresh feed delivery in overstocked conditions (22, 23). Reducing feed-bunk space per cow from 3 feet to 1.5 feet resulted in decreased spacing between cows, increased aggressive interactions, and (most importantly) reduced feeding activity in subordinate cows within the 90-minute period after fresh feed delivery. In contrast, dominant cows showed no change in feeding activity with either spacing regimen (23).

Although dry cows generally have a low DMI compared to lactating cows, they may reduce intake when allelomimetic behavior is frustrated. Field data collected by Kenn Buelow (24) from two herds with dry cows maintained in dry-lots being fed a blended ration from a common source demonstrated a significant reduction in group DMI when cow numbers exceeded 92% of headlocks. Pregnant dry cows are wider than the typical two-foot spacing of headlocks and the maximal filling rate of the feed bunk is likely achieved when these pens are stocked at about 80% of the number of headlocks. Data from a field trial demonstrates an effect of overstocking on mixed primiparous and multiparous groups during the pre-fresh period. Stocking densities greater than 80% of stalls in the pre-fresh group in a 2-row pen adversely affected milk production of the primiparous cows through the first 83 days of the subsequent lactation. Modeling of data demonstrated that for each 10% increase in pre-fresh stocking density above 80%, there was a 1.6 lb per day decrease in milk production. Limited access to feed pre-partum may also impact health. Cameron et al. (25) showed that dry cow feed bunk management had a negative impact on the incidence of displaced abomasum in a herd level model on 67 farms. Management was scored negatively if bunk space was less than 12 inches per cow, or if bunk space was 12 to 24 inches per cow and the ration was limit-fed.

Interactions of rank and overstocking also influence stall access. Wierenga and Hopster (26) showed no significant effect of stocking densities of between 125 and 133% on stall access and resting time, but

mean resting time for the group was adversely affected at 155%. However, when rank was evaluated, there were changes in behavior of low rank cows even at 125% stocking rates. As stall access was reduced, low rank cows shifted lying behavior from night time into early evening hours when competition for stalls was less. At 155% stocking rates, this compensatory mechanism was overwhelmed as stall access in the evening also became reduced and total daily lying time could not be maintained.

Management of Transition Cow Pen Moves and Stocking Density

Very few behavior studies have been conducted using cows in the transition period. However, extrapolation of the findings suggests that effects on low rank individuals, and in particular, primiparous cows in mixed age groups, could be of great significance. A pen move introduces a period of social disruption lasting 2 to 3 days. Residency within a pen confers some elevation in rank of animals already in place. Small heifers will usually be subordinate to larger mature cows, however, cows losing weight; a common occurrence around calving time, may change rank. In any of the several pens that a cow visits during the transition process, agonistic interactions within a group will be amplified wherever overstocking occurs. Grummer et al. (27) point out that the most important nutritional factor in determining metabolic disease in transition cows may not be the absolute level of DMI, but rather the change in DMI at the point of calving. Therefore, the risk of reduced intake following pen moves, and competition in overstocked pens, may well be key determinants of transition cow success. Two critical control points for transition management are therefore to control stocking density changes in the pre-fresh, maternity and post-fresh accommodation, and to limit the number of pen moves around calving time.

Control of Stocking Density

The size of the pens in a transition cow facility are usually based on some estimate of the proportion of the lactating herd that will be in a certain stage of the lactation cycle, depending on the target duration of stay in each group. Table 1 gives estimates for a 1000 cow lactating herd, but assumes a constant number of calvings per month. As the close-up dry pen consists of a small number of cows grouped together for a short period of time, it is continually in a state of flux. Control of stocking density in this group is difficult despite adequate planning, and may relate to occurrences during a few months in the summer in warm climates. It is common for fertility to be very depressed through July and August in many parts of North America. Following return to cooler conditions, the cows recover body condition and reproductive performance rebounds. This has a major impact on throughput through the transition cow facility which may be under-stocked during April and May and extremely overstocked during July and August, right at the time when these cows will face the next round of heat stress. Adequate heat abatement measures for both lactating cows during the breeding period and transition cows are therefore vital for the control of throughput through the transition period.

Table 1. Pen size depends on the size of the herd and the duration of stay in each pen. The table below calculates pen size for a 1000 cow dairy, assuming a constant rate of throughput.

Enter No. of Cows in Herd	1000		
Area	Number of days spent in pen	% of Herd	Pen Size (No. Cows)
Non-Lactating Group			
Far-Dry	40	11.0	110
Close-Up Mature Cows	21	5.8	58
Close-Up Heifers	30	3.3	33
Maternity Area (Cows)	1	0.3	3
Maternity Area (Heifers)	1	0.3	3
Post-Fresh Group			
Non-Saleable Milk Group	2	0.5	5
Fresh Cows	21	5.8	58
Fresh Heifers	14	1.5	15
Work Group (vaccinations, hooftrimming etc)	1	1.1	11
Treatment Cows	10	1.4	14
Lame Cows	21	1.9	19

Sizing of pens for the transition period is therefore helped by reviewing documentation of the historical calving pattern of the herd. It is helpful for expanding herds if dual purpose pens are constructed which may be used for a variety of purposes, one of which would be carry over space for pre-fresh cows, should the need arise. We recommend the allocation of at least one stall per cow and, because of the increased girth of the pregnant cow, a minimum of 30 inches of linear bunk space per cow.

Limiting Pen Moves for Transition Cows

Moving cattle between groups is inevitable on modern dairy farms. However, we suggest that the number of moves be limited as much as possible. Currently, most dairy advisors recommend a two-group dry period where cows are exposed to a close-up ration for the last 14 to 21 days before calving. However, Varga (28) argues that a minimum of 5 weeks of feeding a given ration may be required to establish a new metabolic plateau for liver and intestinal tissues. Shortened dry periods that use a single ration for the entire time are growing in popularity among progressive farmers (29, 30) and benefits from this strategy may also accrue from a reduction in the number of group changes.

As calving becomes imminent, Mee (31) suggests that the ideal time to move the cow is 24 h prior to calving. Unfortunately, a growing amount of field data and experience suggests that this timing is difficult to manage. Predicting calving time is unreliable, and cows may remain in the maternity pen for a week or more rather than 1-2 days as expected. Although the cows in a spacious maternity pen, lying down on a deep bed of clean dry straw may appear to be in an ideal environment for freshening, this may not be the case. Our field investigation experiences, based upon data from farms that maintained excellent records of pen move dates, suggest that non-esterified fatty acid (NEFA) concentration is elevated in a greater proportion of cows that have spent 3 or more days in the maternity pen than in cows that stay in the pen fewer than 3 days. The same farm records show that there is more than a two-fold

greater risk for ketosis and DA for cows that stay on the maternity pack for 3 or more days, compared to cows that calve within 2 days on the pack.

A calving management strategy which is finding favor in a growing number of medium to large size dairies involves moving the cow to a calving pen when the calf's feet begin to show. The practice presents some disadvantages; it requires around the clock monitoring of the close-up dry cow group with approximately hourly checks, and moving at this time may interrupt the calving process, particularly in heifers (31). Once the calf is delivered and the cow has returned to her feet and is able to walk without ataxia, she is transferred to the post-fresh pen and the calf moved to the neonatal housing area. The duration of maternity pen stay is measured in hours rather than days.

Another possible strategy is to maintain several large bedded packs shown diagrammatically in Figure 2, and practice an all-in, all-out policy for the close-up cows. A group of cows expected to calve within a two to three week period would be moved into the pre-fresh pen, where they would remain until they calved. Subsequently, another group, representing the following two to three weeks of calving cows, would be moved to another similar pen, from which they too would calve and move into the post-fresh accommodation. This strategy, which maintains small stable groups throughout the dry period has been made more feasible by the advent of shortened dry periods of 40-50 days. The approach does not obviate the need for regular checking of the pen so that the calf can be removed promptly without sucking (32). Cows could freshen in the pen, or be moved to a calving pen as previously described. No new cows would be added until the pen is emptied, cleaned and re-bedded, completing the cycle. This strategy would almost completely remove the stresses of continually mixing cows.

In traditional grouping systems, the cow may be transferred from the calving pen to a non-saleable milk pen for 2 to 4 days, or moved straight to a post-fresh monitoring pen for 10 to 21 days. We prefer the latter strategy as it removes a pen move, but it does mean that the milk must be diverted from the bulk tank when cows that are still under milk withdrawal are milked through the main parlor. Some individuals that have suffered milk fever or calving difficulties may benefit from a short period of time in a smaller group away from more aggressive cows however. Primiparous cows are uncommonly split from multiparous cows during the immediate post-fresh period, primarily due to the convenience of health monitoring in a single group. However, there are undoubted benefits to grouping primiparous cows separately from multiparous cows after calving. Frequent milking of multiparous cows for 21 days or more after calving is facilitated by separating them from the primiparous cows, but in some herds, both are milked frequently in the same group for ease of management.

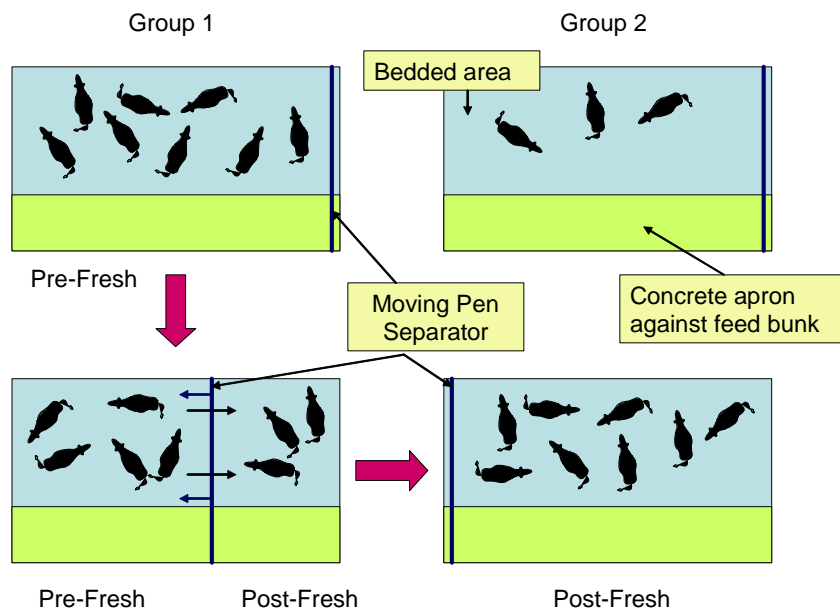


Figure 2. A diagram showing the use of an all in-all out dry cow management policy – moving pre-fresh cows from one side of a pen divider to the other on a bedded pack once they calve. Eventually the same group of animals all transition from the pre-fresh group to the post-fresh group, without changing herd-mates. Group 2 operates in a similar manner for another group of cows.

With these alternative strategies, the cow can proceed through the transition period with fewer pen moves and rank changes. However, for the strategies to work, the facility must be well designed, and the management excellent. We recognize five critical control points for these strategies to succeed:

1. Bedded pack management and hygiene must be excellent, necessitating the need for a plentiful supply of clean dry fresh bedding material on a well designed, comfortable lying surface with excellent drainage.
2. The close-up pen must be checked frequently by a well trained person hourly, 24 hours per day
3. The close-up pen must be located immediately adjacent to the individual cow calving pens, so that the move at the time of delivery, if used, is easy and stress free.
4. The calving pens must also be located in an area away from cow traffic
5. Cows, and in particular heifers, must be allowed to progress through the stages of labor, without repeated disturbance following the guidelines for intervention described by Mee (31)

Problems will occur if a poorly trained individual is responsible for monitoring the close-up pen or if it is done infrequently. Calves sucking the wrong dam may lead to failure of passive transfer problems and breakdowns of disease control programs. If animals must be moved the length of the barn to the calving pen and not given time to deliver undisturbed – especially in the case of heifers, increased rates of dystocia and fetal death may occur (31, 33). Controlled data have yet to be collected to support the

changes suggested, and this is an area in much need of research. However, several large farms are experimenting with these strategies with apparent success in many cases.

Specific Design Considerations for a Special Needs Facility

Pen layout, design and flooring. Most new special needs facilities in large dairy herds in excess of 600 cows will usually add a treatment parlor in addition to the main parlor. For ease of machine maintenance and handling of waste milk for pasteurization, we recommend that they be located adjacent to each other in one area of the farm.

Cows flow towards the milking centers, so those cows that may struggle to get to the parlor – such as lame cows, and those that must be milked more frequently, such as the post-fresh multiparous cow group up to 21 days in milk, should be located nearest the parlor. A straw bedded pack on a separate limb of the barn provides an excellent place for lame cows to recover, and an additional pen adjacent may be used for treatment cows or new arrivals, so that they are isolated away from the main herd.

Pre-calving heifers and dry cows are most easily managed in small groups of approximately 30 cows on either bedded packs or in free stalls, with an area for individual calving pens immediately adjacent, should they be required depending on the grouping strategy being used. Located near these pens should be a storage area for pharmaceuticals and computer record access. The barn design should have the flexibility to achieve the following after the cows calve:

1. Pen multiparous cows under milk withdrawal separately for milking through the treatment parlor.
2. Pen multiparous fresh cows separate from primiparous cows. This allows the option of milking the multiparous cows more frequently (e.g., 4X daily). Fresh cows with antibiotic residue could be milked in the main parlor, but the milk would be diverted into a dump bucket. This group is deliberately located adjacent to the main parlor to reduce turn-around time through the milking facility.
3. Pen primiparous cows separately for a monitoring period after calving, before they are moved to a separate pen elsewhere on the unit.

An automated sort gate can be located in the return lane to the main barn, so that cattle can be diverted into a work area for vaccination, hoof trimming, or other management tasks. The area should house a handling chute and hoof-trimming chute, along with another work station for storage of materials and computer access.

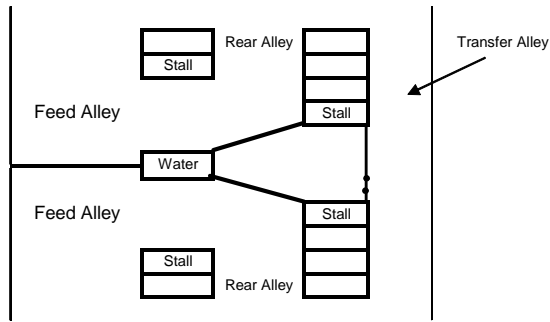
In order for a single person to move a cow from one area to another in the barn, an access lane, usually 8 feet wide, is essential (Figure 3). This lane encircles the barn, and in each pen there is a set of sort gates in the corner. The gate arrangement has been described by Godden et al. (34) and a modification is shown in Figure 4. The gates allow for transfer of the cow, or examination in a simple head lock located adjacent to a stall.



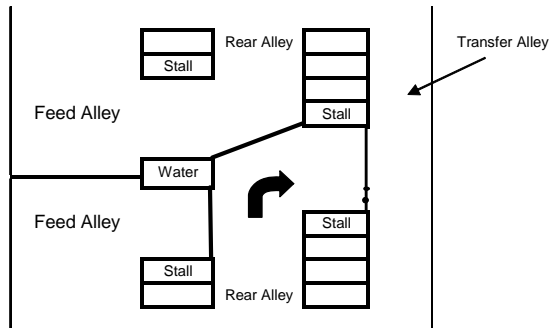
Figure 3. A transfer alley used to move cows between pens in a well managed transition cow facility. Although the front of the stalls are open, note the deterrent bar which is located too low to allow cows freedom to lunge forwards in the stall.

There are three main options for stall layout within a pen, namely; three-rows of stalls, or two-rows of stalls head-to-head, or two-rows of stalls tail-to-tail. We have already argued the case for access to feed earlier in the chapter, hence we do not recommend three-row pens for transition cows. The decision between which two-row layout to use is not clear. With head-to-head stalls, there will be a row of stalls with easy access from the feed-bunk alley for timid cows, which may be bullied and inhibited from accessing a stall in a tail-to-tail design, where all cows must pass through a narrow access area to find a stall. However, the tail-to-tail design may be preferred where handling within the pen is important, as cows can be moved between the feed-bunk alley and the rear alley more conveniently. This may also facilitate manure removal with tractors in non-lactating groups that do not leave the pen for milking. We therefore suggest using the tail-to-tail layout for the special needs

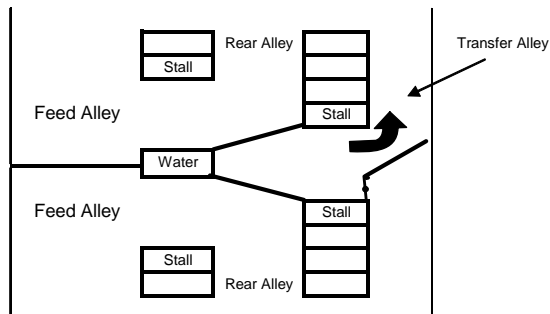
A. Normal position of gates



B. Cow is moved into the triangle



C. Cow may be transferred from the pen



D. Cow may be examined in a headlock

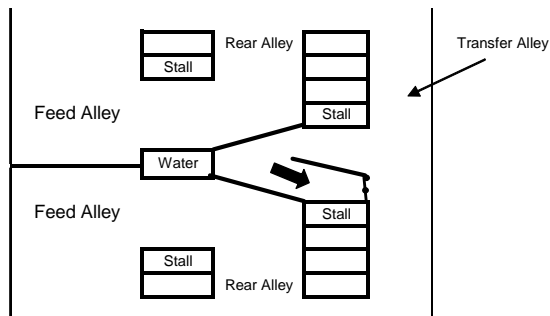


Figure 4. Gate triangle design used for transferring cows from pens to a transfer alley, or to a lock-up for examination or treatment.

barn, but recommend providing a cross-over every 60 feet. This may be easily achieved if we build pens for approximately 30 cows. For cows beyond the transition period, a head-to-head design can be tolerated and probably carries some behavioral advantages with regard to stall access and lying times.

The rear alley in each pen should be at least 10 feet wide. The feed alley width should be at least 13 feet wide in head-to-head pens, with stall access off the feed alley, and 12 feet wide in tail-to-tail pens. Alleys should slope 1.5% to allow drainage along their length and also slope away from the rear of the stall into the center of the alley, to avoid puddles of urine collecting beneath the rear curb. New designs in Europe provide slope to the center where urine and liquid feces pass below to a tunnel where a scraper moves the material to outdoor storage.

Flooring type is important to prevent slippage and injury in animals that may be ataxic. Concrete and rubber are the commonest flooring materials used at present. If concrete is used, it must be 3,500 psi air entrained concrete, at least 4 inches thick and grooved to reduce slipping. Grooving methods and patterns have been reviewed in depth by Gooch (35). Many barns have pen alleys with grooves running parallel to the long axis of the pen, often located 4 to 6 inches apart. This does not appear to offer maximum slip resistance. Parallel grooves 3/8 to 1/2 inch wide and deep, spaced 3 inches on center, as suggested by Graves et al (36) appear to offer a reasonable compromise between a pattern that has optimal non-slip characteristics and one which is too difficult to cut into the concrete. This pattern increases the likelihood that the cow's hoof will land on at least one groove as she walks, allowing manure trapped below the claw to be pushed along the grooves, facilitating contact between the concrete and the sole. This pattern may however not be sufficient for crossovers and high traffic areas where cows must make sharp turns. Here a diamond pattern is preferred, created with an additional set of oblique channels also located 3 inches apart to add additional grip. It is generally easier to cut grooves into dry concrete rather than float grooves into wet concrete. However, whatever technique is used, the final product must result in: 1) a flat concrete surface between the grooves, rather than convex, and 2) smooth edges to the grooves, with little or no aggregate exposure. Once the floor has been grooved, it should be finished with a floor grinder to smooth the surface and remove sharp or broken edges that may damage the cow's feet if left untended.

In large facilities with long travel routes where hoof wear may be an issue, rubber flooring material is a logical choice over concrete. Various types of material exist, but the final product must provide cushion, while being resilient and non-slip. At the moment, however, the value of rubber surfaces in pen alleys is not clear. If stalls are poorly designed, the fitting of rubber may increase standing times in the alley and may even lead to some cows lying in the alley. Two studies have documented a negative behavioral influence of rubber alleys (37, 38) and one study found only a small benefit to claw health, and only in a pen with sand stalls rather than mattress stalls (39). In order of importance, rubber flooring is most valuable in the sloped return alleys from the parlor, in the holding area for the parlor, along return alleys between the pens and the milking center, and finally along the feed alley in the pen, only if the free stalls are comfortable and well designed.

Current recommendations are for at least two water troughs for each group of cows and enough linear space for 15-20% of the group to drink at the same time (40). This would equate to 3.5 to 5 inches of trough perimeter per cow. An ideal location for the trough is on the outside of each end of each pen as it allows one trough to be shared by the cows from two adjacent pens.

Self-locking stanchions or “head-locks” at the feeding fence are a useful way to manage and handle groups that require intensive monitoring. They are probably essential for the post-fresh group. This is obviously not the most appropriate time for a first lactation heifer to be introduced to head-locks, and a period of training is beneficial (41). Therefore, even the far-dry pens may need to have some head-locks. It is wise to provide an additional area in each pen where the feed-bunk has only a post and rail, so that wary heifers can maintain DMI in a new situation.

Each pen should have a pass through 12 to 16 inches wide at each end of the feeding fence to allow for the easy movement of herdsmen in and out of pens.

Heat Abatement

Cooling of transition cows in hot climates is essential to maintain cow health, calf birth weights and milk production in early lactation. By maintaining reproductive performance, it will also ensure even throughput through the facility. Smith et al. (1) recommend two rows of fans, one over the feed bunk and another over head-to-head stalls. To obtain the desired airflow of 800 – 1000 cfm per cow, they suggest that 36 inch diameter fans be spaced every 30 inches, angled down 15 to 25 degrees and hung 8 feet above the stall surface. If 48 inch fans are used, they should be spaced every 40 inches and mounted higher (9 to 10 feet) above the stall. The fans should be activated above 65°F.

For additional cooling, low-pressure sprinklers (10 – 25 psi) may be used along the feed bunk set to provide 0.03 gallons of water per square foot of wetted area per sprinkler per cycle above temperatures of 70 to 75°F. The wetted area should be set to cover the area 6 to 8 inches behind the feed line and the water supply sized to supply the necessary flow rate of water. A standard cycle would be to have sprinklers on for 1 minutes and off for 10 minutes. However, soaking frequency may need to be increased to every 5 minutes during periods of severe heat stress. The nozzles on the water line are typically suspended at least 7 feet above the alley and 12 to 18 inches behind the feed line. The nozzles used in the barn should spray water in a 180° arc and they should be spaced according to their spray diameter – usually 6 to 8 inches (42).

Stall Design and Bedding Management

Stall design has been the subject of considerable interest and revision over the last two years (43, 44). An improved awareness of the needs of the cow in terms of surface cushion and traction, a defined surface area to lie upon, freedom from lunge and ‘bob zone’ (the area between the stall surface and a height of 1.22m (40”) at the most forward point of the lunge) obstructions, and room below and behind the neck rail to rise without hindrance, has led to a dramatic change in stall design recommendations (43). Stall dimensions given in detail in Table 2 and in Figure 5 will be based on a 1400 lb first lactation

(primiparous) heifer a 1600 lb mature (multiparous) cow and an 1800 lb mature (multiparous) pre-fresh cow within three weeks of calving. Dimensions should be adjusted for smaller animals.

Table 2. Recommended stall dimensions for first lactation (primiparous) heifers, mature (multiparous) cows and multiparous pre-fresh cows.

Stall Dimension meters (inches)	Recommendations		
	First Lactation (1400 lb)	Mature Cow (1600 lb)	Pre-Fresh (1800 lb)
Total stall length for stalls facing a wall, inches	108	120	120
Total platform length for head to head stalls, inches	204	216	216
Stall length from rear curb to brisket board, inches	68-70	70-72	72
Stall divider placement on center (width), inches	48	50	54
Height of brisket locator, inches	4	4	4
Height of lower divider rail (maximum), inches	12	12	12
Height below neck rail, inches	48	50	50
Horizontal distance between rear curb and neck rail, inches	68-70 (minus width of rear curb in sand stalls)	70-72 (minus width of rear curb in sand stalls)	72 (minus width of rear curb in sand stalls)
Rear curb height, inches	8	8	8

Maternity Pens and Calving Pens

Cows may calve in individual calving pens or on a bedded pack maternity pen with the group. We have argued against the use of a short-stay maternity pen earlier in the chapter. However, up to 30 cows may be kept on a bedded pack for the duration of the dry period and calve there. Such areas are difficult to manage, but designs should be based on the following management principles:

1. The surface below the bedded pack area should drain well. Sand at least 12 to 18 inches deep is one possibility, with deep clean dry straw maintained above this.
2. The area should provide calving cows 125 square feet lying area per cow, with a 12 feet wide feed alley against the bunk.
3. The short side of the bed should be no more than 30 feet. Long narrow beds should be avoided as cows will tend to walk to the back of the bed and lie down close to a wall as they leave the feed area. A short bed reduces the damage caused by this movement on and off the bedded area.

4. The bed should be demarcated from the concrete feed alley using a raised retainer made of concrete or wood.
5. Water access should never be from the bedded area. Water troughs maybe cut into the bedded area, enclosed with a three sided wall, with access only from the feed alley side.
6. Clean dry fresh bedding, such as straw, must be added daily at a rate of approximately 25 lbs per cow per day, and the whole bed removed every 3 to 4 weeks.

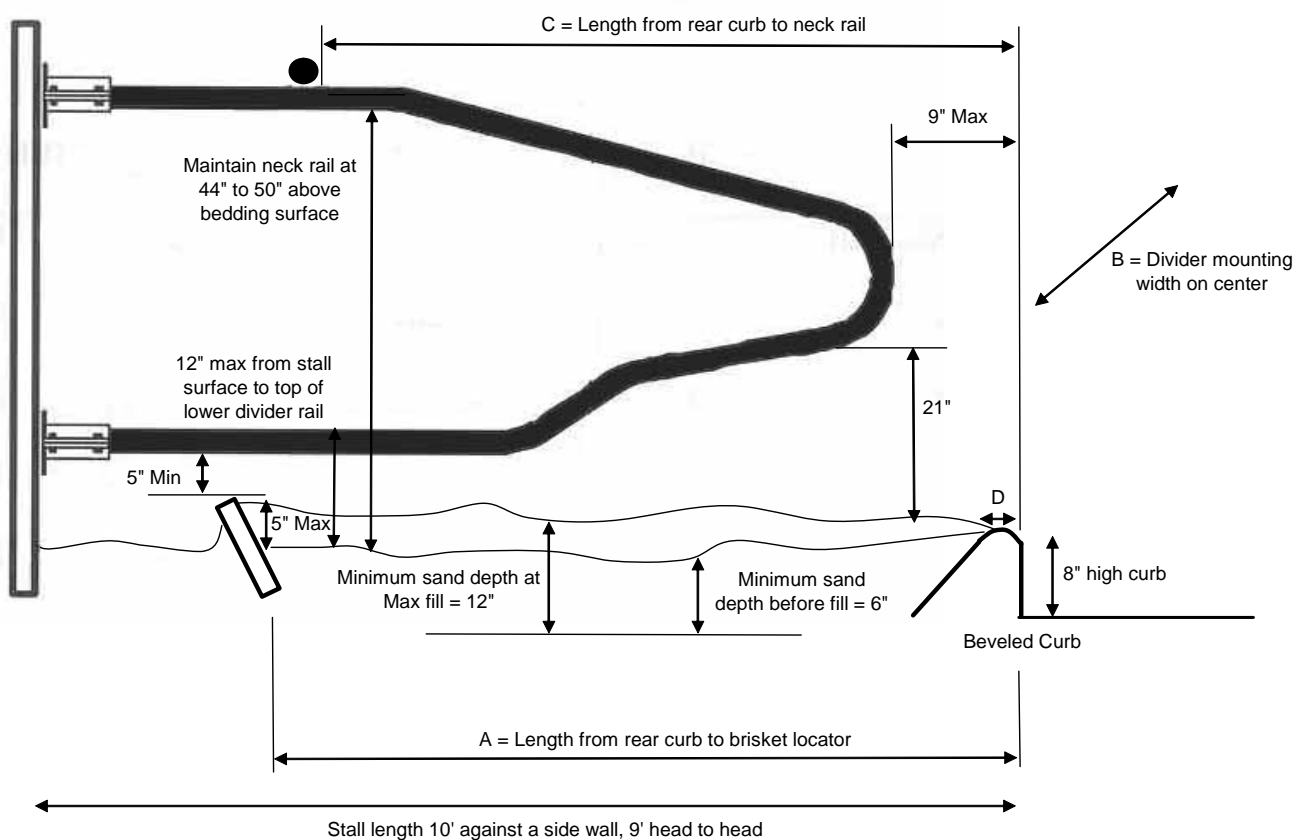


Figure 5. Sand bedded freestall design using a wide-loop divider, with suggested dimensions for first lactation (primiparous) cows, mature (multiparous) cows and multiparous pre-fresh cows.

Calving pens, typically 12 feet x 12 feet, should provide ample room for the animal to lie down in lateral recumbency and allow room for the use of a calving aid if assisted delivery is required. It is useful to have a quick release headlock in one corner and a wrap-around gate to help direct the cow into it. Gates should be mobile, so that they can be lifted out of the floor when the pen is cleaned. If organic bedding is to be used, the cow and calf must only come into contact with clean dry bedding. A concrete floor is a poor option, especially for compromised individuals weakened from a prolonged calving or hypocalcemia. A surface that provides good traction is therefore preferred – such as deep sand with clean

dry fresh straw on top. Some newer facilities have mattress surfaces with organic bedding material on top, which provides cushion, traction and is easily cleaned between cows.

Building Costs

The building of a special needs facility which provides for housing, milking, diagnosis and treatment is costly, and must be supported by improvements in health, milk yield and reduced herd turnover rate. Smith et al., (1) assembled costs for such a facility for cows from the close-up period through 14 days in milk, for a 2,400 lactating cow dairy herd. Total annual expense per cow, including bedding costs, interest on the loan, and a depreciation period of 10 years, ranged from \$23 to \$83.25, depending on the number of groups and whether a treatment parlor was included. Such an investment would require an extra 1 to 8 lbs of milk per cow per day for break-even at typical milk prices. Improvements in health would also be expected, but cost savings are difficult to quantify. However, for the high end facility, with the average cost of a fresh cow health event (including milk fever, ketosis, retained placenta and metritis) of \$320, a 2,400 cow dairy herd would have to reduce the number of events by 625, or 26 per 100 cows. Such reductions are very achievable, if the facility contributes to their epidemiology.

Conclusions

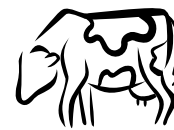
Improved building designs come from a better understanding of the behavioral needs of the dairy cow. The costs to provide for these needs in the facility must be offset by improved milk production, health and longevity. Research is still required to more fully understand the health implications of many building design considerations and their impact on disease. Perhaps the most important end result of an improved environment for the transition cow, however, is an improvement in animal well-being. Better buildings that accommodate the behavioral needs of cows present “win-win” situations where dairy cattle thrive and work is more enjoyable. This results in an improved image for the industry, greater consumer confidence in the quality and safety of the final food product, and a prosperous dairy industry.

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Transition Cow Nutritional Management

Garrett R. Oetzel, DVM, MS
Food Animal Production Medicine Section
School of Veterinary Medicine
University of Wisconsin-Madison

Introduction

The immediate prepartum and postpartum periods are the time in which mature dairy cattle are at highest risk for disease, whether it be of infectious or metabolic origin. These peripartum diseases, especially the metabolic ones, are strongly related to nutritional management during the dry period and the early postpartum period. And even in the absence of clinical or subclinical metabolic disease, nutrition and dry matter intake in this critical period sets the milk production curve for the subsequent lactation.

Nutritional consultants and veterinarians find it particularly difficult to persuade dairy producers to intensively manage their dry period rations. Many producers have a mind-set of devoting minimal effort toward the nutritional management of their dry cows. Because these cows are not contributing to the milk check, nutritional inadequacies do not appear to have negative effects on the dairy's profitability. However, such an appearance is deceiving - a predictable and negative economic effect will occur in the next lactation if dry cow nutrition is suboptimal. Potentially negative effects go beyond increased risk of metabolic diseases and include poor dry matter intake during lactation, poor milk production, and poor reproductive performance in the subsequent lactation.

Overview of Dry Period and Early Lactation Nutrition

General Goals of the Dry Period. The dry period is not merely a time for a cow to rest, but rather is a time in which important changes are occurring that will profoundly influence her next lactation (Oetzel, 1998). Her mammary tissue must involute, regenerate, and then produce high-quality colostrum. The fetus inside her will complete almost two-thirds of its growth during the dry period, and this growth will take priority over maintenance of the cow's own body tissues. In the midst of these changes, the cow's body condition score should remain fairly constant. Modest gains in body condition (about one-fourth unit) may be beneficial in cows that dry off too thin. However, body condition loss in any cow, even a cow with excessive body condition at drying off, is not recommended and may lead to ketosis and/or fatty liver.

Physiological Goals of the Dry Period. Four critical physiological events (Goff and Horst, 1997) are influenced by the quality of the dry cow feeding program. These physiological events are summarized as follows:

1. Adaptation of the rumen to the higher energy diet that will be fed in early lactation. This involves adaptation of both rumen microorganisms and lengthening of rumen papillae for maximal volatile

fatty acid (VFA) absorption. While this adaptation is measurable in research settings and represents interesting science, it appears that the practical implications of ruminal adaptation are minor. This is particularly true for TMR-fed herds, because the forage:concentrate ratio in a TMR diet cannot be confounded by the cow.

2. Maintenance of normal blood calcium concentrations through the parturient period. Both clinical and subclinical hypocalcemia can adversely affect milk production for the duration of the subsequent lactation.
3. Maintenance of a strong immune system through the parturient period. Immune system function has direct effects on the cow's susceptibility to infectious disease and her risk for retained placenta.
4. Maintenance of positive energy balance throughout the dry period. Because dry matter intake may decline dramatically just prior to calving (Bertics and others, 1992), cows may go into negative energy balance before parturition. This greatly increases the risk of fatty infiltration of the liver and subsequent ketosis.

Effective transition feeding allows the cow to accomplish each of these four physiological goals. Good feeding practices often overlap in which of the four areas they aid, thus the remaining discussion in this paper will focus on feeding practices rather than the physiological goals per se.

Stages of Dry Period Feeding. For purposes of optimal nutritional management, the dry period is divided into two distinct categories - cows in the early and middle portion of the dry period ("far-off" or "regular" dry cow group) and cows in the final three weeks prior to their due date ("pre-fresh," "transition," "close-up," "near," "lead-feeding," or "steam-up" group). Group of dry cows is controversial in the industry. Some advocate a one-group strategy, with a lower energy density throughout the dry period. I have seen this strategy work well in some herds, but very poorly in others. The best herds I have observed all have separate pre-fresh and far-off dry cow groups. It is likely that overall herd management and feed ingredient quality is more important than dry cow grouping strategy alone.

One advantage of setting up a two-group dry cow feeding system is that the far-off group does not need to be as intensively managed as all of the dry cows would need to be if there was only one dry cow group. Pastures, round bales, poorer quality forages, and free choice minerals may be acceptable for cows in the far-off group. In contrast, intense management and careful control of feed intakes are essential during the pre-fresh period.

Length of Pre-Fresh Ration Feeding. Pre-fresh rations should be offered starting at least three weeks prior to each cow's due date. Some dairy producers start the pre-fresh diet too close to the cow's due date. This practice negates many of the positive effects of pre-fresh rations. Cows should consume the pre-fresh diet for a minimum of five days to realize its benefits, and ideally should not be moved to a new pen and diet less than 9 days before actual calving. Because cows do not all calve exactly on their due date, it is necessary to start the pre-fresh period feeding much earlier than only nine days prior to the due date. If the pre-fresh period feeding is started ten days prior to each cow's due date, approximately 4% of all cows

will entirely miss receiving the pre-fresh diet and another 18% of the cows will receive the pre-fresh diet for less than five days (Figure 1). By starting the pre-fresh period fully 21 days prior to expected calving, nearly all cows will receive the full benefits of the pre-fresh diet.

It is not sufficient to take the dairy producer's word that cows go onto the pre-fresh diet at the appropriate time. This is a difficult area to manage, even in apparently good herds with computerized record systems. Expanding herds are especially likely to shorten the pre-fresh period, because they are prone to expand their milking cow facilities but neglect to concurrently expand pre-fresh cow capacity. As a result, they either shorten the length of the pre-fresh period and/or over-crowd the pre-fresh pens. Either approach may drastically increase the incidence of peri-parturient diseases.

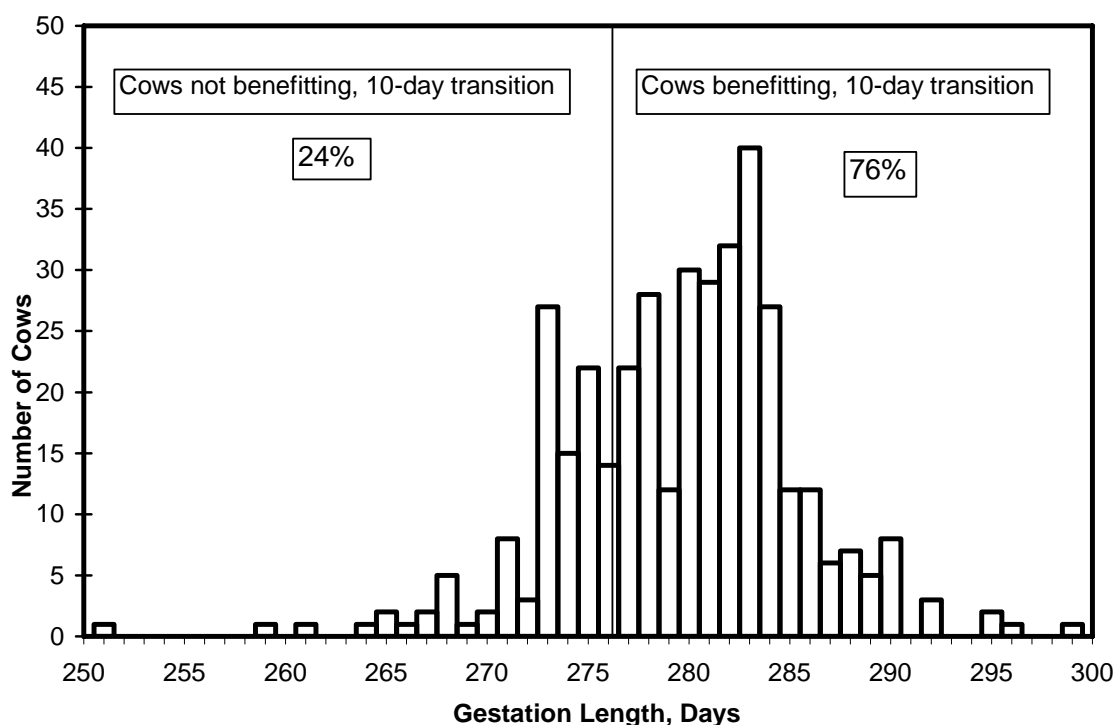


Figure 1. The relationship between gestation length and length of time spent receiving the pre-fresh diet if the pre-fresh diet is fed starting 10 days prior to expected calving date. Data are from 414 cows in four different Holstein herds.

Any herd investigation for peripartum disease problems should include (if the data are available) an analysis of the actual days that individual cows spend in the pre-fresh group. Comparing the average population of the pre-fresh group to the total herd size gives some estimate of the average days spent there. For example, a 500-cow herd with a 13-month (395 day) calving interval that allegedly moves cows into the pre-fresh group 21 days prior to due date should have an average pre-fresh period population of about 27 cows ($500 \times (21/395)$). If the average number of cows in the pre-fresh group is less than this, then the problem is obvious. However, even the proper average number of cows in the pre-fresh group does not assure that

individual cows are getting enough time on the pre-fresh diet. This is particularly important in bull-bred herds, where breeding dates are not precise. An example of a bull-bred herd with pre-fresh cow management problems is as follows: the expected number of cows in the pre-fresh group was 51 cows (1080 herd size, 14.5 month calving interval, and 21 days allegedly spent in the pre-fresh group). Actual average number of cows in the pre-fresh group was 60, which was slightly higher than the expected number and by itself suggested adequate time in the pre-fresh group. However, the actual distribution of time spent by individual cows in the pre-fresh group for the two months prior to our investigation was very erratic (Figure 2).

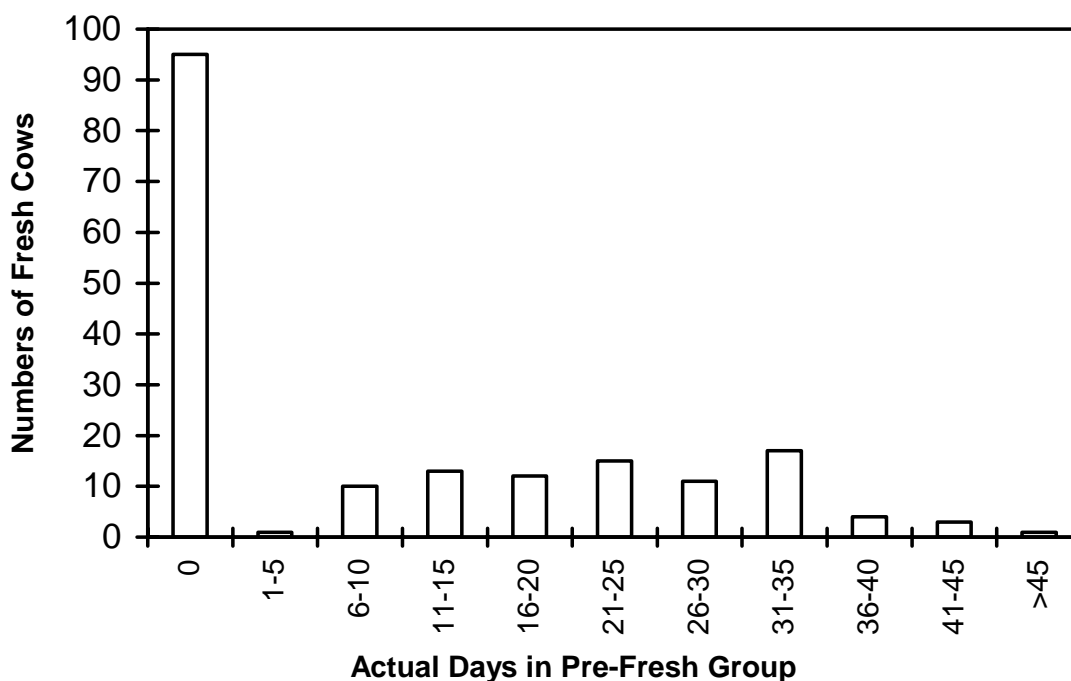


Figure 2. Distribution of days spent in the pre-fresh group for the last two months of calvings (183 calvings) in a dairy herd. 53% of these cows (96/182) spent less than 4 days in the pre-fresh group.

As a general goal, I expect 90% or more of the cows in a herd to actually spend between 5 and 35 days in the pre-fresh group. Longer or shorter days actually spent in the pre-fresh group are likely to increase the incidence of peripartum diseases. In this herd example, the incidence of displaced abomasum was 15%, and the risk for displacement was higher in cows spending <5 days in the pre-fresh group compared to those cows that spent >5 days in the group. The underlying problem in this herd was inaccurate breeding dates from the bull breedings because they were not regularly palpating the eligible cows for pregnancy diagnosis.

It is often very difficult to determine how many days cows actually spend on the pre-fresh diet, even in herds with computerized records. The dates of moves from pen to pen are not typically recorded, so this information is either completely unavailable or must be hand-calculated from daily log sheets on the dairy. It is possible to configure record-keeping systems to track the actual dates of pen moves.

Feeding Management of Dry Cow Rations

Suggested nutrient densities for far-off , pre-fresh, and post-fresh dairy cows are presented in Table 1. In my field experience, there is a considerable range of nutrient densities that can apparently ‘work’ for dry cows. This observation emphasizes that feeding management, stocking densities, and pen moves are also extremely important aspects of good transition cow management.

Formulating effective dry cow rations involves more than meeting nutrient requirements. Numerous other feeding management issues must also be taken into account. These issues are especially critical for pre-fresh rations. For example, a certain amount of subjective manipulation of feed ingredients usually goes into the formulation of an effective pre-fresh ration. Ingredients included in the concentrate portion of the pre-fresh ration should be as similar as possible to the ingredients included in the early lactation diet. This allows both the cow's taste and her ruminal microflora to become adapted to each feed ingredient. This is especially crucial for unpalatable feed ingredients such as animal by-products. As a general rule, about one-fifth of the amount of an ingredient present in the early lactation ration should be included in the pre-fresh ration.

Pre-fresh rations do more than acclimate the rumen to higher amounts of concentrates; they should also help the rumen adapt to the forages that will be fed during early lactation. Ideally, cows should not be forced to make major switches in forages around the time of calving. About one-fifth of the same forage the cow will receive after calving should be included in the pre-fresh ration. Part of the pre-fresh ration should also be coarse, bulky forages that promote fiber mat formation and maximum rumen distention. However, over-zealous feeding of coarse forages is undesirable and may result in energy deficiencies prior to calving. Conversely, feeding a very high energy pre-fresh ration, but in limited amounts without the addition of bulky forage, will impair normal rumen capacity after calving.

Straw is becoming a popular feed ingredient for pre-fresh diets. In my experience, it is very useful when forage quality is high in the herd (making it difficult to create a diet less than about 0.72 Mcal/lb NEL) and when dry matter intakes are already very good in the pre-fresh group (i.e., >28 lbs/cow/day for mixed parity groups or >30 lbs for multiparous pre-fresh cows). However, straw feeding is not a panacea. It is particularly important to avoid adding straw if the dry matter intake of the existing pre-fresh diet is already low. Whenever straw is used it should be of good quality (clean, no weeds) and finely ground (no particles >3/4 inch long). Wheat straw is usually cleaner and softer than oat straw, although I have seen many exceptions to this general rule.

TABLE 1. Recommended Nutrient Content of Diets for Dairy Cattle										
Cow Wt. (lb)	Fat (%)	Lactating Cow Diets					Early Lact 0-3 wks	Dry Cows		Max Tolerable Amount ^a
		Milk Yield (lb/d)						Far-Off	Pre-Fresh	
		40	60	80	100	120				
1400	3.5									
Composition of Diet Dry Matter										
Expected Intakes, Gains:							1550 lbs	1550 lbs		
DMI, lb/d		37.1	42.3	47.0	53.0	61.0	39.0	28.0	25.0	-
DMI, % body weight		2.7	3.0	3.4	3.8	4.4	2.8	1.8	1.6	-
Weight Gain, lb/d		1.0	0.5	0	0	0	0	0	0	-
Energy:										
NEL (min.), Mcal/lb		0.68	0.72	0.76	0.78	0.78	0.78	0.58	0.68-0.70	
Fat:										
Ether Extract (max.), %		4.0	4.0	4.5	4.5	5.0	4.0	3.5	4.0	8.5
Added fat ^b (max.), lb		0.5	1.0	1.5	1.8	2.0	0.5	0.25	0.25	2.5
Protein:										
Crude protein (min.), %		13	14.5	15.5	16.5	16.5	16.5	12	12-14.5	—
RUP (min.), % of CP		30	30	32	32	32	32	25	32-35	—
RUP (min.), %		3.9	4.3	5.0	5.3	5.3	5.3	3.0	3.8	—
SIP (max.), % of CP ^c		50	42	38	38	38	38	45	35	50
SIP (max.), %		6.5	6.1	5.9	6.3	6.3	6.3	5.4	5.1	10
NPN (max.), %		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0
Fiber:										
ADF (min.), %		21	21	21	19	19	21	26	21	—
NDF (min.), %		30	30	30	30	30	30	34	32	—
NDF (max.), % BW		.9	1.0	1.1	1.2	1.3	.9	.9	.9	—
Forage NDF ^d (min.), %		21	21	21	21	21	21	30	21	—
NFC ^e , %		36-40	36-40	36-40	36-40	36-40	36-40	25-30	36-40	44
Macrominerals:										
Calcium (min.), %		.60	.65	.70	.70	.70	.75	.50	.50	2.0
Chlorine (min.), %		.25	.25	.25	.25	.25	.25	.20	.20	2.0
Magnesium (min.), %		.25	.25	.30	.35	.35	.35	.20	.35	0.5
Phosphorus (min.), %		.35	.35	.35	.38	.38	.40	.25	.30	1.0
Potassium ^f (min.), %		.90	.90	.90	1.00	1.00	1.00	.65	.65	3.0
Salt (min.), %		.35	.35	.35	.35	.35	.35	.20	.20	5.0
Sodium (min.), %		.18	.18	.18	.18	.18	.18	.10	.10	1.0
Sulfur (min.), %		.20	.20	.20	.25	.25	.25	.16	.20	0.5
DCAD ^g , meq/kg		+250 to +350							-50 to -100	—
Microminerals:										
Cobalt (min.), ppm		.10	.10	.10	.10	.10	.10	.10	.10	10
Copper ^h (min.), ppm		10	10	10	10	10	10	12	15	100
Iodine ⁱ (min.), ppm		.60	.60	.60	.60	.60	.60	.60	.70	50 ^j
Iron (min), ppm		100	100	100	100	100	100	50	60	1000
Manganese (min.), ppm		40	40	40	40	40	40	40	50	1000
Selenium (min.), ppm		.30	.30	.30	.30	.30	.30	.30	.30	2.0
Zinc (min.), ppm		50	50	50	50	50	50	50	60	500
Vitamins:										
Vit. A (min.), KIU/lb		1.5	1.5	1.5	1.5	1.5	2.0	1.8	2.2	30
Vit. D (min.), KIU/lb		.75	.75	.75	.75	.75	1.0	.75	1.0	4.5
Vit. E (min.), IU/lb		7	7	7	7	7	10 - 25	12	15 - 40	900

Footnotes to the Nutrient Requirement Table:

- ^a Maximum safe levels for many minerals and vitamins are not well defined and may be substantially affected by specific feeding conditions.
- ^b Added fat equals the total dietary fat from feed ingredients containing greater than 5% fat. The maximum amount of added fat tolerable depends greatly on the physical form of the fat (rumen inertness, degree of saturation, etc.). Added fat beyond 1.0 lb/cow/day should be ruminally inert.
- ^c The minimum requirement for soluble intake protein (SIP) is approximately 25% of the CP as SIP.
- ^d Forage NDF equals all NDF from forages, plus NDF from whole cottonseeds and whole sunflower seeds (these concentrate feeds float in the mat layer of the rumen and contribute to rumination).
- ^e NFC (non-fiber carbohydrate) equals 100% minus the NDF, EE, CP, and ash. NFC represents pectin, starch, and sugar; these are the carbohydrates which are fermented rapidly in the rumen.
- ^f Potassium requirements should be increased to at least 1.2% under conditions of heat stress.
- ^g DCAD = (Na+K) – (Cl+S), meq/kg. Higher lactational DCAD indicates adequate ruminal buffering; lower pre-fresh DCAD reduces milk fever.
- ^h Copper requirements may need to be increased if dietary molybdenum and/or sulfur are present in large amounts in the diet.
- ⁱ Iodine requirements may need to be increased two-fold or more if the diet contains 25% or more strongly goitrogenic feed ingredients.
- ^j Although cattle can tolerate up to 50 ppm dietary iodine, lower dietary levels are desirable in order to reduce the iodine content of milk.

Component-fed herds. In herds where the forage and concentrate are offered as separate components of the diet, the pre-fresh ration should not be suddenly introduced starting 21 days prior to a cow's due date. Rather, the cow should be gradually introduced to the amount of concentrates in the pre-fresh ration over a three to five day period. Concentrate intakes in component-fed herds can be effectively controlled if the pre-fresh cows are brought into the barn prior to calving and are individually fed there. Forage intake may be difficult to manage in component-fed herds, especially if only poorly palatable forages are offered at feed bunks that are too small for the number of animals expected to eat from them. Pre-fresh period cows should ideally receive their forages individually so that forage intakes can be carefully monitored.

Some component-fed herds fill their stall barns with only milking cows and are unable to make space for pre-fresh cows in the barn. This policy makes proper management of the pre-fresh cows very difficult. On these farms, dry cows are usually kept in one large group in loose housing. Without the option of TMR feeding, any reasonable control over concentrate intakes becomes extremely difficult. While this may be acceptable for the far-off dry cows, it usually leads to severe problems with the pre-fresh cows. Additional investments in facilities or feeding equipment may be necessary in such herds.

Total mixed rations. Cows leaving the far-off dry cow group can be directly introduced to the pre-fresh ration, if the ration is delivered as a TMR. With TMR feeding, cows cannot overeat concentrate at the expense of forage and thus unbalance a ration as they can when forage and concentrate are fed separately. A cow that calves after receiving a well-formulated TMR during the pre-fresh period can go directly onto the high cow, lactating TMR without any further adaptation. Post-fresh groups can have advantages for grouping and monitoring of sick cows, but the nutrient requirements of these cows are not substantially different from the high cows.

Small dairy herds that make use of TMR may face special challenges in using their TMR mixer to deliver pre-fresh rations. The number of cows in the pre-fresh group of such herds may be very small (or zero) at any given time. Thus, it often seems impractical to mix a separate ration for such a small group of cows. Dairy producers often look for more practical means of delivering pre-fresh rations, such as diluting the TMR already mixed for the high cows with coarse forage, or simply feeding the low-producing cows' TMR to the pre-fresh cows. Either approach may be feasible, provided the nutrient requirements of the pre-fresh cows are properly met and intakes of the components of the pre-fresh ration can be carefully controlled.

Some dairy producers manage their pre-fresh cows by offering somewhat uncontrolled intake of high cow TMR and free choice access to poor-quality round bales. This is an obviously unacceptable feeding strategy. Cows will eat too much TMR whenever possible and will not consume enough of the round bale hay to meet their requirements. However, if the TMR intake could be carefully and individually limited, and if the round bale quality was good and its intake was carefully monitored, then a mixture of these two components might nicely meet the nutrient requirements. An even better approach would be to leave some of the high cow TMR in the mixer, add the appropriate amount of additional forage to it (shredded baled hay, grass haylage, ground corn stalks, etc.), and mix the components before feeding. Feed ingredients unique to the pre-fresh cows, such as dry cow premixes or anionic salts, could also be added to the pre-fresh ration during this second mixing period. The extra labor of creating a "hybrid" TMR can easily be justified.

Pre-fresh cows need to be fed only once daily, as long as there is adequate daily feed refusal and feed is not heating in the bunks during hot weather. If this feeding is done in the evening, most calvings will occur in daylight hours.

Both high cow TMR mixes and milking cow grain mixes may be effectively used as components of good pre-fresh rations. However, certain precautions are in order. These components of the lactating diet should not bring excessive amounts of sodium or potassium to the pre-fresh diet. If they do, the dry cows will be strongly predisposed to milk fever. For example, inclusion of buffers such as sodium bicarbonate in the high cow TMR or grain mix may result in excessively high sodium content in the pre-fresh ration. Use of lactating cow forages very high in potassium may result in excessively high potassium content for pre-fresh cows. However, high potassium content can be a problem for any forage. Dairy operators may need to designate certain fields for dry cow forage production, and then refrain from adding potassium-containing fertilizers or manure to these fields. Otherwise, there may be no source of low-potassium forages available for the pre-fresh cows.

A low group TMR can be formulated so that it can be used for both the late lactation and pre-fresh cows, but careful formulation and feeding management are required. Low group TMR rations may be too low in protein, too low in fiber, and/or too high in calcium to be suitable for pre-fresh cow rations. Also, low group rations may not contain the same array feed ingredients found in the early lactation ration. If the pre-fresh and low group cows are fed the same TMR, they should not be housed together. Late gestation

cows are relatively timid and poorly compete at the feed bunk with the much more aggressive late lactation cows.

Dry matter intake of pre-fresh cows may be dramatically reduced by over-crowding pre-fresh pens and/or by limiting bunk space (see Figure 3). Pre-fresh groups should never be crowded beyond 100% of the available stalls and headlocks. This can be especially difficult for herds with strong seasonal calving patterns or expanding herds; however, the difficulty of this recommendation does not diminish its importance. An ideal stocking rate for pre-fresh pens is about 80% of the available headlocks (assuming 24 inch wide headlocks). Adequate feeding space is more important than resting space, although both should be available.

Pre-fresh dry cows, because of their extra girth in late pregnancy, do not make good use headlocks that are set on 24-inch centers and will typically use no more than 2 out of every 3 headlocks available. Either 30-inch center headlocks (or better yet, no headlocks at all) should be used in pre-fresh pens. When headlocks are not used in pre-fresh pens, a minimum of 30 inches of bunk space per cow should be provided.

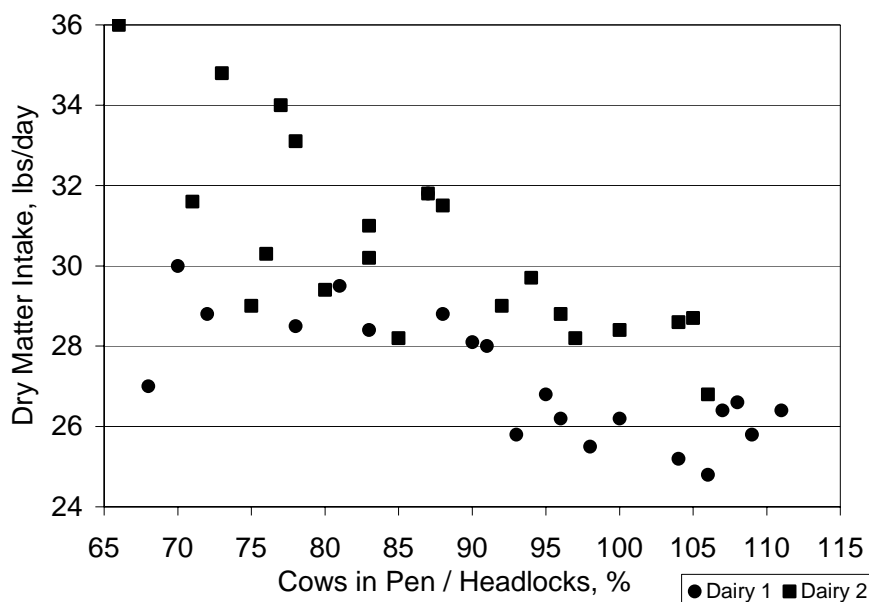


Figure 3. Effect of crowding on dry matter intake in two dairy herds in New Mexico (loose housing in drylots with headlocks provided). Unpublished data, courtesy of Dr. Kenn Buelow.

In pre-fresh pens with loose housing (manure packs, drylots, etc.), a minimum of 75 square feet per cow should be provided. This recommendation includes only the bedded resting area and excludes the feeding alley and feeding area. About 25 lbs of dry straw per cow per day is required to maintain good sanitation in a bedded pack. Straw can be added to packs about twice weekly (e.g., 75 lbs of straw per cow added once every 3 days).

Maternity areas separate from the pre-fresh group often become significant bottlenecks in dry cow management. I often find maternity areas to be over-crowded, dirty, and extremely short of bunk space. To make matters worse, maternity pens often have very poorly-designed feed bunks (often with a surface lower than the surface the cow stands on) that are out of feed for much of the day. Cows eat less feed if housed individually, so individual cow maternity pens are not optimal for encouraging dry matter intake at this critical time. If cows spend more than about 12 hours in a compromised maternity pen, all of the effort spent on dry cow management might be wasted (depending on the adequacy of the maternity area). Ideally, cows should calve in a clean birthing area that is a part of the pre-fresh pen, or be moved to a separate, well-managed maternity pen for only the last few hours prior to birth. Cows need at least 100 square feet per cow in a maternity pen.

Dairy producers are generally aware that cows should not spend excessive amounts of time in the maternity pens; therefore, they will almost always underestimate the amount of time their cows actually spend in those pens. Therefore, it is necessary to quantify this number rather than accepting the owners' opinion. The same quantitative principles can be used here as to evaluate time spent in the pre-fresh group. The average number of cows in the maternity pens gives a general idea of the amount of time a cow spends in them. For example, a 500-cow herd with a 13 month calving interval that allegedly keeps cows in the maternity pens for only 12 hours on average should have an average maternity pen population of less than one cow ($500 * (.5/395)$). If you consistently observe 2 or 3 cows in the maternity area, then you know the 12-hour number is bogus and you should begin evaluating the actual amount of time that cows spend in the maternity pens. As for days spent in the pre-fresh group, this number may be difficult or impossible to determine. Record systems may need to be modified to record this data.

Pen moves just before and just after calving can cause decreased dry matter intake and stress hormone responses. These responses are especially detrimental to cows around calving and lead to negative energy balance, increased blood non-esterified fatty acid (NEFA) concentrations, and fatty liver infiltration. These untoward metabolic events have been associated with increased risk for ketosis and displaced abomasum soon after calving.

Feeding Management in Early Lactation

Some dairy producers leave cows on the pre-fresh ration for a few days after calving; others move them immediately to the early lactation ration after calving. Either approach is acceptable, as long as cows are properly acclimated to the lactation diet and are not left on pre-fresh ration, which is too low in energy for lactating cows, for more than a few days after calving.

In component-fed herds, it is important not to introduce concentrates too rapidly following calving. Since forage intake is usually neither controlled nor known in these herds, it is difficult to assure that cows are receiving all the forage expected. Thus, concentrate intake must be increased slowly. The increase should ideally occur at the same rate as the expected increase in dry matter intake in early lactation. We have developed formulation strategies for feeding concentrates in the first six weeks of lactation without

compromising fiber nutrition. Weekly DMI predictions (Kertz, Reutzel, and Thomson, 1991) were used to accomplish this. Using several different formulation strategies, the proper increase in concentrate feeding was only 2 to 3.5 lbs/week (0.25-0.5 lbs/day). Examples of early lactation grain feeding are shown in Figures 4 and 5.

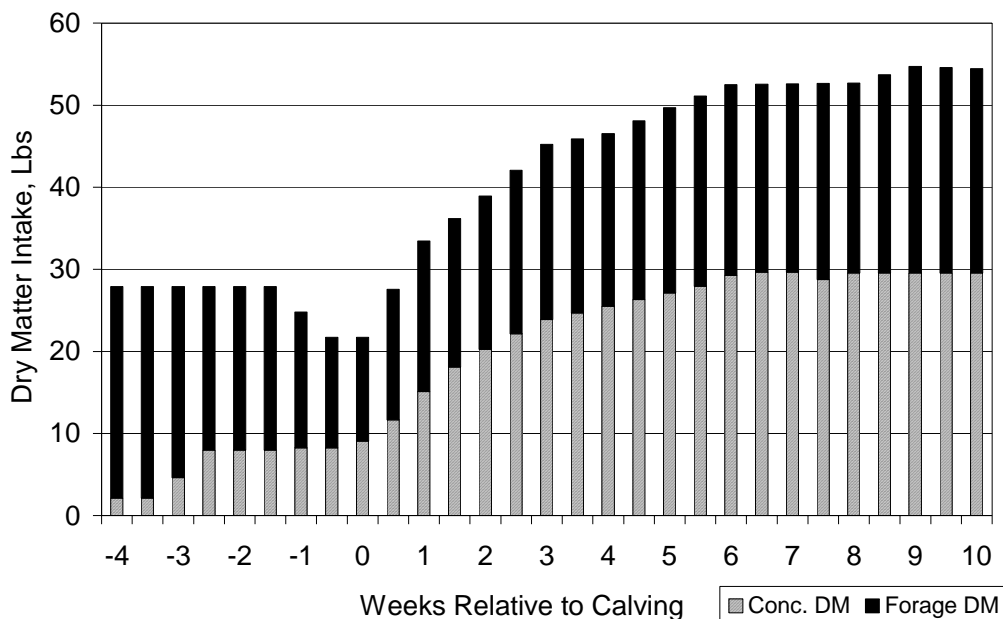


Figure 4. Concentrate, forage, and total dry matter intake through the parturient period with properly formulated rations.

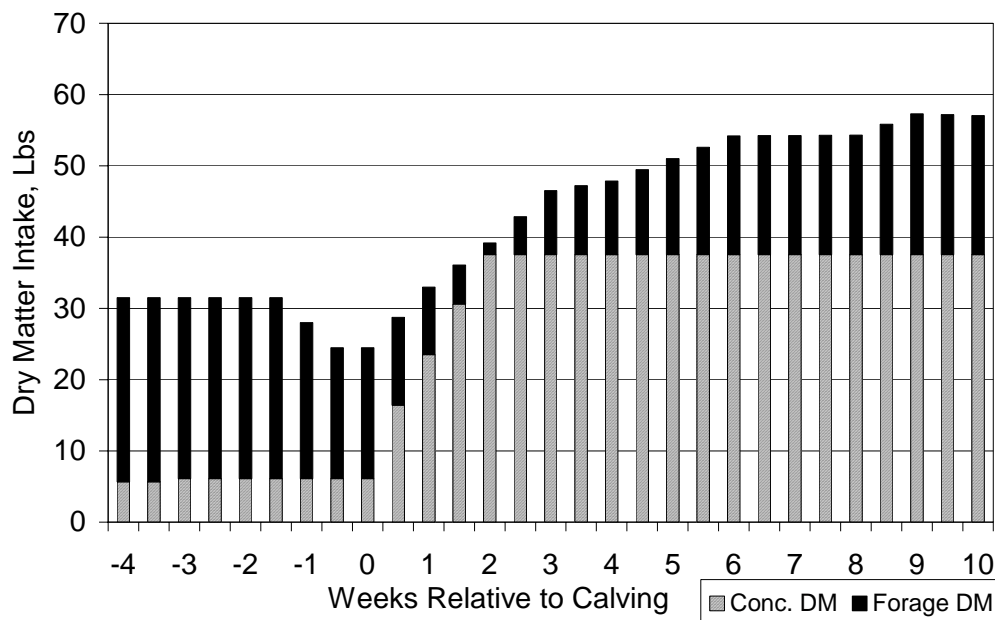


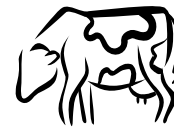
Figure 5. Rapid introduction of concentrates after feeding. Note the low forage intakes in early lactation.

Care must be taken to assure that early lactation cows receive enough dietary energy to prevent problems with primary (underfeeding) ketosis. While most producers tend to overfeed concentrates in early lactation and cause rumen acidosis, a few do restrict concentrate feeding so severely as to cause primary ketosis. Limited access to forages and/or poor quality forages in early lactation can also contribute to primary ketosis. Early lactation cows should be kept slightly hungry for concentrates but given full access to the highest-quality forages available on the farm.

Fresh cows in TMR-fed herds may be moved directly onto the high group TMR if they have been properly acclimated to this diet by using a good pre-fresh ration prior to calving. As mentioned before, the main value of post-fresh groups is for provision of extra feeding space and ease observation during very early lactation. Formulation and feeding management errors in post-fresh groups are common. Very high crude protein (>19%, dry matter basis), excessive fat supplementation (>5.0% total dietary fat), or inadequate energy (< .76 Mcal/lb NEL) may unnecessarily increase the risk for ketosis. The addition of excessive amounts of long hay to post-fresh diets (especially if the hay is coarse, not finely chopped, or sortable) may aggravate these problems. A small amount of baled hay may be top-dressed to the post-fresh TMR once daily without causing problems – this practice encourages the cows to lock up and makes observation and examination of cows easier. However, adding more than a few pounds of dry hay outside the TMR, or adding hay particles over 1.5 inches long to the TMR, usually leads to problems.

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Fresh Cow Treatment Programs – Wisconsin Experiences

Garrett R. Oetzel, DVM, MS
Food Animal Production Medicine Section
School of Veterinary Medicine
University of Wisconsin-Madison

Introduction

A growing portion of my clinical work in dairies in Wisconsin now includes an evaluation of the fresh cow diagnosis and treatment protocols. Most of this clinical work has been done with the assistance of Dr. Sheila McGuirk, a board-certified large animal internist. Her assistance has been invaluable as we have launched into routine evaluations of on-farm diagnostic and treatment protocols.

Listed below is my “Top 10” list of the deficiencies we most commonly find in fresh cow diagnosis and treatment protocols on dairies.

10. Inadequate Diagnosis of Ketosis

Ketosis is now the most important metabolic disease of fresh cows. However, a minority of dairy producers actually diagnose it correctly. It is not sufficient to diagnose a fresh cow who “doesn’t look right” with ketosis merely because no other cause can be readily found. It also is not sufficient to rely on the smell of ketones on the cow’s breath. This is only about 50% sensitive in detecting ketosis – even for individuals who claim they can always smell it.

We recommend that early lactation cows be screened for ketosis evaluation by decreased appetite (best observed by locking up the post-fresh group to new feed immediately after the first milking of the day), decreased milk yield (either daily parlor milk weights or by visual evidence of a “slack udder” before milking), or lack of rumen fill (determined visually and/or by palpation of the left paralumbar fossa). It may also be useful to automatically screen high risk cows after calving (i.e., cows with twins, dystocia, retained placenta, or body condition score >3.5). Whatever criteria are used, a certain subset of the fresh cows should be checked daily for ketosis using a cowside test.

Cowside Urine Tests for Ketosis. Urine can be evaluated for cowside ketosis testing; however it is much more difficult to collect a urine sample than a cowside milk sample. And even with considerable effort, some cows inevitably fail to urinate within a reasonable time period and cannot be tested at all. In research trials, urine samples are not usually collected from 100% of eligible cows. An example is a recent study in which urine samples were successfully collected from only 64% of eligible cows (Osborne et al., 2002). This is a substantial practical limitation on farms and greatly increases labor costs for testing.

Urine acetoacetate can be evaluated quantitatively by nitroprusside tablets (Acetest; Bayer Corp. Diagnostics Division, Elkhart, IN). This test has excellent sensitivity but poor specificity (Nielen et al., 1994) – see Table 1. This makes it a useful test for evaluating individual sick cows (for whom a false positive result is preferred to a false negative one), but not very useful for herd-based monitoring.

A dipstick designed for evaluating milk BHBA has been evaluated for use with urine (Osborne et al., 2002), despite lacking a label for use with urine. As for the urine tablets, this test has good sensitivity but poor specificity (Table 1). The higher cost of these strips compared to other urine ketone tests makes them impractical for use on urine, although they are an excellent cow-side test for milk BHBA, as described later.

Table 1. Sensitivity and specificity of urine cow-side tests compared to blood β -hydroxybutyric acid (cut-point of ≥ 14.4 mg/dL).

Test type / Study	Herds Tested	% Ketosis	Total Samples	TP	FN	FP	TN	Sensitivity	Specificity
<i>Acetest tablet:</i>									
(Nielen et al., 1994)94	18	11.3%	124	14	0	45	65	100%	59%
<i>KetoTest:</i>									
(Carrier et al., 2004)04	1	18.2%	159	28	1	52	78	97%	60%
<i>Ketostix, \geq trace (5 μmol/L):</i>									
(Carrier et al., 2004)04	1	7.0%	741	47	5	101	588	90%	85%
(Oetzel, 2004)04	6	12.0%	83	9	1	18	55	90%	75%
<i>Ketostix, \geq small (15 μmol/L):</i>									
(Carrier et al., 2004)04	1	7.0%	741	41	11	31	658	79%	96%
(Oetzel, 2004)04	6	12.0%	83	8	2	6	67	80%	92%
<i>Ketostix, \geq moderate (40 μmol/L):</i>									
(Carrier et al., 2004)04	1	7.0%	741	26	26	7	682	50%	99%
(Oetzel, 2004)04	6	12.0%	83	7	3	2	71	70%	97%

BHBA = β -hydroxybutyric acid, mg/dL; **Ketosis** = blood BHBA ≥ 14.4 mg/dL.

TP = true positives; **FN** = false negatives; **FP** = false positives; **TN** = true negatives.

The best test for cow-side urine ketone evaluation is a semi-quantitative dipstick (Ketostix; Bayer Corp. Diagnostics Division, Elkhart, IN) that measures acetoacetate. Urine ketone tests on the whole have a reputation for very poor specificity; however, recent data suggest that poor specificity may not be a problem with the Ketostix. The urine dipstick has very good specificity (and sensitivity) compared to the blood BHBA test (Table 1).

Prolonged contact of urine with the reagent may explain some of the false positive results obtained with the urine ketone tablet or the milk BHBA strip. The label for the urine dipsticks states that the test result should be interpreted exactly 15 seconds after contact with the urine sample. Results were read within

five seconds in one study (Carrier et al., 2003), and this study reported the highest specificity results for a urine test.

Interestingly, results for urine testing with the Ketostix suggest that lower concentrations (e.g., ‘small’) should not be ignored if the purpose of the test is to identify cows with ketosis that might benefit from treatment for ketosis. Since oral treatment with glucose precursors is generally inexpensive and safe, it is most appropriate to use a low cut-point for urine ketones in making individual cow treatment decisions. At a cut-point of ‘small’, only about 2% of urine test negative cows have ketosis, and about 43% of urine test positive cows do not have ketosis (calculated from pooled data presented in Table 1).

Cowside Milk Tests for Ketosis. Cowside milk tests have tremendous advantages over urine cowside tests for ease of collection and for assurance that all eligible cows can be tested. However, milk tests are generally not as sensitive as urine tests in detecting ketosis.

Nitroprusside powders (Utrecht powder, KetoCheck powder) can be used to qualitatively test milk acetoacetate. However, these tests generally have very poor sensitivity for ketosis compared to blood BHBA (see Table 2) and cannot be recommended as tests for herd-based monitoring. They have some, but very limited value as cowside tests for diagnostic decisions for individual cows.

Table 2. Sensitivity and specificity of cowside milk nitroprusside powders compared to blood β -hydroxybutyric acid (cut-point of ≥ 11.7 or 14.4 mg/dL).

Test type / Study	BHBA Cut-Point,	Herds Tested	% Ketosis	Total Samples	TP	FN	FP	TN	Sensitivity	Specificity
<i>Utrecht powder:</i>										
(Nielen et al., 1994)	≥ 14.4	18	10.3%	185	17	2	7	159	89%	96%
(Geishauser et al., 1998)	≥ 11.7	25	16.4%	529	37	50	0	442	43%	100%
<i>KetoCheck powder (\geq trace):</i>										
(Geishauser et al., 1998)	≥ 11.7	25	16.4%	529	24	63	0	442	28%	100%
(Carrier et al., 2003; Carrier et al., 2004)	≥ 14.4	1	7.5%	878	28	38	9	803	42%	99%
<i>Bioketone powder (\geq trace):</i>										
(Geishauser et al., 1998)	≥ 11.7	25	16.4%	529	24	63	0	442	28%	100%

BHBA = β -hydroxybutyric acid, mg/dL; **Ketosis** = blood BHBA ≥ 11.7 or 14.4 mg/dL.

TP = true positives; **FN** = false negatives; **FP** = false positives; **TN** = true negatives.

The most promising cowside milk ketone test is a semi-quantitative milk BHBA test strip manufactured by Sanwa Kagaku Kenkyusho Co., Ltd. (Nagoya, Japan). This test strip is marketed under various names (KetoTest, Ketolac BHBA, and Sanketopaper) in different parts of the world. It is not commercially marketed in the US, although it may be imported into the US from Canada (CDMV, St. Hyacinthe, Quebec) and costs about \$2.00 (USD) per strip.

Results of numerous studies evaluating the sensitivity and specificity of the milk BHBA test strip compared to blood BHBA results are presented in Table 3. My own clinical experience with this test (221 cows from 17 herds) corroborates previously published results.

Table 3. Sensitivity and specificity of a cowside milk β -hydroxybutyric acid strip compared to blood β -hydroxybutyric acid (cut-point of ≥ 14.4 mg/dL).

Test type / Study	Herds Tested	% Ketosis	Total Samples	TP	FN	FP	TN	Sensitivity	Specificity
<i>Milk BHBA strip (≥ 50 $\mu\text{mol/L}$):</i>									
(Geishauser et al., 2000)	21	11.9%	469	51	5	182	231	91%	56%
(Carrier et al., 2003; Carrier et al., 2004)	1	7.6%	883	59	8	100	716	88%	88%
(Oetzel, 2004)	17	17.2%	221	34	4	36	147	89%	80%
Pooled data (by cow)	39	10.2%	1573	144	17	318	1094	89%	77%
<i>Milk BHBA strip (≥ 100 $\mu\text{mol/L}$):</i>									
(Jorritsma et al., 1998)	8	8.4%	190	14	2	31	143	88%	82%
(Geishauser et al., 2000)	21	11.9%	469	45	11	99	314	80%	76%
(Carrier et al., 2004; Osborne et al., 2002)	1	16.5%	248	39	2	65	142	95%	69%
(Duffield et al., 2003)	5	27.2%	235	52	12	64	107	81%	63%
(Carrier et al., 2003; Carrier et al., 2004)	1	7.6%	883	50	17	54	762	75%	93%
(Oetzel, 2004)	17	17.2%	221	33	5	32	151	87%	83%
Pooled data (by cow)	53	12.6%	2246	233	49	345	1619	83%	82%
<i>Milk BHBA strip (≥ 200 $\mu\text{mol/L}$):</i>									
(Jorritsma et al., 1998)	8	8.4%	190	14	2	31	143	88%	82%
(Geishauser et al., 2000)	21	11.9%	469	45	11	99	314	80%	76%
(Duffield et al., 2003)	5	27.2%	235	52	12	64	107	81%	63%
(Carrier et al., 2003; Carrier et al., 2004)	1	7.6%	883	50	17	54	762	75%	93%
(Oetzel, 2004)	17	17.2%	221	17	21	5	178	45%	97%
Pooled data (by cow)	52	12.1%	1998	129	112	100	1657	54%	94%

BHBA = β -hydroxybutyric acid, mg/dL; **Ketosis** = blood BHBA ≥ 14.4 mg/dL.

TP = true positives; **FN** = false negatives; **FP** = false positives; **TN** = true negatives.

When used at the cut-point of ≥ 100 $\mu\text{mol/L}$, the milk BHBA test is about 83% sensitive and 82% specific. For individual cow testing, the ≥ 50 $\mu\text{mol/L}$ cut-point provides better sensitivity (89%) but has a false positive rate of 69% (calculated from pooled data presented in Table 4). Increasing the cut-point to ≥ 200 $\mu\text{mol/L}$ reduces test sensitivity to 54% (Table 4). At this higher cut-point the test is of little value for

diagnosing ketosis in individual sick cows but has potential use for herd-based evaluations, as discussed later.

The cowside milk BHBA test strip has limited value for herd-based monitoring of ketosis. Blood BHBA test results are much more reliable for this purpose, and immediate cowside results are not particularly critical for herd-based testing (as they are for individual sick cow diagnosis). The imperfect sensitivity and specificity of the milk BHBA test distort the prevalence of ketosis in a herd. The true herd prevalence of ketosis may be either higher or lower than the prevalence measured by the milk BHBA test strip, depending on the cut-point chosen (Table 4). The degree of disparity between ketosis prevalence determined by the milk BHBA strip vs. the blood BHBA test also depends on the true prevalence of ketosis. The best cut-point for herd monitoring when using the milk BHBA strip appears to be ≥ 200 $\mu\text{mol/L}$. At this cut-point the prevalence of test positive results is similar to the true prevalence, allowing the same alarm level for ketosis prevalence (10%) to be used for both tests. Unfortunately, milk BHBA test strip prevalence changes little as true prevalence increases (Table 4), rendering the test practically useful only for identifying herds with a very high prevalence of ketosis.

Table 4. Expected test positive prevalences for milk BHBA test strip results at different true herd prevalences and test strip cut-points.

	Herd Ketosis Prevalence Category:			
	Low	Alarm Level	Moderate	High
<i>Milk BHBA ≥ 50 $\mu\text{mol/L}$ (89% sensitivity, 77% specificity):</i>				
True prevalence	7.5%	10.0%	15.0%	30.0%
Milk strip test positive prevalence	28.0%	29.6%	32.9%	42.8%
<i>Milk BHBA ≥ 100 $\mu\text{mol/L}$ (83% sensitivity, 82% specificity):</i>				
True prevalence	7.5%	10.0%	15.0%	30.0%
Milk strip test positive prevalence	22.9%	24.5%	27.8%	37.5%
<i>Milk BHBA ≥ 200 $\mu\text{mol/L}$ (54% sensitivity, 94% specificity):</i>				
True prevalence	7.5%	10.0%	15.0%	30.0%
Milk strip test positive prevalence	9.6%	10.8%	13.2%	20.4%

BHBA = β -hydroxybutyric acid; **Ketosis** = blood BHBA ≥ 14.4 mg/dL.

Results from my herd investigations illustrate the difficulty in using the milk BHBA test strip for herd-based monitoring. In nine herds I had sufficient sample size to categorize the herd for ketosis using both milk BHBA (≥ 200 $\mu\text{mol/L}$ cut-point, 10% alarm level) and blood BHBA (≥ 14.4 mg/dL cut-point, 10% alarm level). Categorization of five herds was the same using either test method. However, two herds classified positive by blood BHBA were classified negative by the milk BHBA test strip, and both herds had apparently high ketosis prevalences (44% and 24%). The classification of two other herds was different for the milk BHBA test strip compared to the blood BHBA test; however, this was not as concerning because these two herds had intermediate prevalences of ketosis.

Cowside milk ketone tests have not been evaluated for the effect of sample collection method (strip milk sample vs. proportional milk sample from the entire milking) and for time of sample collection relative to feeding. A better understanding of these potential effects could improve the usefulness of the milk BHBA test in diagnosing and monitoring ketosis.

9. Ketosis Treatment with Excessive IV Glucose

Intravenous treatment of ketosis with 500 ml of a 50% dextrose solution is common. This treatment generally results in clinical improvement, but is associated with frequent relapses when used as the only therapy. The very large amount of glucose in this treatment (250 g) may contribute to the relapses. The total extracellular glucose deficit in ketotic cows is about 20 grams, and cows can metabolize only about 50 grams of glucose per hour. The rest of the IV glucose is either lost in the urine (most cows are glucosuric after IV glucose treatment) or is taken up by the udder to make milk lactose. The uptake of glucose by the udder increases milk production. This is a net energy drain for the cow, since milk synthesis requires additional protein and fat besides lactose. Persistent hyperglycemia has been clearly associated with decreased appetite and increased risk for displaced abomasum. Even though we lack empirical data on the effects of treatment with 250 grams of glucose IV, these physiological facts suggest that we should avoid hyperglycemia when treating ketosis.

Oral glucose precursors (propylene glycol, glycerol, or calcium propionate) are the best treatments for mild to moderate cases of ketosis (see Table 5). Intravenous glucose is reasonable for treatment of more severe cases of ketosis (or nervous ketosis). When IV glucose is used, a reduced dose (e.g., 250 ml of a 50% solution, which provides 125 g of glucose) makes more sense pharmacologically. The lower dose reduces the risk for hyperglycemia and should make it easier for cows to maintain glucose homeostasis. It is interesting that European and Asian veterinarians use this lower dose of IV glucose (100 to 125 g).

Table 5. Classification of ketosis cases based on cowside test results*

Ketosis test:	Ketostix® strip			Keto-Test™ strip		
	Compound detected:	acetoacetate		BHBA		
Test medium:	urine		milk			
Scale:	qualitative	qualitative	mg/dl	qualitative	mg/dl	umol/l
<i>Classification of Ketosis Cases:</i>						
Not a ketosis case	"Negative"	0	0	"Negative"	0	0
	"Trace"	1+	5	"Negative"	0.5	50
Mild ketosis case	"Small"	2+	15	+/-	1	100
Moderate ketosis case	"Moderate"	3+	40	+	2	200
Severe ketosis case	"Large"	4+	80	++	5	500
	"Large"	5+	160	++	10	1000

* always include clinical signs (appetite, depression, other disease problems, nervous signs) as well.

8. Excessive Use of Isofluprednone Acetate to Treat Ketosis

Isofluprednone acetate (Predef®) has potent glucogenic properties, but also has mineralocorticoid effects. When used according to the manufacturer's recommendations it is not usually a problem. However, larger or repeated doses by any route of administration (IV, IM, IMM) appear to greatly increase the risk for hypokalemia. Oral KCl can be particularly useful if Predef® is used as a ketosis treatment. If a producer wants to use a steroid, dexamethasone has lower risk for hypokalemia.

A corollary to this concerns above about Predef® use is the general concern about using steroids to treat Type II ketosis (early lactation, probably underlying fatty liver). Steroid treatment for ketosis is a two-edged sword at best; it does increase blood glucose, but also impairs insulin response and immune function. In general, we recommend limiting steroid use to Type I ketosis cases (onset of ketosis after about 14 days in milk, usually no underlying fatty liver). Type II cases may already have insulin sensitivity and immune function problems.

7. Failure to Cover Chronically Ketotic Cows with Oral Potassium

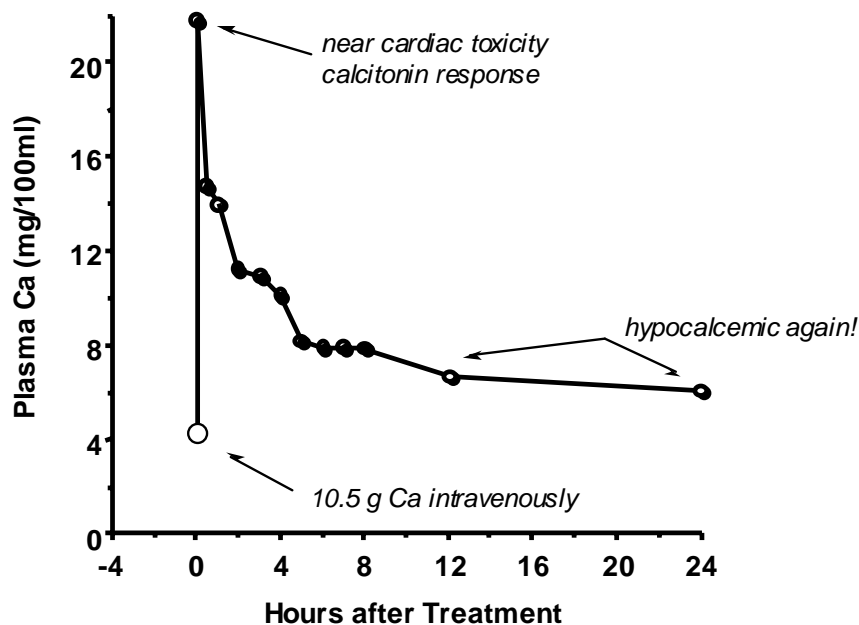
Any cow that is ketotic for 3 or more days is at risk for potentially fatal hypokalemia. We recommend routine oral dosing with 100 g KCl once daily for cows that are ketotic for 3 or more days. The KCl can be given as part of an oral drench package (see below) or in gelatin capsules. It appears that this is virtually 100% effective in preventing clinical cases of hypokalemia.

6. Milk Fever Treatment with Excessive IV Calcium or Glucose

Standard intravenous treatment for cattle in Stage II clinical milk fever (lateral recumbency) should be 500 ml of a 23% calcium gluconate solution. This treatment provides 10.8 g Ca. A precise calculation of the dose of calcium salts necessary to correct milk fever cannot be made because of the dynamic nature of calcium metabolism. The immediate total body calcium deficit in a dairy cow with milk fever is about 6 g, so a standard dose of 500 ml of 23% calcium gluconate (10.8 g Ca) is adequate.

Many dairy producers insist that a second IV bottle is necessary for many cows. However, much or all of the calcium in the second bottle will be excreted in the urine. Cows that get up only after a second bottle is given IV were able to rise only because more time elapsed after blood calcium concentrations were restored, not because of the extra calcium given. Just one bottle raises blood calcium above 15 to 22 mg/dl.

A very undesirable side effect of IV calcium is the extreme hypercalcemia it induces (see Figure 1). Besides the risk for sudden death due to cardiac toxicity, this hypercalcemia effectively shuts off PTH secretion, triggers calcitonin release, and reduces the renal threshold for calcium reabsorption in the kidney. This sets the cow up for a hypocalcemic relapse 12 to 18 hours later. Cows given two bottles of calcium IV for milk fever have a higher relapse rate than cows just given one bottle.



J.P. Goff, unpublished data

Figure 1. Plasma calcium following IV Ca treatment to a Jersey cow with clinical milk fever.

Glucose should not be included in IV or subcutaneous treatments for milk fever. Cows with clinical milk fever are almost universally hyperglycemic already. Adding more glucose IV results in glucose loss in the urine and/or increased milk yield. As mentioned above, both are very undesirable effects. Adding glucose for IV treatment of milk fever increases the relapse rate.

Cases of Stage I milk fever (not yet recumbent) are best treated by administering calcium via a slowly absorbed route. Oral or subcutaneous calcium treatment is preferred over IV treatment for Stage I cases, since both provide enough calcium to correct the hypocalcemia and neither cause a large spike in blood Ca that inhibits normal calcium homeostatic mechanisms. Solutions containing glucose should never be given subcutaneously, since glucose can only be actively absorbed into cells (a problem in the subcutaneous space, with its low cellular activity) and because glucose easily supports bacterial growth. Common complications of subcutaneous glucose administration in dairy cows are tissue destruction, abscess formation, and/or sloughing at the site of injection.

5. Failure to Prevent Hypocalcemic Relapses Following IV Treatment

About 25 to 40% of dairy cows with milk fever that respond favorably to initial intravenous calcium therapy will relapse into hypocalcemia within 12 to 48 hours. Every case of clinical milk fever that responds to the initial IV treatment should be given additional treatment to prevent a hypocalcemic relapse. Incidence of hypocalcemic relapses in dairy cattle may be reduced to only 5 to 10% of the total cases by administration of an additional 500 ml of 23% calcium gluconate subcutaneously or a dose of oral calcium at the time of initial treatment with intravenous calcium.

Cows with pre-partum milk fever and older cows are at greater risk for a hypocalcemic relapse because of their impaired bone responsiveness and generally higher milk production. A subgroup of cows experiencing hypocalcemic relapses may have an impairment in 1,25-(OH)₂D production that lasts for two to three days after calving.

Oral calcium supplements are generally undervalued and underutilized. They are ideal choices for preventing hypocalcemic relapses, treating Stage I milk fever, and even for milk fever prevention in older cows. Calcium provided by oral dosing is also gradually absorbed. A variety of oral calcium salt preparations are available. They typically contain between 25 and 100 g Ca in the form of calcium chloride or calcium propionate. They work by rapidly raising calcium in the intestine to such a high concentration that a small amount is passively absorbed. For example, about 4 g Ca will be absorbed and enter the bloodstream of a cow given an oral solution containing 50 g of calcium chloride. Calcium chloride also rapidly causes a compensated metabolic acidosis, which improves the animal's own calcium homeostatic mechanisms via improved tissue responsiveness to PTH. However, high or repeated doses of calcium chloride can cause uncompensated metabolic acidosis. Calcium chloride is also irritating and may cause transient ulcers in the mouth, esophagus, rumen, and abomasum of some cows. Calcium propionate is less irritating to the cow and in high doses is nearly as effective as calcium chloride in supporting blood calcium concentrations. The propionate contained in calcium propionate can be converted to glucose and used as an energy source. This decreases the risk of developing ketosis in early lactation. Care must be taken during administration of any oral calcium supplement to avoid laceration of the pharyngeal region or aspiration of the solution. Thinner liquid drenches, while absorbed faster, pose a greater risk for aspiration than do the thicker gels or the boluses.

Typical doses of oral calcium supplements will increase blood calcium concentrations 1 to 3 mg/dl within 30 minutes of administration. Blood calcium levels return to baseline values by six to twelve hours post-treatment. Even though oral calcium chloride has been successfully used to treat recumbent cases of milk fever, the risk of allowing a cow to remain recumbent any longer than necessary precludes their use for this purpose.

4. Overuse of Antibiotics to Treat “Fever”

Many of the herds we investigate report that fresh cows have fevers that are unresponsive to antibiotic treatment. When we investigate further, we usually find that these herds are using a very low threshold for defining fever and initiating or continuing antibiotic treatment. We recommend not classifying a cow as having a “fever” until her rectal temperature is >103.0°F. On hot summer days, increase this threshold to 104 or 104.5°F as needed.

Even cows with mild “fever” (e.g., 103.0 to 103.5°F) may not need or benefit from antibiotic treatment. For example, a cow with a temperature of 103.2°F that has no other physical exam abnormalities, is eating well, and has normal milk yield for her days in milk does not need antibiotics. Put her on the recheck list for the next day and evaluate her then. A common objection to this recommendation is that

the cow will be “too sick” by the time a decision is finally made to administer antibiotics. However, this is not a practical concern in our experience if the producer is doing a good job identifying truly sick cows and treating them appropriately.

Some antibiotic injections result in tissue destruction that may itself be pyrogenic. Thus, treatment for “fever” alone may become an almost never ending cycle of persistent fever and more antibiotic treatment.

It can be a real challenge to wean some dairy producers off excessive antibiotic use. The best approach we have found is to work the sick pens with the producer and to make treatment “non-decisions” in the context of individual cows. After a few successes, the producers will come to appreciate the value of lowered antibiotic costs, less labor, and less risk for residues.

3. Underdosing Antibiotics

We have found it most revealing to quiz dairy producers about the exact dose (and duration) of antibiotic treatments they are using. We find underdosing to be remarkably common. It is a fairly straightforward exercise to explain the correct doses. It is not usually difficult to convince the dairy producer to use correct doses, and especially if we have already reduced the number of cows that need dosed.

2. Irrational Oral Nutritional Supplementation

A number of oral electrolyte and nutritional supplements are now available for fresh cow drenching. A sampling of these supplements are listed in Table 6. Oral nutritional supplements should be positioned so that nutrients are supplemented according to each cow’s medical problems and nutritional needs. For example, ketotic cows need extra glucose precursors; cows off-feed more than a few days need extra calcium, potassium and magnesium; older cows around calving benefit from extra calcium; and hypophosphatemic downers may benefit from extra phosphorus. Unfortunately, optimal or exact doses of need nutrients are not known. A ‘one-size-fits-all’ approach does not work for oral nutritional support. Appendix Table 1 lists suggested treatments for a variety of fresh cow disease situations.

Most of these oral nutritional supplements are given in large volumes of water (5 to 15 gallons) and pumped into cows via an esophageal or rumen tube. Drownings and aspiration pneumonia can approach 1 to 2% of cows treated if done incorrectly. It appears that these are almost always due to regurgitation of fluid, which is triggered by distention of the esophagus. Fluid regurgitation with a tube in place results on fluid going into the trachea. Placement of the tube directly in the trachea is very difficult and unlikely. Cows are most likely to regurgitate if a short tube (esophageal feeder) is used, and if the fluid is pumped in rapidly. We do not recommend the use of short tubes or mechanized pumps for oral drenches. The safest means of providing large volume oral drenches is slow pumping via a long tube that reaches the rumen. Allow the cow to keep her head level during pumping, and observe her carefully throughout the process. Cows normally chew on the tube (or speculum) the entire time that the tube is in place. If the cow stops chewing, she may be trying to regurgitate. Stop pumping immediately and wait until she resumes chewing to re-start pumping. Remove the tube if the cow does not resume chewing.

Table 6. Examples of oral nutritional supplements and the nutrients they provide

Name of Product / Formula	Total Weight	Potential Glucose	Available Calcium	Available Magnesium	Available Phosphorus	Available Potassium
	(g)	(g)	(g)	(g)	(g)	(g)
Goff Formula - 1.5 lbs Ca prop, 200 g MgSO ₄ (7 H ₂ O), and 100 g KCl Calcium propionate (1.0 lbs)	981	659	139	17.8	---	47.2
Propylene glycol, 8 oz, undiluted	454	439	93	---	---	---
Glycerol, 8 oz, undiluted	237	280	---	---	---	---
Sodium monophosphate, 220 g (dose for hypo-P downers)	298	292	---	---	---	---
Potassium chloride, 454 g (dose for hypo-K downers)	220	---	---	---	44.4	---
Amcalcilyte Forte (1000 ml) (calcium hypophosphite, etc.)	454	---	---	---	---	214.3
	329	275	8	---	12.1	7.2

1. Lack of Veterinary Involvement in Diagnosis and Treatment Protocols

As diagnosis and treatment of fresh cow disorders is increasingly done by non-veterinarians, it is particularly important that dairy practitioners occasionally work the sick pens alongside on-farm personnel, become aware of the programs in place on farms, and offer professional advice to improve these programs. Annual death loss on many of our large dairies now exceeds 8%; many of these deaths could be prevented with proper diagnosis and prompt treatment.

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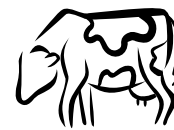


Appendix Table 1. Guidelines for Oral Nutritional Supplementation of Dairy Cows

Treatment Category	Diagnostic Criteria	Goal of Supplement	Oral Nutritional Supplement
Prophylactic treatment Just prior to calving 1st lactation	No abnormalities	No strong risk factors for disease	No strong rationale for oral supplementation prior to calving in normal 1st calf heifers.
Prophylactic treatment Just prior to calving 1st lactation	Obese springing heifer	Help prevent ketosis (Type II)	<i>Ideal:</i> Dose with propylene glycol (or glycerol), 8 ounces once or twice daily.
Prophylactic treatment Just prior to calving 2+ lactation	No abnormalities Previous history of clinical MF	Help prevent hypocalcemia	<i>Ideal:</i> Dose with oral calcium paste or gel prior to calving (use calcium chloride, calcium propionate, or a combination of these two calcium sources) Pumping large volumes of fluid (5 gallons or more) into the esophagus or rumen at this time is not necessary and is more stressful to the cow than a small dose given into the mouth.
Prophylactic treatment Just after calving 1st lactation	No abnormalities	No strong risk factors for disease	No strong rationale for oral supplementation just after calving in normal 1st calf heifers.
Prophylactic treatment Just after calving 1st lactation	Dystocia or twins Obese springing heifer	Help prevent ketosis (Type II)	<i>Ideal:</i> Continue dosing with propylene glycol (or glycerol), 8 ounces once or twice daily; stop dosing after three days of treatment
Prophylactic treatment Just after calving 2+ lactation	No abnormalities	Help prevent hypocalcemia Help prevent ketosis	<i>Ideal:</i> Drench 1.0 lbs calcium propionate in 5+ gallons of warm water <i>OK:</i> Repeat dose of oral calcium paste after calving <i>OK:</i> Subcutaneous calcium (500 ml. 23% calcium gluconate, several sites) <i>Contraindicated:</i> IV glucose to any just fresh cow (probably hyperglycemic already; IV dextrose causes diuresis and electrolyte loss) <i>Contraindicated:</i> IV calcium to normal fresh cows (oral calcium works better and does not increase the risk for later hypocalcemic relapses) <i>Contraindicated:</i> Subcutaneous calcium solutions containing glucose (causes swelling and possible abscessation)
Prophylactic treatment Just after calving 2+ lactation	Dystocia or twins Obese cow Previous history of clinical MF	Help prevent hypocalcemia Help prevent ketosis (Type II)	Stronger justification for drenching with oral calcium propionate, as described above. Free-choice oral electrolytes might also be helpful (as long as free water is also available).

Treatment Category	Diagnostic Criteria	Goal of Supplement	Oral Nutritional Supplement
Stage I milk fever Just after calving Usually 2+ lactation	Wobbly, cold ears, depressed Possible weight shifting, ataxia Still standing but weak	Prevent the hypocalcemia from progressing to Stage II (lateral recumbency)	<i>Ideal:</i> Oral calcium chloride paste, gel, or liquid drench <i>OK:</i> IV calcium, 500 ml 23% calcium gluconate (does increase the risk for relapse) <i>Poor:</i> Oral calcium propionate (probably absorbed too slowly to prevent progression to Stage II)
Stage II milk fever Just after calving Usually 2+ lactation	Lateral recumbency Flaccid paralysis Just before or just after calving	Correct the hypocalcemia Prevent musculoskeletal damage due to recumbency	<i>Ideal:</i> IV calcium, 500 ml 23% calcium gluconate administer over >4 minute period <i>Ideal:</i> Also include oral calcium propionate or calcium chloride (paste, gel, or liquid) to prevent relapse; wait until cow is standing and swallowing before giving the oral dose <i>OK:</i> Subcutaneous calcium, 500 ml 23% calcium gluconate, spread over several sites <i>Contraindicated:</i> IV or subcutaneous solutions containing added glucose (probably hyperglycemic already; IV dextrose causes diuresis and electrolyte loss) <i>Contraindicated:</i> more than 750 ml 23% calcium gluconate IV (no benefit to calcium status by giving more calcium than this; it only increases the risk for fatal arrhythmia)
Hypophosphatemia Early lactation Usually within ~3 days of calving Usually 2+ lactation	Alert downer Successful correction of hypocalcemia Confirmed low blood phosphorus (<2 mg/dl); blood sample must come from the tail vein	Correct the hypo- phosphatemia	<i>Ideal:</i> Drench 220 grams sodium monophosphate in 5+ gallons of warm water <i>Optional:</i> Add 100 g potassium chloride to the drench (especially if the cow is off-feed) <i>Optional:</i> Add 200 g magnesium sulfate to the drench (especially if the blood work shows depressed blood magnesium) <i>Optional:</i> Administer IV phosphorus (phosphate forms only) <i>Contraindicated:</i> IV or subcutaneous solutions containing added glucose <i>Contraindicated:</i> Hypophosphite sources of phosphorus (they are biologically inactive)
Hypokalemia Early lactation Any lactation	Usually follows repeated treatments for ketosis Usually 5 to 25 days in milk Confirm by blood K <2.2 mEq/l.	Correct the hypokalemia (without causing fatal arrhythmia)	<i>Ideal:</i> Drench with .5 lb (220 g) potassium chloride in 5 gallons warm water; repeat once every 12 hours until the cow gets up or dies <i>Optional:</i> IV potassium solutions (requires careful monitoring of blood potassium!) <i>Contraindicated:</i> IV glucose or oral glucose precursors (will drive potassium into the cells)
Grass Tetany (hypomagnesemia) Usually early lactation Any parity	Aggressive, belligerent downer Hyperesthesia +/- confirmation of low blood Mg (<1.5 mg/dl)	Correct the hypo- magnesemia (without getting hurt!)	<i>Ideal:</i> IV or subcutaneous magnesium sulfate solutions (e.g., 250 ml 20% magnesium sulfate) <i>Optional:</i> Magnesium-containing enema <i>Optional:</i> Oral magnesium supplementation by commercial paste, or 200 g magnesium sulfate in 5+ gallons of warm water (provide after IV or subcutaneous treatment to prevent relapse)

Treatment Category	Diagnostic Criteria	Goal of Supplement	Oral Nutritional Supplement
Prophylactic treatment Early lactation Off-feed	Not eating TMR, or refusing grain or protein in component- fed herd +/- Droopy ears, mild depression +/- Positive ketones in milk or urine	Help prevent ketosis (or its further development) Enhance appetite by correcting possible hypocalcemia Prevent hypokalemia (especially if the off-feed is prolonged)	<i>Ideal:</i> Drench 1.0 to 1.5 lbs calcium propionate, 100 g potassium chloride, and 200 grams magnesium sulfate in 5+ gallons of warm water. <i>Alternative:</i> Use 8 ounces of propylene glycol or glycerol instead of the calcium propionate (this would be OK for first lactation, but calcium propionate is preferred for 2+ lactation) <i>Optional:</i> IV treatment with 250 ml 50% dextrose (usually only if the ketosis is severe) <i>Optional:</i> Add yeast or other direct-fed microbials to the drench mixture. <i>Optional:</i> Add alfalfa meal to the drench mixture. <i>Contraindicated:</i> Repeated (more than one dose) or high doses (>10 cc) of Pre-Def 2X by any route of administration (including intra-mammary) <i>Contraindicated:</i> Repeated drenching with glucose precursors without adding supplemental potassium <i>Contraindicated:</i> IV treatment with 500 ml of 50% dextrose (too much dextrose, too much electrolyte loss via the urine)
Dehydration treatment Any stage of lactation Severe toxemia (mastitis, metritis, etc).	Confirmation of source of the toxemia. Moderate to severe dehydration (skin tent test, sunken eyes)	Support the cow by correcting the dehydration	<i>Ideal:</i> Drench with 5 to 10 gallons of a balanced oral electrolyte solution (provides sodium potassium, chlorine, bicarbonate, and possibly other electrolytes) <i>Optional:</i> IV fluids (balanced electrolytes, isotonic or hypertonic). Provide free access to water if hypertonic solutions are given IV



Class Discussion Exercise - Problem Herd Investigation

Garrett R. Oetzel, DVM, MS
Food Animal Production Medicine Section
School of Veterinary Medicine
University of Wisconsin-Madison

Herd Data

Date of Investigation: February 23, 2000

Herd Signalment: 380-cow Holstein herd, TMR-fed, 16,800 lb rolling herd average,
3X milking with full rBST use (following label)

Herd Complaints:

Loss of ~3,200 lbs/cow/year in rolling herd average milk within 18 months

Death loss problems - 14 cows dead or salvaged in January, 2000

53 deads in 360 calvings in the last year (14.7% annual death loss)

Displaced abomasum problems - 34 cases in the last year (9.4%)

Herd Background:

Moved into a new free stall barn / parlor about 12 months ago

Herd is on Wisconsin DHI official test (allows us to do WiscGraph download and plot herd historical performance)

On-farm herd management software – obscure program; not accurate or current except for some repro information

Monthly DHI milk weights (no milk meters in the parlor).

Herd Discussion Questions

Investigations of herds with possible ketosis problems can involve a lot of data and complex interactions among the data. It helps to work through the herd data systematically and to sequentially answer three key questions about the herd:

Does the herd truly have a ketosis problem?

If a ketosis problem exists, then what are the key risk factors for it?

What practical recommendations will reduce the risk for ketosis?

Does the herd have a ketosis problem?

Question #1 Is there a suggestion of ketosis problems in the herd history?

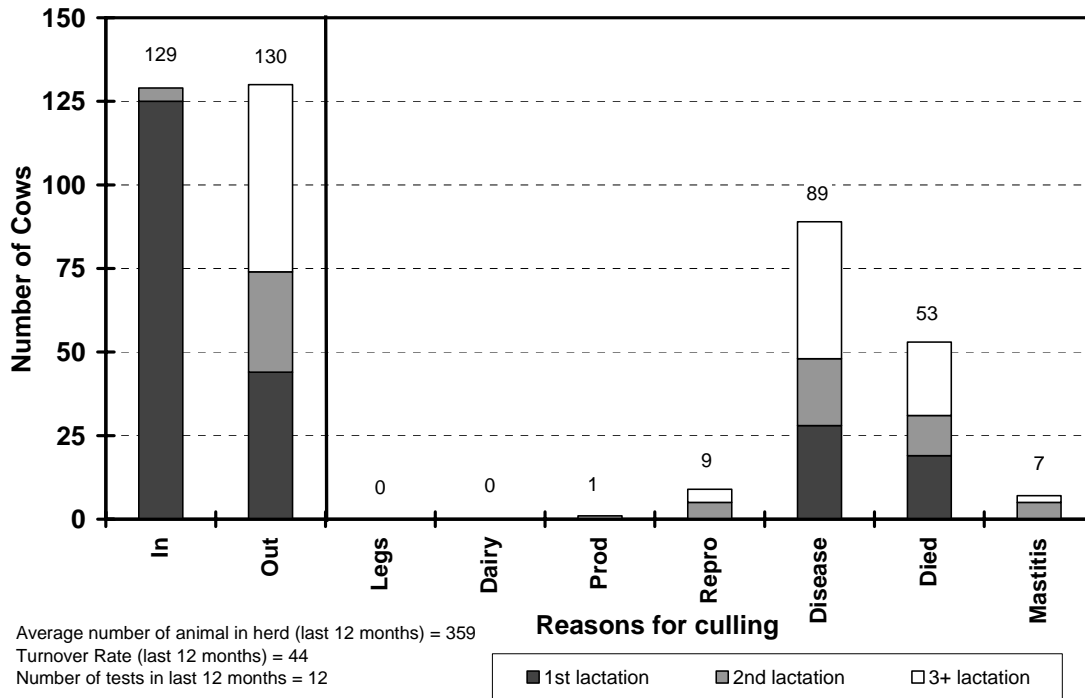
Question #2 Does the pattern of herd turnover, death loss, and days in milk at herd removal suggest a ketosis problem (see attached Wisc Graph charts)?

Question #3 Do the milk components suggest a ketosis problem (see attached Wisc Graph charts)?

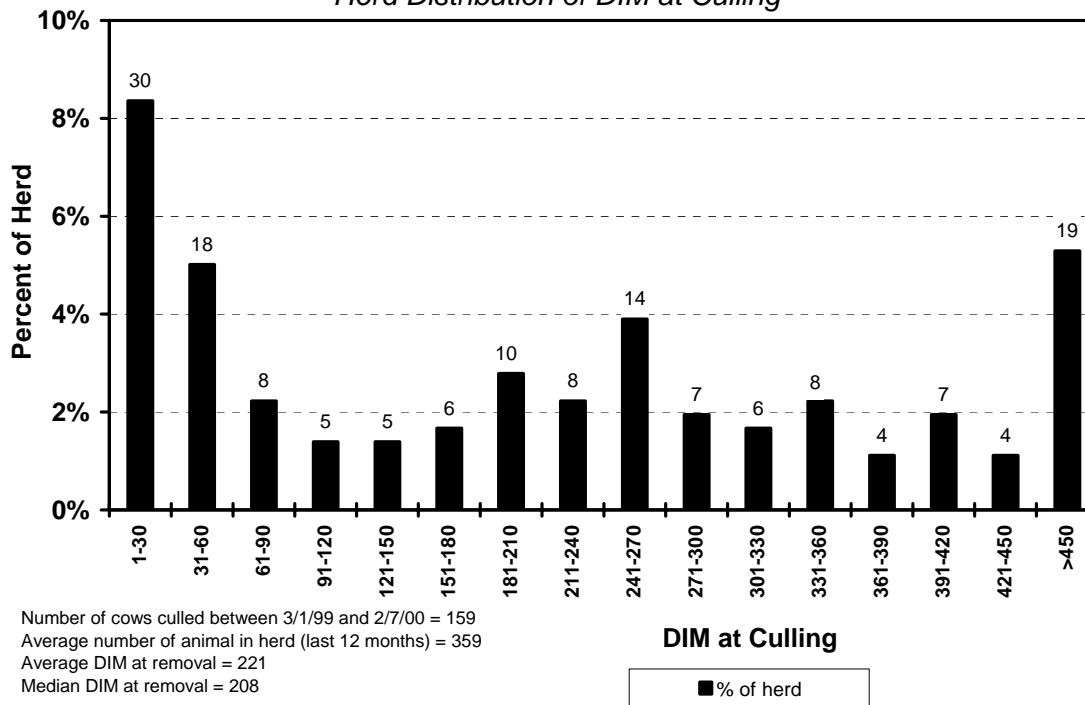
Question #4 Do the ketosis blood testing results (see attached table) substantiate a ketosis problem?

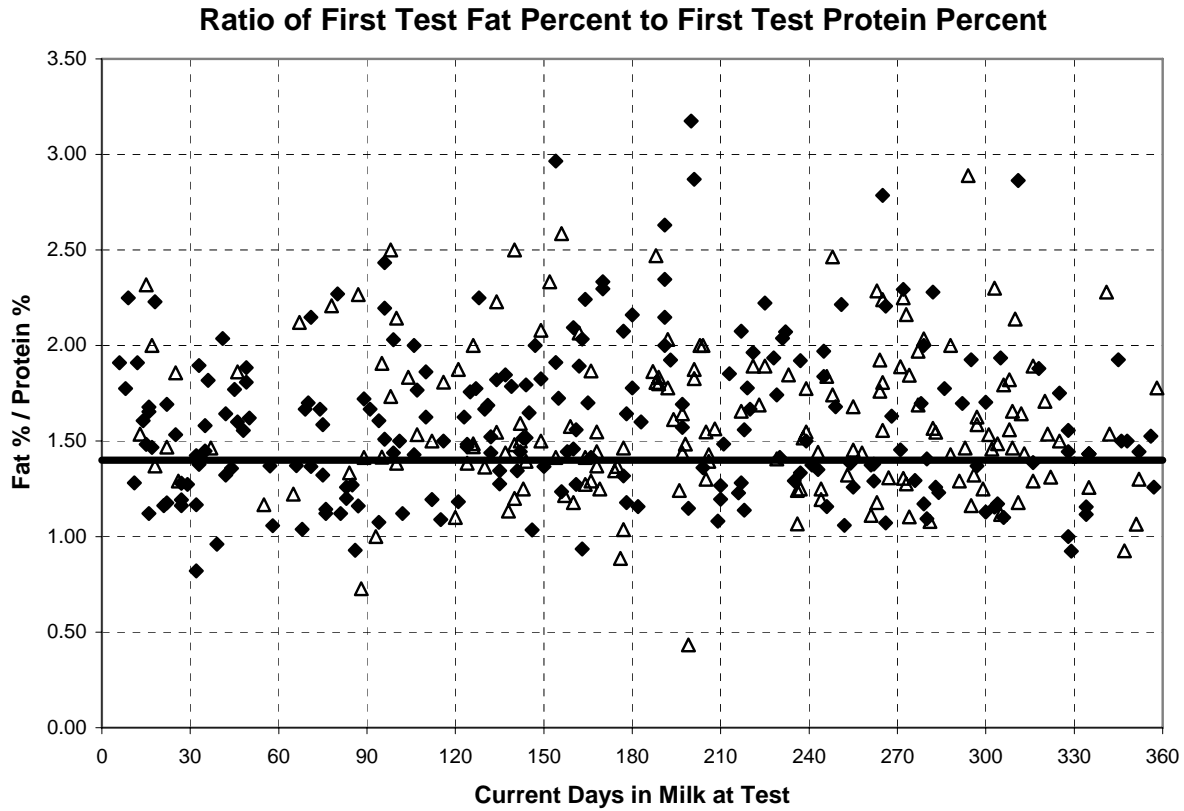
Question #5 Do the data suggest a Type I, Yype II, or butyric acid silage ketosis?

Turnover Summary (Last 12 Months)



Herd Distribution of DIM at Culling

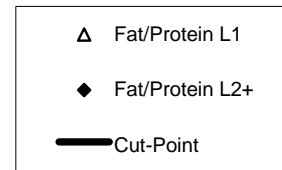




Percent of Animals greater than 1.4 = 63.4%

Percent of 1st Lactation Animals greater than 1.4 = 65.2%

Percent of 2+ Lactation Animals greater than 1.4 = 62.1%



Interpretive comment: >40% above 1.4 Fat/Protein Ratio is suggestive of a herd subclinical ketosis problem.

Post-Fresh Cows - BHBA Testing						
Herd Name:		Subclinical Ketosis Study Herd			Testing Date:	2/23/00
#	Cow ID	Group	Lact	Days in Milk	Ketolac BHB Milk Test (uM)	Blood BHBA (mg/dl)
1	O313	Post-fresh	2	5	>1000 (++)	17.2
2	O549	Pen 2	1	6	>1000 (++)	43.2
3	Y311	Pen 2	1	7	500 to 1000 (++)	27.9
4	W1033	Pen 2	1	10	0 to 50 (-)	10.0
5	1008	Post-fresh	2	12	0 to 50 (-)	9.1
6	W835	Pen 2	1	14	100 to 200 (+/-)	15.1
7	Y252	Pen 1	2	23	100 to 200 (+/-)	6.2
8	W1664	Pen 1	4	30	0 to 50 (-)	16.9
9	Y321	Pen 1	3	31	>1000 (++)	50.4
10	W745	Pen 2	1	31	0 to 50 (-)	9.8
11	W827	Pen 2	3	31	0 to 50 (-)	6.4
12	Y27	Pen 1	3	32	0 to 50 (-)	5.9
13	W639	Pen 1	3	44	0 to 50 (-)	6.7
14	W335	Pen 2	1	45	0 to 50 (-)	3.4
Group Summary:					6/14*	6/14
Interpretation of Results:						
BHBA:		(beta-hydroxy butyric acid)				
Less than 10% of cows tested should have serum BHBA > 14.4 mg/dl.						
* A cut point of >100 uM was used for the Ketolac BHB test on milk samples.						

What are the herd risk factors for ketosis?

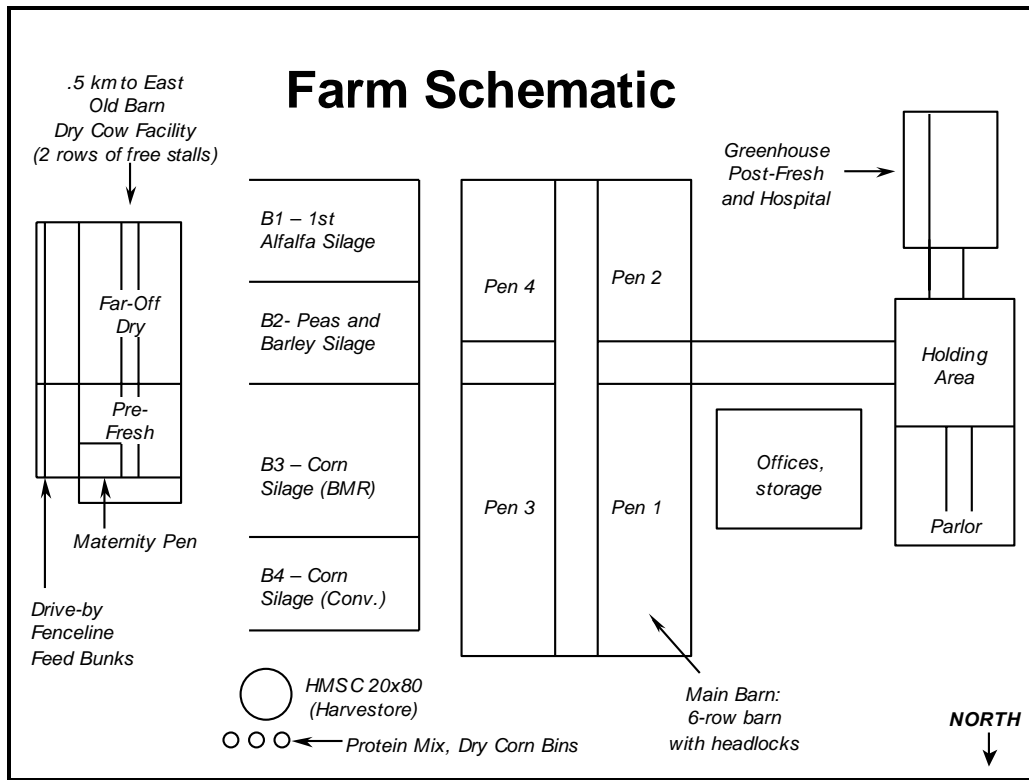
Question #6 Are there inappropriate pen moves just before or after calving in the herd (see attached schematic of the farm layout and table of pen movement)?

Question #7 Are the pre- or post-fresh pens overcrowded or lacking in bunk space (see attached tables)?

Question #8 Is there problem with over-conditioning of dry cows (see attached chart)?

Question #9 Do the results of pre-fresh cow NEFA testing suggest a problem with negative energy balance prior to calving (see attached table of results)?

Question #10 Do the results of the forage analyses and fermentation analyses suggest a problem with butyric acid silage consumption (see attached silage fermentation results table)?



Cow Movement Summary

Pen	Group Name	# Cows	Days in Pen(s)
Old Barn South	Far-Off Dry	43	53
Old Barn North	Pre-Fresh	12	17
Old Barn North	Maternity	4	3
Greenhouse	Just Fresh and Sick	10 / 14	10
1 or 2	Pen 1 – 2+ Lact Early Pen 2 – 1st Lact Early	177	183
3 or 4	Pen 3 – Mid to Late Lact Pen 4 – High SCC, JD+	150	155

Pen Summary – Stall Information

Pen	Group Name	# of Cows	Rows of Stalls	#Stalls	Stocking Rate (%)
Old Barn South	Far-Off Dry	43	2	55	78%
Old Barn North	Pre-Fresh	12	2	25	48%
Old Barn North	Maternity	4	pack	pack	--
Greenhouse	Just Fresh and Sick	24	2	22	109%
1	Early, 2+ Lact	105	3	96	109%
2	Early, 1st Lact	72	3	60	120%
3	Mid to Late Lact	100	3	96	104%
4	High SCC, JD+	50	3	60	83%

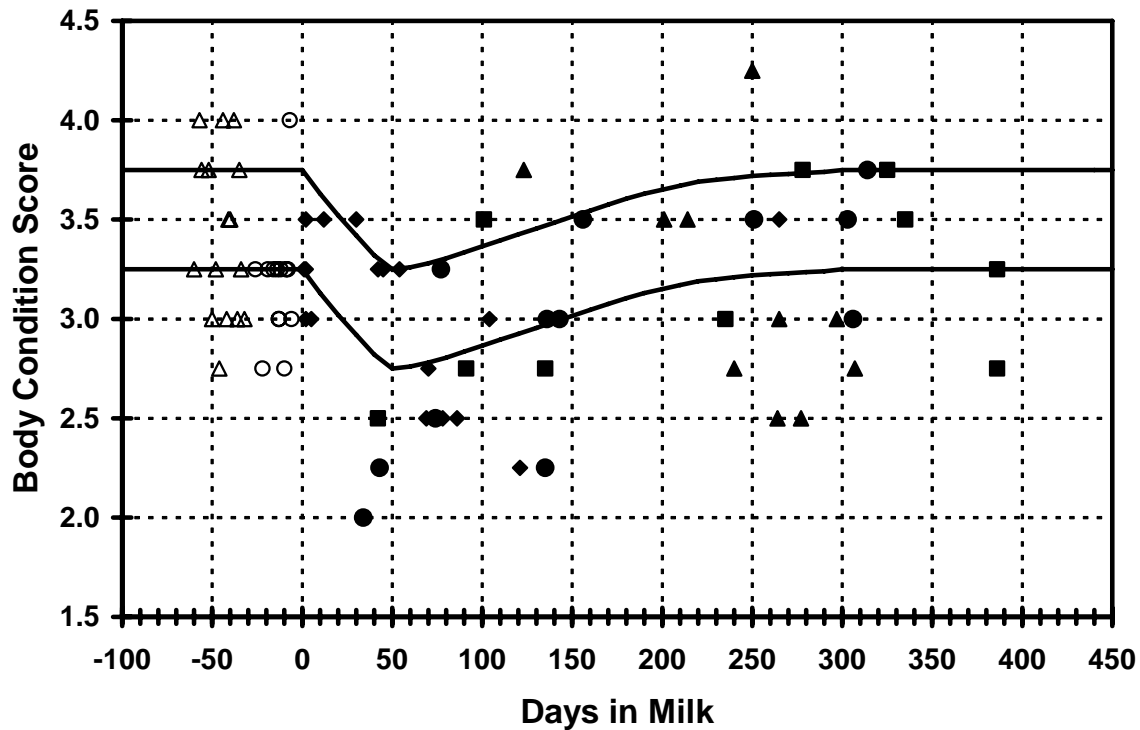
Pen Summary – Bunk Information

Pen	Group Name	# Cows	Bunk Space or Headlocks	Bunk space or % Headlocks
Old Barn South	Far-Off Dry	43	105 feet	2.4 ft./cow
Old Barn North	Pre-Fresh	16	70 feet	4.4 ft./cow
Old Barn North	Maternity	(are turned out 2X daily to eat with pre-fresh)		
Greenhouse	Just Fresh and Sick	24	70 feet	2.9 ft./cow
1	Early, 2+ Lact	105	65 head locks	162%
2	Early, 1st Lact	72	45 headlocks	160%
3	Mid to Late Lact	100	65 head locks	154%
4	High SCC, JD+	50	45 head locks	111%

Plot of Body Condition Scores by Days in Milk

Herd Name: SCK Study Herd

Date: 2/23/00



○ Pre-Fresh △ Far-Off Dry ● Pen 1 ◆ Pen 2 ▲ Pen 3 ■ Pen 4 ◆ Post-Fresh

"Ideal" body condition scores should fall between the two curved lines

Chart adapted from a spreadsheet originally developed by J. Fetrow, VMD, MBA

Pre-Fresh Cows - NEFA Testing									
Herd Name:		Subclinical Ketosis Study Herd				Testing Dates:		2/23/00 and 3/7/00	
#	Cow ID	Group	Lact	Due Date	Date Bled	Actual Fresh Date	Days to Actual Fresh	NEFA (mEq/l)	
1	W326	Pre-Fresh	2	n/a	3/7/2000	3/10/2000	3	0.29	
2	500	Pre-Fresh	1	n/a	2/23/2000	3/8/2000	14	0.14	
3	O515	Pre-Fresh	3	n/a	2/23/2000	3/6/2000	12	0.31	
4	342*	Pre-Fresh	3	n/a	3/7/2000	3/13/2000	6	1.24	
5	W651	Pre-Fresh	2	n/a	3/7/2000	3/12/2000	5	0.51	
6	Y232	Pre-Fresh	1	n/a	3/7/2000	3/15/2000	8	0.41	
Group Summary:								3/6	
Note:		A total of 14 samples were collected on two different dates; however, only 6 cows calved 2 to 14 days after sample collection. The other 8 sample results were not interpreted.							
Interpretation of Results:									
NEFA:		(Non-Esterified Fatty Acids)							
		Less than 10% of cows tested should have NEFA above .40 mEq/l if 2 to 14 days from calving.							
		Cows that calve more than 14 days after collecting the sample commonly have low NEFA concentrations which are difficult to interpret.							
		Cows that calve within 48 hours of collecting the sample commonly have elevated NEFA concentrations which are difficult to interpret.							
		* Cow #342 developed a DA on 3/21/00 (8 days in milk)							

Silage Fermentation Analyses							
Subclinical Ketosis Study Herd							
Feed Ingredient:		1st Alfalfa Silage		Peas & Barley Silage			
Analysis Source:		#1680067		#1680066			
Nutrient	Units	Result	Source	Result	Source	Result	Source
Dry matter	% AF	28.2	lab	26.6	lab		
pH	pH	5.49	lab	4.72	lab		
Lactic acid	% DM	1.9	lab	6.1	lab		
Acetic acid	% DM	2.53	lab	3.65	lab		
Propionic acid	% DM	0.36	lab	0.26	lab		
Iso-butyric acid	% DM	0.28	lab	<.01	lab		
Butyric acid	% DM	2.64	lab	0.36	lab		
Total VFA	% DM	7.71	lab	10.37	lab		
CP from Ammonia	% of CP	4.8	lab	2.8	lab		
Goals for Alfalfa Silage or Alfalfa/Grass Mix Silage:							
Dry matter	% AF	>35%					
pH	pH	4.2 to 4.8					
Lactic acid	% DM	2 to 4%					
Acetic acid	% DM	1 to 2%					
Propionic acid	% DM	0 to .25%					
Iso-butyric acid	% DM	<.01%					
Butyric acid	% DM	<.01%					
Total VFA	% DM	3 to 6%					
CP from Ammonia	% of CP	<7%					

What are your herd recommendations?

Assume that all other herd testing results (and we collected a lot more data than what is presented here!) were unremarkable. What are your key recommendations for solving this herd's problems. I suggest that you list only five recommendations. Each recommendation should be presented so that the herd owner clearly knows exactly what he must do in order to prevent future ketosis problems in this herd.

1.

2.

3.

4.

5.

Utility of Body Condition Scoring and NEFA Testing in a Small Herd with Chronic Transition Cow Problems

Ellen E. Hartz

OSU College of Veterinary Medicine

Class of 2008

Keystone Veterinary Service Summer Scholarship



Zimmerman Dairy Farm

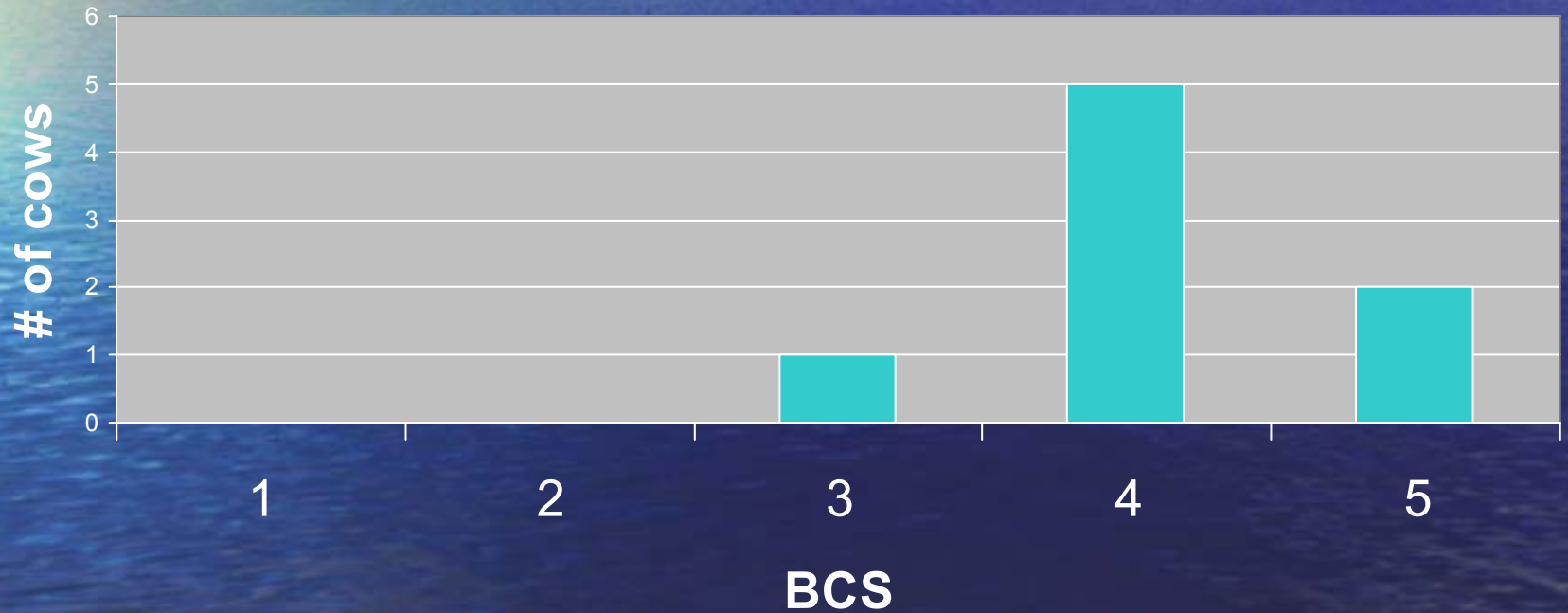
- 50 cow dairy, Mennonite Farm
- Willard, OH
- Production: Milk flow avg. = 70lbs.
- Milk Quality: SCC = 130
- Reproduction:
 - Days open = average 105 days
 - 21 Day Preg. Rate = 24%

Problem:

- April 2005 to July 2006
- Average rate of clinical ketosis in fresh cows = 38%
- Average rate of LDA in fresh cows = 20%

Body Condition Score

BCS of Dry Cows







NEFA Testing

- VDX (In House) Analyzer Kit
 - VDX Diagnostic Analyzer P.O. Box 237 Newburg, WI 53060 www.vetdx.biz 262.675.2499
- Plasma non-esterified fatty acids
- Indication of negative energy balance in pre-fresh cows
- >0.400 mEq/l in cows 2-14 days pre-calving (Oetzel, 2003 AABP Conference)
- Herd level significance if $>10\%$ of at risk herd is above threshold

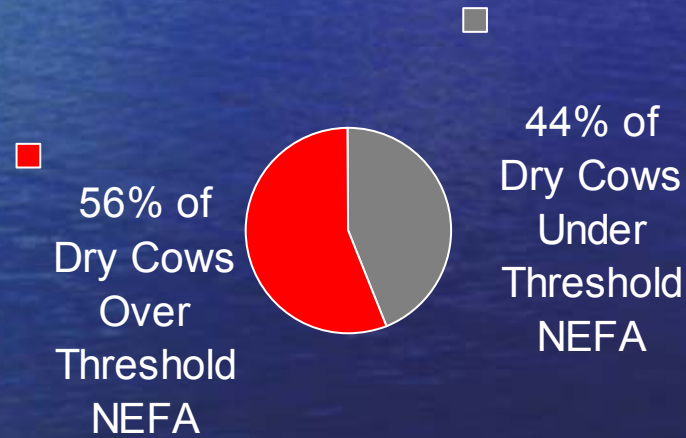


Long
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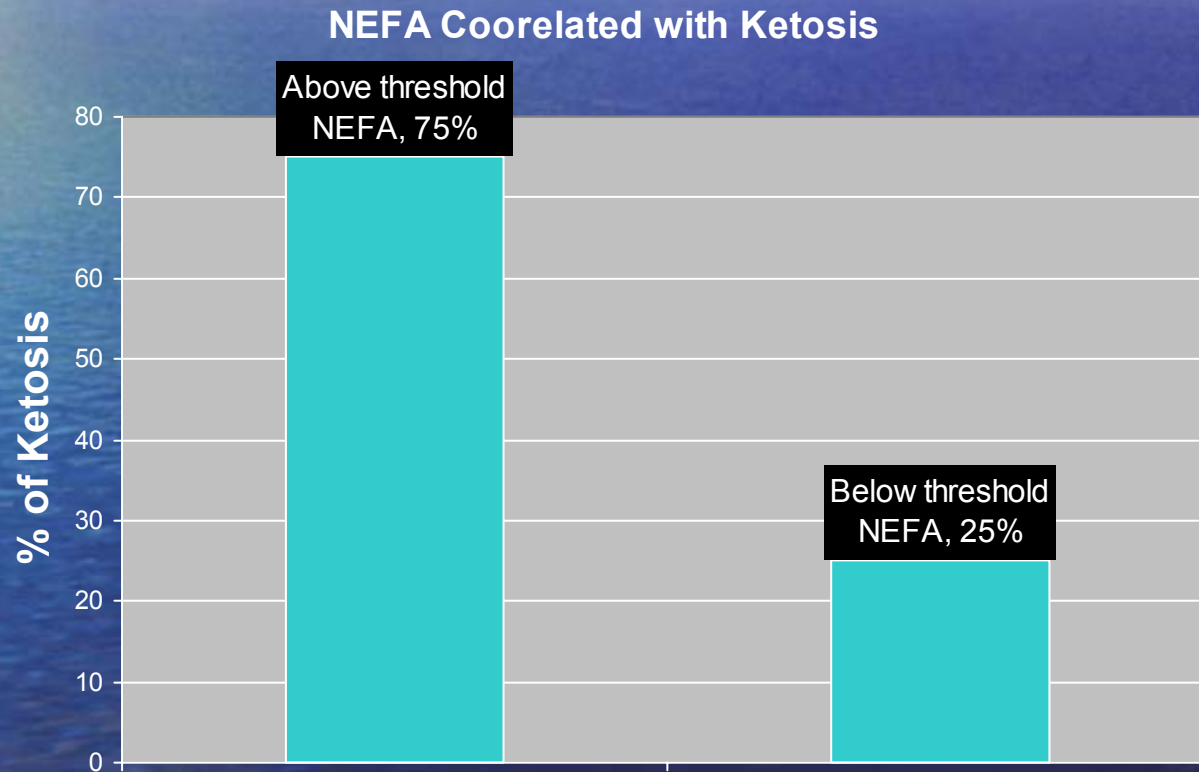


NEFA Results

Dry Cow NEFA Testing Results



Individual NEFA Significance



Overview

- Body Condition Scoring is an under-utilized tool in transition cow management
- NEFA is best used as a herd monitoring tool for early detection and future prevention of negative energy balance
- Update and changes.
 - Ration changes: added fiber
 - Dry Cow Housing/Bunk Remodeling
 - Dry Cow management
 - Decreased ketosis and LDA

THANK YOU!

- Dr. Fred Gingrich and Dr. John Knox of Keystone Veterinary Services
- Melvin Z. Zimmerman Dairy
- Ohio Dairy Vets
- Dr. Epperson



**2007 Ohio Dairy Veterinarians Meeting
Transition/Fresh Cow Management**

**K. Fred Gingrich II DVM
Keystone Veterinary Services, Inc
776 Main St R.D. #5
Ashland, OH 44805
419-962-4344
fmgingrich@zoominternet.net**

Transition Cow Challenges for Small Dairy Farms

1. Labor. The owner of the dairy usually has multiple jobs versus the division of labor seen on large herds with a work force. Often dry cows are “forgotten” and are at the bottom of the list of chores for the day.
2. Lack of goals. Since our practice started doing the Johnes RAMP forms, I have discovered a number of our clients lack goals. What are production goals, fresh cow goals, reproduction goals, etc?
3. Monitoring. Few of our clients have a computer. Convincing clients to keep records that are not related to breeding is difficult. Assisting clients with keeping these records is a good area for veterinarians to become involved. Due to the low number of animals on a small dairy farm, we also find it difficult to interpret the statistical significance of things we see on the dairy in regards to cow health, production and reproduction.
4. Nutrition management. Small farms often use feed sales representatives for nutrition advice. TMR use is less prevalent on small dairies versus large dairies. Home grown feeds can be of lower quality than purchased forages.
5. Large herd management practices can be difficult to implement on small farms. An example of this is having multiple groups of cows can often be impractical from a numbers standpoint on a small dairy farm.

Questions we ask when faced with a fresh cow problem

1. Is there a problem?
2. What is the problem the fresh cows are experiencing?
3. Is it a fresh cow problem or a dry cow problem?
4. What is the incidence rate of metabolic disease?
5. What is the days in milk at the time the metabolic disease occurs?
6. Where are the dry cows housed?
7. What is the stocking density of the dry cow pen?
8. How is the ventilation, air quality, and cleanliness of the dry cow facility?
9. What is the dry cow ration? When is it fed? Are feedstuffs analyzed?
10. Are cows moved prepartum to a different pen?
11. What is the body condition of cows at dry off, fresh, and peak production?

Approach to Transition Cow Management on Small Dairy Farms

1. Facilities

- a. Tie stall dairies common and occasionally house dry cows
- b. Tie rail should be raised to 48 inches and the chain should hang to the curb.
- c. Pen packs should be designed so that there is 100 sq ft per cow and ideally stocked to 85%.
- d. Feedbunk should be comfortable for cows to eat – smooth surface, not elevated, no obstacles to eating
- e. If headlocks are only installed in the dry pen and not elsewhere we have seen decreased intakes on some farms and resultant ketosis problems. If no headlocks are in the lactating barn then we recommend post and rail feeding system in the dry barn as well.
- f. Ventilation is often poor in dry cow areas. Ventilation assessments using a Kestrel Weather Meter can be performed by the veterinarian. Kestrel meters are available at www.weatheressentials.com

2. Monitoring

- a. We provide producers with blank Microsoft Excel sheets for a variety of record keeping.
- b. Data can be entered by office staff if you want to track with a computer.
- c. Charts can be reviewed after herd checks or sick cow visits. We have found that using monitoring charts will generate discussion and increase billable hours on the farm for consultations.
- d. Charts are easy for producers to fill out therefore increasing client compliance.
- e. Chart examples we use:
 - i. Fresh cow disease rates (ketosis, LDA, RP, MF)
 - ii. Milk Production off bulk tank slips
 - iii. Culls and deaths by days in milk
 - iv. Particle separator analysis of TMR vs refusals
 - v. Also used for reproduction and TAI programs

3. Pen Moves

- a. More easily accomplished on large farms where cows are moved once a week and pens are full of lots of cows
- b. Small farms have 5-10 dry cows and if 20% of these are close we end up with 1-2 cows in a transition pen.
- c. Cows are usually moved too late (less than 3 weeks), fed a high energy “steam up” ration full of starch and carbohydrates and lacking NDF, fed unpalatable ration additives, and put in a pen by themselves when it is instinctive for them to be with a group.
- d. A maternity pen works better on a small farm. Cows are housed in a dry group and moved to a maternity pen at calving. Since cows only spend time in the maternity pen to calve, the pen is clean and more easily managed when labor is an issue. This not only is better for fresh cow health but also helps control Johnes and neonatal diseases.

Specific Recommendations We Make to Our Small Dairy Clients

1. Monitoring charts with review after herd checks
2. NEFA's run during periods of heavy calving and during disease outbreaks.
3. One group dry pen that is well ventilated
 - a. Tunnel ventilation for tie stalls
 - b. Natural ventilation with open ridge and sidewalls for pen packs and free stalls
4. Headlocks if elsewhere on the dairy. Post and rail if no headlocks on dairy
5. Dedicated maternity pen. Cows moved to maternity pen at calving (when you see feet). Cow and calf moved out of maternity pen ASAP.
6. Low energy dense dry cow ration
 - a. Cost effective and easy to manage
 - b. One ration during entire dry period
 - c. All forages must be chopped
 - d. Dry hay or straw works best in my opinion. Must be palatable and digestible
 - e. Starch is severely limited. Excess starch leads to a bigger drop in prepartum dry matter intake which is the key to ketosis prevention in my opinion
 - f. Works great for fat cows and heifers
 - g. Potassium has not been a problem even when some of these rations contain a high level that is over the amount for DCAD balance
 - h. Udder edema has not been a problem as long as protein and energy are low
7. Low energy ration numbers we use as guidelines:
 - a. DMI = 23-25 lbs
 - b. NDF = 48-53%
 - c. NFC = 28-29%
 - d. Starch = 12-14%
 - e. CP = 13.5 – 14.0%
 - f. NEI = 0.60 to 0.64

Ohio Dairy Veterinarians Meeting January 2007.

The Ohio State University CVM Food Animal Abstracts

- 1. Assessing Agreement of DeLaval Direct Cell Counter with Somacount 300 on Quarter Milk Samples from Dairy Cows.** J.B. Walker, P.J. Rajala-Schultz, F.J. Degraives, Department Veterinary Preventive Medicine, The Ohio State University, Columbus, Ohio.
- 2. Antimicrobial Use and Biosecurity Practices on Custom Heifer Rearing Operations in the United States.** W. L. Walker, DVM, W. B. Epperson, DVM, MS, L. K. Lord, DVM, PhD and J. Lakritz, DVM, PhD Department of Veterinary Preventive Medicine and Department of Veterinary Clinical Sciences The Ohio State University College of Veterinary Medicine.
- 3. Body condition scoring and NEFA testing in a small herd with chronic transition problems.** Ellen Hartz VME III; William B. Epperson DVM, MS.
¹Department Veterinary Preventive Medicine, The Ohio State University, Columbus, Ohio.
- 4. Dissecting serum Haptoglobin: A subset of serum haptoglobin is produced by neutrophils and is present in cattle with sepsis.** J Lakritz, G. A. Bannikov, J. Mattoon, E. Abrahamsen, C. Premanandan, S. Weisbrode. Department of Veterinary Clinical Sciences and Veterinary Biosciences, The Ohio State University College of Veterinary Medicine.

Abstract 1. Assessing Agreement of DeLaval Direct Cell Counter with Somacount 300 on Quarter Milk Samples from Dairy Cows. J.B. Walker, P.J. Rajala-Schultz, F.J. Degraives, Department Veterinary Preventive Medicine, The Ohio State University, Columbus, Ohio.

The objective of this study was to determine the agreement of the DeLaval Direct Cell Counter (DCC) with the Somacount 300 (DHI Cooperative, Inc) in reporting somatic cell counts (SCC). Over a period of 14 days, quarter milk samples (n= 500) were taken from sixteen cows ranging from 42 to 145 days in milk at a single farm. Samples excluded from analysis included those with measurement errors (n=8) and DHI values less than 10,000 (n=129) or greater than 4 million (n=63) SCC as they fell outside the reported detection limits of the DCC.

Although there was reasonably good correlation (91%) between SCC and DCC, Bland and Altman (BA) analysis revealed poor agreement within the published working range provided by DeLaval for the DCC. Limits of Agreement determined by BA revealed that you may expect the DCC value to be as much as 545,000 cells below to 787,000 cells above that reported by DHI with a mean difference of 121,000. This study is contrary to others that have employed methods of correlation in comparing these two tests. Our findings indicate that, when evaluating the two tests strictly on agreement, there is insufficient agreement for the tests to be used interchangeably. However, from a clinical aspect, when records were examined on a case by case basis only 9% of the samples would have proved contrary in clinical interpretation when subclinical mastitis is defined as >200,000 cell/ml.

Abstract 2. Antimicrobial Use and Biosecurity Practices on Custom Heifer Rearing Operations in the United States. W. L. Walker, DVM, W. B. Epperson, DVM, MS, L. K. Lord, DVM, PhD and J. Lakritz, DVM, PhD
Department of Veterinary Preventive Medicine and Department of Veterinary Clinical Sciences
The Ohio State University College of Veterinary Medicine

Antimicrobial use and its perceived and documented effects on antimicrobial resistance is a major concern for livestock producers, consumers and animal health care providers. Custom heifer rearing operations (CHRO) are specialized livestock operations that focus on dairy heifer care and management. The segment of the dairy industry has expanded over time and should continue to represent a viable alternative to traditional home-rearing of replacements. The authors know of no published reports of antimicrobial use or biosecurity practices employed by CHRO. A survey will be constructed to elucidate antimicrobial use and biosecurity practices employed on CHRO. The survey population will be identified through their membership in the Professional Dairy Heifer Grower's Association and through other industry contacts. Survey questions and the final formatted questionnaire undergo intense scrutiny before distribution with a combination of institutional review, veterinarian review, a focus group of dairy producers and growers and pilot distribution to a sub-sample of the grower population. Survey implementation procedures are designed to maximize response and include a specifically timed and worded series of contacts. The series of contacts include a pre-letter, survey questionnaire with cover letter, postcard follow-up, repeat questionnaire mailing to non-respondents and a final telephone contact.

Abstract 3. Body condition scoring and NEFA testing in a small herd with chronic transition problems. Ellen Hartz VME III; William B. Epperson DVM, MS. Department Veterinary Preventive Medicine, The Ohio State University, Columbus, Ohio.

No Abstract Available.

Abstract 4. Dissecting serum Haptoglobin: A subset of serum haptoglobin is produced by neutrophils and is present in cattle with sepsis. J Lakritz, G. A. Bannikov, J. Mattoon, E. Abrahamsen, C. Premanandan, S. Weisbrode. Department of Veterinary Clinical Sciences and Veterinary Biosciences, The Ohio State University College of Veterinary Medicine.

Serum Haptoglobin (Hp) is used as a marker of acute inflammation in cattle. There is disagreement as to the prognostic value of this APP in livestock. One possible reason is the response is due primarily to liver production during inflammation. Hepatic production of haptoglobin is dramatic and may reach 10 mg/mL in serum. Other cell types (neutrophils, macrophages, lung, uterine and other epithelial cells) produce haptoglobin albeit at a lower level than the hepatocyte. The purpose of this report is to define the contribution of neutrophil haptoglobin to the acute phase response and the potential use of PMN haptoglobin as an indicator of sepsis in cattle. Serum was obtained from cattle with confirmed: acute sepsis (peritonitis n=5; septic myositis n=1); chronic lung abscess (n=1); chronic mastitis (n=1), and sera from healthy animals (routine Johnes' surveillance). Serum from healthy cattle and animals with chronic infectious diseases (lung/liver abscesses, mastitis) did not contain any Hp produced by neutrophils. Serum from cattle with acute septic peritonitis and mysositis contained high molecular weight Hp in complex with matrix metalloproteinase 9 (MMP 9) which is produced by neutrophils.

These haptoglobin-MMP 9 complexes retain the functional properties of each constituent protein (bind hemoglobin, protease activity). Hp-MMP 9 complexes are present in the sera of septic cattle, but not healthy or chronically ill animals. Using a combination of anti-bovine MMP 9 and anti-bovine Hp in an ELISA may prove useful in the diagnosis of sepsis in cattle.