PREDICTING TRANSITION COW HEALTH AND PERFORMANCE – USE OF BLOOD AND FECAL BIOMARKERS FOR HERD-LEVEL EVALUATION AND DIAGNOSTICS

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OVERVIEW

Blood metabolites have been used in herd-level diagnostics of transition cow management for a number of years (Ingraham and Kappel, 1988; Herdt, 2000; Oetzel, 2004), mostly with focus on identifying opportunities to decrease the incidence of metabolic disorders related to energy metabolism. Recently, there has been a resurgence of interest in the use of blood metabolites, primarily nonesterified fatty acids (NEFA) and beta-hydroxybutyrate (BHBA) for evaluation of transition cow programs. This resurgence is largely based on recent findings that both NEFA and BHBA are associated with economically important herd parameters beyond metabolic disease incidence, namely milk production and reproductive performance. In addition, the increased availability of accurate cow-side tests for BHBA in blood (Precision Xtra, Abbott Laboratories) and milk (KetoTest, Elanco Animal Health) has made routine evaluation of BHBA in herds simple, fast, and low cost. In light of these findings, new research has begun to evaluate the relationships of biomarkers related to stress and inflammation [e.g. plasma haptoglobin (Hp) and fecal cortisol metabolites (FCORT)] with metabolic disease and milk production in order to identify other useful and physiologically relevant markers for herd-level diagnostics and evaluation of transition cow programs. This paper reviews our recent findings in these areas and provides recommendations on how these markers should be interpreted for evaluating transition cow programs.

USE OF ANALYTES RELATED TO ENERGY METABOLISM – NEFA & BHBA

Oetzel (2004) characterized well the typical use of blood analytes related to energy metabolism in transition management diagnostics – NEFA during the prepartum period to assess precalving energy status and BHBA during the postpartum period to assess incidence of subclinical (and clinical) ketosis. This approach was supported in part by work conducted in Michigan (Cameron et al., 1998) that associated increased prepartum concentrations of NEFA, reflective of negative energy balance, with a greater incidence of displaced abomasum. Duffield et al. (1998) defined and characterized subclinical ketosis in herds in Ontario during the postpartum period and demonstrated that administration of monensin in a controlled-release capsule would decrease the incidence of subclinical ketosis in dairy cows during early lactation.

Recently, our group conducted a large-scale evaluation of the associations of prepartum NEFA and postpartum NEFA and BHBA with postpartum health, milk production, and reproductive performance in dairy herds in the northeastern US (Ospina et al., 2010a, 2010b, 2010c). In order to have been included in the study a herd must

have: 1) had greater than 250 milking cows, 2) housed cows in free-stalls, 3) fed a total mixed ration (TMR), and 4) participated in DHIA and/or use Dairy Comp 305 (Valley Ag. Software, Tulare CA). Farms were visited once and during the farm visit two cohorts of animals were selected: those 14 to 2 days prepartum and those 3 to 14 days postpartum. Within each cohort, convenience samples of 15 apparently healthy animals were evaluated. Briefly, 10 mL of blood was collected from the coccygeal vein or artery into a red-top tube. The sera from the prepartum cohort were analyzed for NEFA and the sera from animals sampled after calving were analyzed for NEFA, BHBA. For all animals sampled, the incidence of the diseases of interest [displaced abomasum (DA), clinical ketosis (CK), and metritis (MET) and/or retained placenta (RP)] within 30 days in milk, time to pregnancy within 70 days post voluntary waiting period and Mature Equivalent 305 (ME 305) milk at 120 days in milk were recorded. The final dataset included 100 herds with an average herd size of 840 cows. A total of 2758 cows were sampled within these herds (1440 animals sampled prepartum and 1318 sampled postpartum) with an approximate distribution of 35% primiparous (entering first lactation) and 65% multiparous (entering second or greater lactation) cows.

Critical threshold values for prepartum NEFA and postpartum NEFA and BHBA and the associated risk ratios for disease are presented in Table 1. If animals had prepartum serum NEFA concentrations greater than about 0.30 mEq/L, they were twice as likely to develop one or more of the diseases of interest. Animals with postpartum serum NEFA and BHBA concentrations greater than about 0.60 mEq/L and 10 mg/dL, respectively, were four times as likely to develop one of more of the diseases of interest than animals with lower concentrations of these metabolites. The risk ratio for individual disorders varied widely within these groups. These results are consistent with prior work and support the importance of maintaining adequate energy intake prepartum and controlling body condition score loss and overall energy status during the postpartum period with respect to disease.

The relationships of prepartum NEFA and postpartum NEFA and BHBA with reproductive performance for the first 70 days after voluntary waiting period are described in Table 2. Animals with prepartum NEFA greater than about 0.3 mEq/L were nearly 20% less likely to become pregnant than animals with lower concentrations. Animals with greater than about 0.70 mEq/L of NEFA (while controlling for BHBA) and/or greater than 10 mg/dL of BHBA were 13 to 16% less likely to become pregnant than animals with lower concentrations. In all models, multiparous cows were less likely than primiparous cows to become pregnant in the first 70 days following the voluntary waiting period.

Associations of analytes related to energy metabolism with subsequent milk production (assessed as mature-equivalent 305-day lactational milk, predicted at approximately 120 DIM) are depicted in Table 3. Regardless of parity, animals with greater than about 0.3 mEq/L of NEFA during the prepartum period had nearly 700 kg less ME305 projected milk than animals with lower concentrations. During the postpartum period, there were interesting differences in associations of energy-related analytes with milk production depending upon parity. In primiparous cows (heifers), postpartum NEFA concentrations greater than about 0.6 mEq/L and BHBA

concentrations over about 9 mg/dL were associated with increased milk yield. In multiparous cows, postpartum NEFA concentrations greater than about 0.7 mEq/L and BHBA concentrations greater than about 10 mg/dL were associated with lower predicted milk yield.

Table 1. Receiver operator characteristic (ROC) curve determination of critical NEFA (mEq/L) and BHBA (mg/dL) thresholds as predictors of disease and risk ratios of disease based upon these critical thresholds (Ospina et al., 2010b).

Prepartum cohort (2 to 14 days prepartum)				
Disease	**Critical prepartum NEFA[1]**	**Risk Ratio**	**95 % CI[2]**	**P-value**
DA	0.27	2.0	1.1 – 3.7	0.03
CK	0.26	1.8	1.2 – 2.5	0.001
Met and/or RP	0.37	2.2	1.6 – 3.0	< 0.0001
Any of the three	0.29	1.8	1.4 – 2.2	< 0.0001
Postpartum cohort (3 to 14 days postcalving)				
Disease	**Critical postpartum NEFA[1]**	**Risk Ratio**	**95 % CI[2]**	**P-value**
DA	0.72	9.7	4.2 – 22	<0.0001
CK	0.57	5.0	2.3 – 11	<0.0001
Met	0.36	17	2.0 – 134	0.008
Any of the three	0.57	4.4	2.6 – 7.3	< 0.0001
Disease	**Critical BHBA[1]**	**Risk Ratio**	**95 % CI[2]**	**P-value**
DA	10	6.9	3.7 – 12.9	<0.0001
CK	10	4.9	3.2 – 7.3	<0.0001
Met	7	2.3	1.1 – 5.1	0.037
Any of the three	10	4.4	3.1 – 6.3	<0.0001

[1] Highest combination of specificity and sensitivity based upon ROC analysis
[2] Risk ratio confidence interval

Table 2. Cox proportional hazard model of the effect of NEFA (mEq/L) and/or BHBA (mg/dL), covariates, and animals clustered within herds on days to conception after voluntary waiting period (Ospina et al., 2010a).

Sampled population	**Variable**	**Hazard**	**P-value**
Prepartum cohort	NEFA ≥ 0.27	0.81	0.01
	Parity	0.73	0.001
Postpartum cohort	NEFA ≥ 0.72	0.84	0.05
	BHBA ≥ 10	0.93	0.4
	Parity	0.81	0.01
Postpartum cohort	BHBA ≥ 10	0.87	0.1
	Parity	0.80	0.01

Table 3. Mixed models for the effect of NEFA (mEq/L) and/or BHBA (mg/dL), covariates, and herd as a random effect on milk production assessed as ME305 milk at 120 days in milk (Ospina et al., 2010a).

Sampled Population	Variable	Difference in ME milk yield (kg)	P-value
Prepartum	NEFA ≥ 0.33	-683	0.001
	Parity	-556	0.01
Postpartum -- heifers	NEFA ≥ 0.57	+488	0.02
	BHBA ≥ 10	-143	0.5
Postpartum -- heifers	BHBA ≥ 9	+ 403	0.04
Postpartum -- cows	NEFA ≥ 0.72	-647	0.001
	BHBA ≥ 10	-165	0.4
Post-partum -- cows	BHBA ≥ 10	-393	0.04

Among animals sampled during the prepartum period (2 to 14 days before calving), 45% of primiparous animals and 26% of multiparous cows had NEFA concentrations at or above 0.3 mEq/L. Among animals sampled during the postpartum period (3 to 14 days after calving), 25% of primiparous animals and 33% of multiparous cows had NEFA concentrations at or above 0.7 mEq/L. Furthermore, 15% of primiparous animals and 27% of multiparous cows had BHBA concentrations at or above 10 mg/dL. In the vast majority of participating farms, primiparous and multiparous animals would have been commingled during the period before calving– these results suggest that heifers in particular may be compromised from the standpoint of energy intake relative to requirements in these systems. Furthermore, these energy-related analytes appear more likely to be elevated in multiparous cows than primiparous cows during the period after calving.

Ospina et al. (2010c) also used this dataset to compare herds with greater than 15% of animals over the critical thresholds for the analytes during the prepartum and postpartum periods with those with less than 15% of animals over the thresholds during each period and results from this analysis are presented in Table 4. It should be noted that the numbers in this table reflect the associations among all animals in the herd, not just sampled animals in the study. As suggested by the results in the table, those herds with more than 15% of animals with prepartum NEFA and/or postpartum NEFA and BHBA over the critical thresholds had slightly greater disease incidence, poorer reproductive performance, and lower ME305 projected milk yield in both primiparous and multiparous cows. In the U.S. system, the associations of these analytes at the herd-level with decreased milk yield and poorer reproductive performance would be much more economically meaningful than those with disease incidence.

Herd-level prevalence of elevated NEFA and BHBA in this dataset is described in Table 5. This study illuminated that many herds have elevated concentrations of these metabolites during both the prepartum and postpartum periods. Among the most striking findings were the large number of herds (59% of herds) with elevated NEFA in more than 35% of prepartum heifers and the large number of herds (30 to 40% of herds) having more than 35% of heifers and cows with elevated NEFA during the postpartum period. Finally, more than 50% of herds had more than 25% of cows with elevated BHB during the postpartum period. It should be noted that herds were not

selected because they were experiencing transition period health challenges – collectively these results indicate that there is a large underlying opportunity for improved management during the transition period.

Table 4. Herd-level impacts of elevated prepartum and postpartum nonesterified fatty acids (NEFA) and postpartum beta-hydroxybutyrate (BHBA) in commercial dairy farms (Ospina et al., 2010c)

Metabolite level	**Herd alarm**	**Herd-level impact**
Prepartum NEFA (14 to 2 d prepartum) > 0.3 mEq/L	> 15%	- 1.2% 21-d pregnancy rate + 3.6% disease incidence - 282 kg ME305 milk
Postpartum NEFA (3 to 14 d postpartum) > 0.6 (heifers) – 0.7 (cows) mEq/L	> 15%	- 0.9% 21-d pregnancy rate + 1.7% disease incidence Heifers: - 288 kg ME305 milk Cows: -593 kg ME 305 milk
Postpartum BHBA (3 to 14 d postpartum) > 10 (cows) – 12 (heifers) mg/dL	> 15% > 20%*	- 0.8% 21-d pregnancy rate + 1.8% disease incidence *Heifers: -534 kg ME305 milk Cows: -358 kg ME 305 milk

15% of 15 animals sampled = 2 to 3 animals over threshold; 90% confidence interval that it sample represents herd prevalence

In terms of practical application of this information, we believe that measurement of energy-related analytes is a useful tool for monitoring herds, evaluation of potential opportunities for improved transition cow management, or diagnostics. In terms of the target windows, we recommend sampling 12 to 15 cows per group within the windows of interest described above – prepartum samples should be analyzed for NEFA and postpartum samples can be analyzed for NEFA and/or BHBA. The cowside blood or milk tests for BHBA described above are very accurate and represent an excellent first step or front line analysis because of convenience and cost. Because the incidence of herds with high postpartum NEFA in our dataset was much greater than that with high postpartum BHBA, we would encourage practitioners and consultants to take the extra step and consider analysis for postpartum NEFA in situations where they believe that early lactation milk production and reproductive performance are compromised yet the BHBA data are unrevealing. Finally, prepartum NEFA continue to be useful in helping to identify situations in which larger than desired proportions of prepartum cows have compromised energy status.

Table 5. Distribution of herds by prevalence of elevated prepartum NEFA or postpartum NEFA or BHBA concentrations (Ospina et al., 2010c)

	Number of herds by prevalence of elevated metabolite			
Item	< 15 %	15 – 25%	25 – 35%	> 35%
Prepartum NEFA ≥ 0.3 mEq/L				
Heifers	23	3	11	59
Cows	34	16	22	28
Postpartum NEFA ≥ 0.7 mEq/L				
Heifers	43	6	19	30
Cows	24	15	22	38
Postpartum BHB ≥ 10 mg/dL				
Heifers	61	8	17	12
Cows	30	18	26	25

Table 6 describes three possible outcomes and potential interpretations for a herd to consider after NEFA and/or BHBA evaluation in prepartum and postpartum groups. If NEFA is elevated in prepartum cows, it is generally a good signal that either energy intake as a whole is inadequate or facility/management issues exist and are causing significant cow to cow variation in DMI and hence NEFA concentration. Independent of postpartum analyte values, we associate elevated prepartum NEFA with negative disease, reproductive, and production outcomes at the herd level (Table 4). The most likely analyte pattern for a herd that is overfeeding energy either far-off or close-up is low NEFA values prepartum but high NEFA and/or BHB values postpartum. Herds and consultants should remember, however, that a number of factors specific to either nutritional management or facility/grouping management also can elevate postpartum concentrations of NEFA and/or BHB independent of prepartum values. Typically, when herds are overfed either far-off or close-up, we see a subsequent rapid and marked loss of BCS among fresh cows – NEFA testing of the fresh cows can help to confirm this.

Table 6. Interpretation of energy-related metabolites [nonesterified fatty acids (NEFA) and beta-hydroxybutyrate (BHBA)] to assess herd-level opportunities.

Scenario	Likely cause and possibilities
High prepartum NEFA High postpartum NEFA and/or BHBA	Likely starting with low DMI in close-up cows Too low energy in prefresh diet, facility and/or management issues (grouping, stocking density, heat stress?)
High prepartum NEFA Low postpartum NEFA and/or BHBA	Low DMI in close-up cows Sampling the survivors in the fresh pen? Is herd outmanaging or putting band-aids on fresh cow issues?
Low prepartum NEFA High postpartum NEFA and/or BHBA	Is herd overfeeding energy either far-off or close-up? Diet or facility/management issues specific to maternity/fresh group

POTENTIAL FIELD-BASED MARKERS FOR INFLAMMATION AND STRESS IN TRANSITION COWS

An emerging area of focus within our research group is in understanding the relationship of inflammation and stress with transition cow health and performance (Huzzey et al., 2011; Huzzey and Overton, 2010). We envision that biomarkers related to inflammation [e.g. Haptoglobin (hp)] or stress [fecal cortisol metabolites (FCORT)] could also be useful for evaluating the effects of non-nutritional management factors, such as overstocking or commingling of cows and heifers, on physiology. Haptoglobin is an acute phase protein that is synthesized and released by liver as part of the inflammatory response and has been shown to be elevated in cows with metritis (Huzzey et al., 2009). Although there are many acute phase proteins, Hp has been of particular interest for the detection of sick animals due to its very low concentrations in the blood of healthy animals (Eckersall, 2000). Fecal cortisol metabolites are reflective of circulating concentrations of cortisol approximately 10 to 12 hours prior to the collection of the fresh fecal sample. Concentrations of FCORT have been suggested to be a better indictor of physiological stress responses than direct measurements of plasma cortisol due to the feedback-free nature of the sampling method (Palme et al., 1999). Restraint and handling, which are required during blood sampling, can cause a physiological stress response and raise circulating cortisol concentrations quickly (Cook et al., 2000). Further, the release of cortisol from the adrenal gland during the day is pulsatile and has a diurnal cycle that is subject to substantial individual variation. Because FCORT does not have the same limitations relative to sampling, as does serum or plasma cortisol, it offers a potential way to study activation of the hypothalamic-pituitary-axis in response to exposure to stressors.

To evaluate whether prepartum physiological indicators of stress and inflammation were associated with the occurrence of health disorders after calving and milk yield, data were collected from 412 cows on two commercial dairies in New York State. Farms were visited weekly to collect blood, fecal samples, and BCS. Sampling began approximately 4 wk prior to each cow's expected calving date. One blood and fecal sample per cow was collected between d -21 to -15 relative to the actual calving date to represent wk -3, d -14 to -8 (wk -2), and d -7 to -2 (wk -1). Prepartum plasma was analyzed for NEFA, Hp, and cortisol and FCORT concentrations (11,17-dioxoandrostanes) were determined from fecal samples.

Health events occurring within 30 DIM, including retained placenta (RP), displaced abomasum (DA), and death (not including voluntary culls) were collected from DairyCOMP 305. A postpartum blood sample was collected within 3 to 10 d after calving. Based on this postpartum blood sample, sub-clinical ketosis (SCK) was diagnosed when plasma BHBA was ≥ 10 mg/dl (Ospina et al., 2010a) and High Haptoglobin (HiHp, suggestive of an infection such as metritis) was diagnosed when plasma Hp was ≥ 1 g/L (Huzzey et al., 2009). Cows were divided into 3 health categories for statistical analysis: 1) No disorder of interest (NDI); 2) One disorder (RP, DA, SCK, or HiHp); or 3) More than one disorder (RP, DA, SCK, HiHp) or death.

As expected prepartum plasma NEFA was a strong predictor of postpartum health; however, this relationship was dependant on the degree of illness after calving. Cows that developed multiple disorders after calving or that died had the greatest concentrations of NEFA, relative to the other two health categories, particularly during the 2-week period before calving. There were no associations between prepartum Hp or FCORT concentration and the occurrence of one disorder (RP, DA, SCK or HiHP) by 30 DIM. Hp concentration tended to be greater during wk -2 and -1 and FCORT tended to be greater during wk -3 and -2 for cows that developed more than one disorder or that died by 30 DIM relative to cows the NDI category; however, neither of these analytes could predict which cows would go on to develop health complications as well as prepartum NEFA concentration (Figure 7; Huzzey et al., 2011).

Table 7. Least squares means (± SE) for plasma NEFA (stratified by parity), plasma haptoglobin (Hp), and fecal cortisol metabolite (FCORT) concentrations for cows in three different postpartum health categories[2] during 3 wk before calving.

		Week (wk) from Calving		
Analyte	**N**	**wk -3**	**wk -2**	**wk -1**
NEFA (mEq/L) - Primiparous Cows				
NDI	86	0.29 ± 0.02	0.34 ± 0.02	0.38 ± 0.02
One Disorder	58	0.31 ± 0.02	0.37 ± 0.02	0.41 ± 0.03
> One Disorder or Death	38	0.28 ± 0.03	0.41 ± 0.03 *	0.49 ± 0.04 **
NEFA (mEq/L) - Multiparous Cows				
NDI	97	0.17 ± 0.02	0.22 ± 0.02	0.29 ± 0.03
One Disorder	69	0.20 ± 0.02	0.28 ± 0.03 †	0.40 ± 0.04 *
> One Disorder or Death	64	0.29 ± 0.02 ***	0.42 ± 0.03 ***	0.60 ± 0.04 ***
Hp (g/L)				
NDI	183	0.24 ± 0.03	0.27 ± 0.03	0.23 ± 0.03
One Disorder	127	0.29 ± 0.03	0.29 ± 0.04	0.28 ± 0.04
> One Disorder or Death	102	0.18 ± 0.04	0.34 ± 0.04 †	0.33 ± 0.05 †
FCORT (ng/g fecal DM)				
NDI	183	1593.8 ± 58.4	1764.5 ± 66.7	1979.0 ± 98.7
One Disorder	127	1659.4 ± 69.9	1678.9 ± 79.9	1972.1 ±
> One Disorder or Death	102	1777.0 ± 84.1	1950.9 ± 92.5	2117.9 ±

† $P \leq 0.1$; * $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$

In order to evaluate the relationships of these analytes with subsequent milk yield, herd DC305 records were used to collect information on each cows predicted 305ME from the 2nd test day (approximately 62 DIM). A range of metabolic cutpoints were evaluated for each period and the effect of being above or below the cutpoint on predicted 305ME was then evaluated (Huzzey and Overton, 2010).

Table 7 presents the analyte cutpoints used for this analysis and the proportion of animals that were above the cutpoints at each period relative to calving. These cutpoints were selected based on the magnitude of the difference in 305ME between the categorized cows (those above the cutpoint and those below the cutpoint) and also on the proportion of animals in each category. In other words a higher cutpoint may have revealed greater differences in 305ME between the two categories but resulted in so few animals in one category that the data were not practically useful; consequently a lower cutpoint was selected.

Table 7. Percent of cows above the analyte cutpoints (Huzzey and Overton, 2010).

	Primiparous Cows (n=182)				Multiparous Cows (n=230)			
Cutpoint	wk -3	wk -2	wk -1	wk +1	wk -3	wk -2	wk -1	wk +1
NEFA > 0.5 mEq/L	18.1	24.7	33.0	-	5.7	9.1	12.6	-
NEFA > 0.6 mEq/L	-	-	-	12.1	-	-	-	14.3
Hp > 1.1 g/L	4.9	7.7	6.0	39.0	3.0	4.8	3.0	27.4
FCORT > 2500 ng/g DM	8.2	17.0	25.3	-	6.1	13.0	27.0	-
FCORT > 700 ng/g DM	-	-	-	20.3	-	-	-	35.2

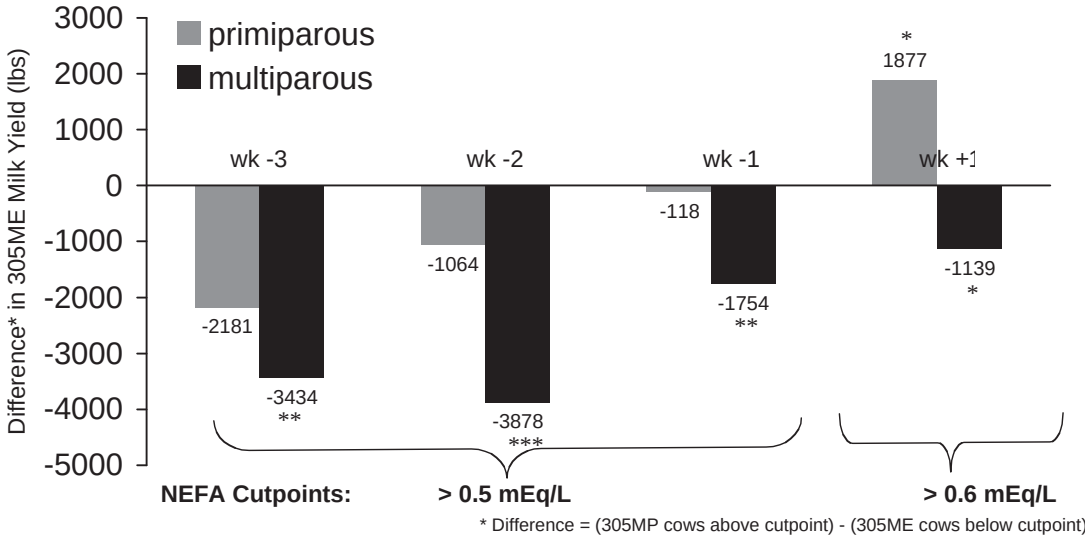
Analysis was stratified by parity because the relationships of NEFA, Hp and FCORT at various periods relative to calving with 305ME milk yield were not consistent between cows and heifers. Heifers with NEFA > 0.5 mEq/L during wk -3, tended to have lower projected 305ME milk yield; however, during the postpartum period, heifers with NEFA > 0.6 mEq/L during had a projected 305ME milk yield 1877 lbs greater than heifers below this NEFA threshold (Figure 1). Multiparous cows with NEFA > 0.5 mEq/L during weeks -3, -2, or -1 had a projected 305ME milk yield that averaged 3022 lbs lower than the projected 305ME of multiparous cows below this cutpoint (Figure 1). During week +1, multiparous cows with NEFA > 0.6 mEq/L had a 1139 lbs lower projected 305ME milk yield. Although the cutpoints and magnitude of response in the study were different than those used in Ospina et al. (2010a), the patterns of response were similar.

Projected 305ME milk yield tended to be 2328 lbs lower in heifers with haptoglobin concentrations > 1.1 g/L during weeks -3 and -2, relative to heifer below this cutpoint. Multiparous cows with haptoglobin > 1.1 g/L during weeks -2, -1 or +1 had on average 3315 lbs lower projected 305ME milk yield (Figure 2), relative to multiparous cows below this cutpoint.

There was no association between plasma cortisol and milk yield at any period relative to calving for either multiparous or primiparous cows (data not shown). Concentrations of FCORT were not significantly associated with 305ME milk yield in primiparous cows; however, multiparous cows with FCORT > 2500 ng/g fecal DM during weeks -3 or -2 relative to calving had on average 2429 lbs lower 305ME milk yield relative to cows below this cutpoint. Projected 305ME milk yield was 2926 lbs

lower among MP cows with fecal cortisol metabolites > 700 ng/g fecal DM during week +1 (Figure 3).

Figure 1. Difference[1] in predicted 305ME milk yield for cows above the indicated NEFA cutpoints relative to cows that are below the cutpoints.



In summary, cows with higher concentrations of NEFA (with the exception of heifers during week +1), haptoglobin, or fecal cortisol metabolites around calving have lower projected 305ME at the 2nd test day and these associations are apparent up to 3 weeks prior to the onset of lactation. While higher concentrations of NEFA, Hp, and FCORT are associated with lower predicted milk yield, the significance of these relationships was stronger for Hp and FCORT relative to NEFA, particularly when these analytes are measured during the week after calving. If we focus on the postpartum period it is also appears that both Hp and FCORT are more sensitive to 305ME milk yield projections than NEFA; the magnitude of the difference in projected 305ME between those animals that were above versus below the indicated cutpoints were much greater when using HP or FCORT to predict these differences compared to NEFA. Finally, a greater proportion of animals were above the Hp and FCORT cutpoints during week +1 then were above the NEFA cutpoint. These results suggest that haptoglobin or fecal cortisol metabolites may be alternative and perhaps more effective analytes for detecting cows at risk for reduced milk yield, than NEFA. Our next step for this research will be to determine how herds vary in the concentrations of these analytes and how management factors impact these measures on dairy farms.

Figure 2. Difference in predicted 305ME milk yield for cows above the indicated Haptoglobin (Hp) cutpoints relative to cows that are below the cutpoints

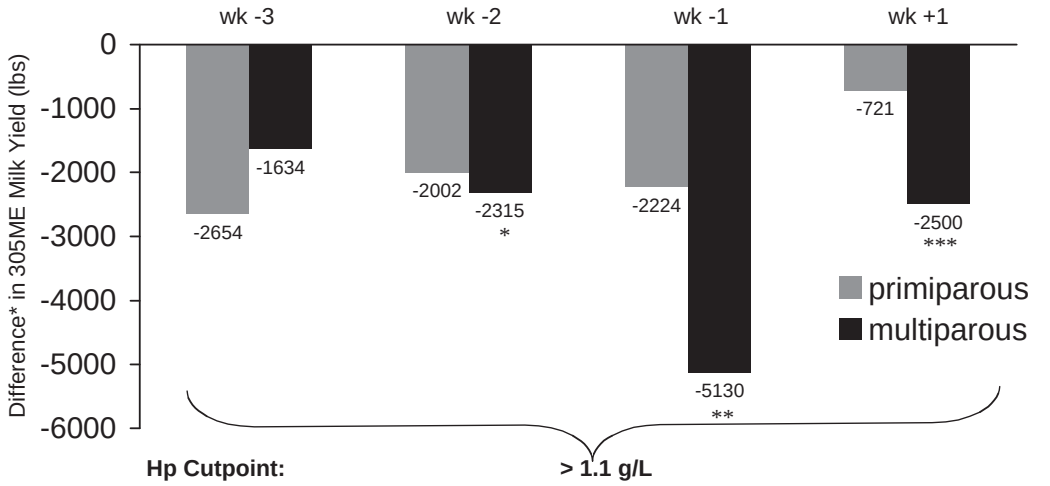
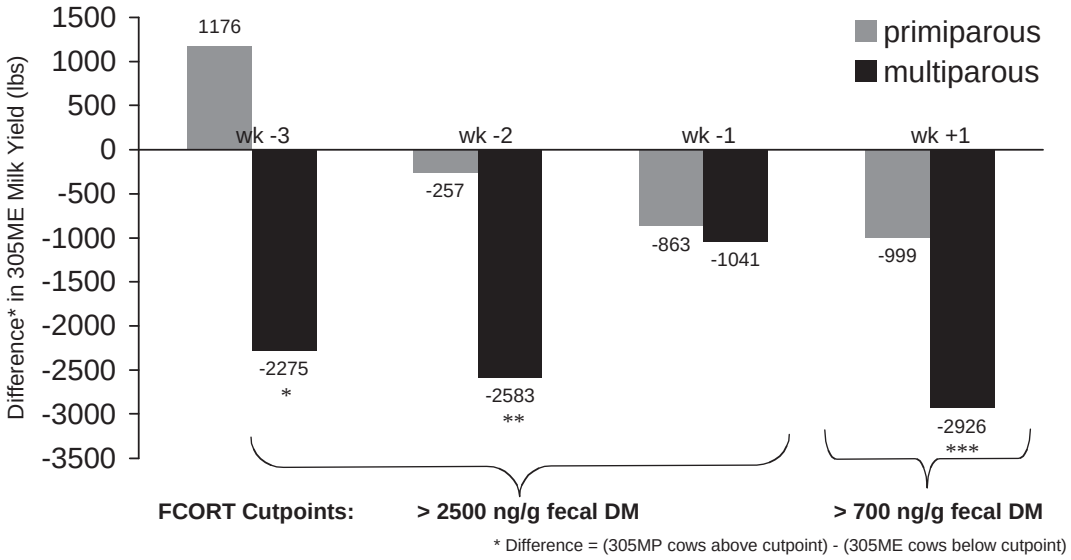


Figure 3. Difference in predicted 305ME milk yield for cows above the indicated fecal cortisol metabolite (FCORT) cutpoints relative to cows that are below the cutpoints



SUMMARY AND CONCLUSIONS

Circulating concentrations of energy-related metabolites (prepartum NEFA and postpartum NEFA and/or BHBA) are highly associated with postpartum outcomes relative to disease, milk production, and reproductive performance in dairy cattle. As such, they can be an important component of evaluation of transition cow programs. Our recent data suggest that associations of elevated concentrations of these

metabolites during the prepartum and postpartum period with subsequent milk yield and reproductive performance may be more meaningful at the farm level than their associations with metabolic disease. Because of convenience and cost, evaluation of postpartum BHBA in milk or blood at the farm level is a preferred first-line monitoring tool, although prepartum and postpartum NEFA concentrations in serum or plasma can provide additional insight into transition management opportunities. New research from our group suggests that elevated concentrations of biomarkers related to inflammation and stress (plasma haptoglobin and fecal cortisol metabolites) during the transition period also are associated with decreased milk yield in early lactation – we will be conducting further research to develop these as potential tools to help identify opportunities for improved transition cow management.

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