Letter to the Editor: A Response to the Comments of Borderas et al. (2007)

J. D. Quigley,^{*1} T. A. Wolfe,[†] and T. H. Elsasser[‡]

^{*}Diamond V Mills, Cedar Rapids, IA 52407

[†]Iowa State University, Ames 50011

[‡]Growth Biology Laboratory, USDA-ARS, Beltsville, MD 20705

We appreciate the opportunity to respond to the *Letter to the Editor* by Borderas et al. (2007) in response to our paper published in the *Journal of Dairy Science* (Quigley et al., 2006). In their letter, the authors offer an alternative interpretation of our data and offer criticisms of our methodology. Responses to their comments are below.

Feed Refusals and Force-Feeding

The authors propose that increased morbidity and mortality in our study was caused by administration of refused calf milk replacer (CMR) by esophageal feeder. They wrote “we suggest that the increased incidence of illness observed in the calves fed the higher levels of milk replacer was due to sick calves being force-fed.” They further suggested that feed refusals were a manifestation of anorexia caused by expression of pro-inflammatory cytokines. To determine the role of pro-inflammatory cytokines in any observed anorexia, we measured concentrations of tumor necrosis factor- α (TNF- α) in blood samples on d 7, 14, 28, 42, and 56. Regarding the interaction of cytokines, anorexia, and illness, we wrote (p. 215) “Although we recorded temporal changes in TNF- α concentrations in blood, these changes were unrelated to dietary treatment. . . There were no differences in proportion of calves refusing CMR or in the number of refusals recorded. Additionally, there were no effects of feeding regimen on concentrations of plasma TNF- α , suggesting that feeding method per se had no effect on anorexia or the calf’s ability to use ingested nutrients.”

Number of Feed Refusals

The authors wrote “Quigley et al. (2006) did not report the number of calves that were fed with the esopha-

geal feeder, but the likelihood of force-feeding was greater for the calves receiving the higher quantities of milk, due to both increased intakes and the longer milk-feeding period (41 vs. 28 d).” We reported that there were no differences in proportion of calves refusing CMR or in amount of CMR refused (p. 215). Further evaluation of our data (determined after publication) showed that calves voluntarily consumed 99.6, 99.4, and 99.4% of the CMR for calves fed fixed amount of CMR (CON), variable amount of CMR in an accelerated feeding program (VAR), or VAR plus dietary supplement (GAM) treatments, respectively. During the study, 50, 50, and 56% of calves refused ≥ 40 mL of CMR on at least 1 d during the study for CON, VAR, and GAM treatments, respectively. The authors’ contention that force-feeding was greater for calves fed more CMR is not supported by the data presented here or in our article.

Our Decision to Administer Refused CMR

The authors criticized our decision to administer refused CMR by esophageal feeder. It is understood that administration of CMR by esophageal feeder entails significant risk, but we determined that the practice was necessary to minimize variation in nutrient intake among calves during the study. Administration of CMR into the rumen may induce ruminal and metabolic acidosis, particularly if large amounts of milk (3 L/d) are repeatedly administered into the rumen (>2 d) by esophageal feeder (Gentile et al., 2004). It should be noted that, in our study, calves were tubed with less CMR than that reported by Gentile et al. (2004). In addition, in most cases ($>53\%$ of all instances), calves were administered CMR by esophageal feeder for 1 d only; thereafter, they consumed all CMR offered.

The authors also wrote “Clearly, force-feeding sick animals should not be (and never has been) recommended.” First, we disagree with the implication that all feed refusals occurred when calves were sick. Most incidences of administration of refused CMR were isolated incidents. Furthermore, we believe that adminis-

Received May 4, 2007.

Accepted May 30, 2007.

¹Corresponding author: jquigley@diamondv.com

tration of refused CMR by esophageal feeder is a common practice. For example, McGuirk and Ruegg (2001) stated "Sick calves must be able to stay clean and dry. . . . Offer milk/milk replacer at the usual dilution and temperature but reduce volume (to 1 liter, for example) and feed more frequently (4 times/day, if needed). What liquid feed isn't consumed, administer by an esophageal feeder that has been cleaned, disinfected, and rinsed between calves."

Fecal Scores

The authors criticized our paper for including the use of fecal scoring in calves fed varying amounts of CMR and wrote "Although this system has been widely used to evaluate diarrhea in limit-fed calves, the authors provide no evidence that this measure was repeatable or a valid indicator of any underlying pathology." The authors further suggested that ". . . this increased intake of liquids likely decreased fecal consistency in a way that was not related to pathology." If this were the case, others should have reported increases in fecal scores associated with increased CMR feeding. However, Bartlett et al. (2006) and Cowles et al. (2006) reported no difference in fecal scores between groups of calves fed conventionally or in an accelerated feeding program. Khan et al. (2007) reported that calves fed at 20% of BW to d 25 had lower fecal scores during w 3 and 4 compared with calves fed at 10% of BW to 45 d. Jasper and Weary (2002) reported no difference in "diarrhea" [defined as a score of 3 or 4 using the fecal scoring system of Larson et al. (1977)] when calves were fed milk at 10% of BW or offered milk for ad libitum consumption. Conversely, Diaz et al. (2001) and Nonnecke et al. (2003) reported that calves fed accelerated feeding programs had higher fecal scores compared with calves fed conventionally. The data suggest that there is not necessarily an increase in fecal scores associated with accelerated CMR feeding programs, as was implied by the authors.

Fecal scoring is a widely used and reported tool for determination of incidence of diarrhea in young milk-fed calves and has been used by many researchers, including authors of this letter (Tikofsky et al., 2001; Jasper and Weary, 2002; von Keyserlingk et al., 2006). Several of these published studies used fecal scoring with calves fed in accelerated or ad libitum liquid feeding programs.

Abrupt Change in Amount of CMR Offered

The authors criticized our manuscript for including abrupt changes in the amount of CMR offered. Our feeding rates, including abrupt changes, were selected

to exactly mimic those being recommended in the industry at the time the research was conducted. At that time (as now), commercial milk replacer companies in the United States recommend increasing the amount of CMR in accelerated programs by 40 to 50% from wk 1 to wk 2, as we did in our study. We do not consider our selection of feeding rates to constitute a methodological problem.

Measurement of Body Temperature

The authors wrote "Furthermore, body temperatures were only measured in calves that showed high fecal scores rather than being done systematically for all calves. Thus, the method of detecting fever was likely biased towards calves fed higher amounts of milk replacer." Although we reported (p. 208) that rectal temperatures were recorded on all calves with fecal score >2, we recorded rectal temperatures when calves showed clinical signs of disease, including anorexia and dehydration, according to normal good management practice. This was reported on p. 210.

Contaminated Bedding

The authors wrote that our use of contaminated bedding was uncontrolled and potentially lacked equal distribution among treatment groups. Use of contaminated bedding to introduce an immunological challenge is not without precedent. Others (Coffey and Cromwell, 1995; Williams et al., 1997; Bassaganya-Riera et al., 2001) have used contaminated bedding to compare "clean" and "dirty" housing environments and found significant differences in growth and responses to immunological support in young pigs. Wray and Sojka (1981) used contaminated bedding as a means of infection of calves with *Salmonella dublin*. Although we accept the criticism of the authors that the coronavirus exposure was not controlled, we believe that it represented a situation that could normally be found on commercial calf facilities in the United States and, therefore, contributed to the overall goals of the research.

Summary

The evaluation of our work is appreciated. However, we conclude that many of their criticisms overlooked information available in the published article or from other sources. Their alternative hypothesis does not provide a more accurate interpretation of the data. We continue to believe that the paper is an important contribution to the understanding of feeding calves a higher plane of nutrition and we stand by the methods and interpretations of the data.

REFERENCES

- Bartlett, K. S., F. K. McKeith, M. J. VandeHaar, G. E. Dahl, and J. K. Drackley. 2006. Growth and body composition of dairy calves fed milk replacers containing different amounts of protein at two feeding rates. *J. Anim. Sci.* 84:1454–1467.
- Bassaganya-Riera, J., R. Hontecillas-Magarzo, K. Bregendahl, M. J. Wannemuehler, and D. R. Zimmerman. 2001. Effects of dietary conjugated linoleic acid in nursery pigs of dirty and clean environments on growth, empty body composition, and immune competence. *J. Anim. Sci.* 79:714–721.
- Borderas, F., M. A. G. von Keyserlingk, D. M. Weary, J. Rushen, A. M. de Passillé, and M. E. Van Amburgh. 2007. The effects of force-feeding sick dairy calves: A comment on Quigley et al. (2006). *J. Dairy Sci.* 90:3567–3568.
- Coffey, R. D., and G. L. Cromwell. 1995. The impact of environment and antimicrobial agents on the growth response of early-weaned pigs to spray-dried porcine plasma. *J. Anim. Sci.* 73:2532–2539.
- Cowles, K. E., R. A. White, N. L. Whitehouse, and P. S. Erickson. 2006. Growth characteristics of calves fed an intensified milk replacer regimen with additional lactoferrin. *J. Dairy Sci.* 89:4835–4845.
- Diaz, M. C., M. E. Van Amburgh, J. M. Smith, J. M. Kelsey, and E. L. Hutten. 2001. Composition of growth of Holstein calves fed milk replacer from birth to 105-kilogram body weight. *J. Dairy Sci.* 84:830–842.
- Gentile, A., S. Sconza, I. Lorenz, G. Otranto, G. Rademacher, P. Famigli-Bergamini, and W. Klee. 2004. D-Lactic acidosis in calves as a consequence of experimentally induced ruminal acidosis. *J. Vet. Med. A.* 51:64–70.
- Jasper, J., and D. M. Weary. 2002. Effects of ad libitum milk intake on dairy calves. *J. Dairy Sci.* 85:3054–3058.
- Khan, M. A., H. J. Lee, W. S. Lee, H. S. Kim, S. B. Kim, K. S. Ki, J. K. Ha, H. G. Lee, and Y. J. Choi. 2007. Pre- and postweaning performance of Holstein female calves fed milk through step-down and conventional methods. *J. Dairy Sci.* 90:876–885.
- Larson, L. L., E. G. Owen, J. L. Albright, R. D. Appleman, R. C. Lamb, and L. D. Muller. 1977. Guidelines towards more uniformity in measuring and reporting calf experimental data. *J. Dairy Sci.* 60:989–991.
- McGuirk, S. M., and P. Ruegg. 2001. Calf Diseases and Prevention. http://www.uwex.edu/MilkQuality/PDF/calf_diseases_prevention.pdf Accessed May 1, 2007. Extension Report, University of Wisconsin-Madison.
- Nonnecke, B. J., M. R. Foote, J. M. Smith, B. A. Pesch, and M. E. Van Amburgh. 2003. Composition and functional capacity of blood mononuclear leukocyte populations from neonatal calves on standard and intensified milk replacer diets. *J. Dairy Sci.* 86:3592–3604.
- Quigley, J. D., T. A. Wolfe, and T. H. Elsasser. 2006. Effects of additional milk replacer feeding on calf health, growth, and selected blood metabolites in calves. *J. Dairy Sci.* 89:207–216.
- Tikofsky, J. N., M. E. Van Amburgh, and D. A. Ross. 2001. Effect of varying carbohydrate and fat content of milk replacer on body composition of Holstein bull calves. *J. Anim. Sci.* 79:2260–2267.
- von Keyserlingk, M. A. G., F. Wolf, M. Hötzel, and D. M. Weary. 2006. Effects of continuous versus periodic milk availability on behavior and performance of dairy calves. 2006. *J. Dairy Sci.* 89:2126–2131.
- Williams, N. H., T. S. Stahly, and D. R. Zimmerman. 1997. Effect of chronic immune system activation on the rate, efficiency, and composition of growth and lysine needs of pigs fed from 6 to 27 kg. *J. Anim. Sci.* 75:2463–2471.
- Wray, C., and W. J. Sojka. 1981. *Salmonella dublin* infection of calves: Use of small doses to simulate natural infection on the farm. *J. Hyg. (Lond.)* 87:501–509.