Calf Note 201 – Serum total protein and IgG

Introduction

A practical method to monitor passive immunity in newborn calves is to use the refractometer to measure a sample of serum for total protein. Early in life serum total protein (STP) is highly correlated with serum IgG, and STP is easy to measure with a refractometer. For more information on how refractometers work and the relationship between STP and serum IgG, see Calf Notes 39, 62, 183, 186, and 187.

In Calf Note #62, I suggested that the age at which calves were sampled may affect the relationship between STP and IgG. Remember, when we use the refractometer, we are NOT measuring IgG directly, but instead measuring STP, which is correlated with IgG. I further suggested that the correlations between STP and IgG was adequate to approximately 5 days of age; thereafter the changing nature of STP probably made the relationship between STP and IgG less reliable.

(Not to confuse the issue at hand, but measuring STP with a total protein refractometer is probably unnecessary, as a BRIX refractometer has been shown to be highly correlated to serum IgG without the need to evaluate STP. For more information on using a BRIX refractometer to estimate serum IgG, see Calf Note #187.)

The Research

In the July 2018 issue of the Journal of Dairy Science, Wilm and coworkers (Wilm et al., 2018) evaluated the relationship between STP and serum IgG in calves to 10 days of age.

Newborn male (n = 6) and female (n = 6) Holstein calves with an average BW of 42.7 kg (94 lbs.) were used. Calves were fed 4 L of colostrum containing >50 g of IgG/L by 4 h of age. Any colostrum not voluntarily consumed was administered by esophageal tube. Thereafter, calves were fed pasteurized whole milk (4 L/feeding) twice per day to the end of the study at 10 days. Blood samples were taken by jugular venipuncture and serum IgG was measured by radial immunodiffusion and STP using a total protein refractometer. The authors reported a number of interesting observations, but for the sake of this Calf Note, we'll focus on the change in STP and serum IgG.

Figure 1 is adapted from two figures in the original manuscript of Wilm et al. (2018). We can see that, on d 1, serum IgG concentrations had increased from 0 g/L to their greatest concentration, then declined with advancing age. Serum IgG concentrations at 10 d of age were approximately 17 g/L. On the other hand, STP concentrations increased to approximately 5.8 g/dl and then remained constant.

So, what's happening? We know that immunoglobulins in the bloodstream at not static – they move throughout the body – and even are re-secreted back into the intestine to protect the animal against ingested bacteria and viruses. Many researchers have shown that the concentration of serum IgG from ingested colostrum declines over time. This loss of serum IgG is measured and the term "half-life" is used to define the rate of decay in IgG concentration. Half-life is the time needed for the initial concentration to fall by 50%. Depending on the study, the half-life of colostral IgG is thought to be approximately 3 weeks (Murphy et al., 2014; Quigley et al., 2017). In the study by Wilm et al. (2018), serum IgG concentrations declined by 0.7 g/L every day after 24 h

of age, whereas the STP concentration did not change from 1 to 10 d of age. The authors also reported that the correlation between STP and IgG was highest on d 1 but began to decline over time. Compared with 24 h, STP concentrations were highly correlated on d 2 and 3 ($r \geq 0.98$), still correlated, but more variable from d 4 to 9 ($r \geq 0.88$), and lowest at d 10 ($r = 0.76$). The authors concluded *"These results indicate that calves may be reliably tested for passive transfer of immunity using IgG or STP concentrations up to 9 d of age."*

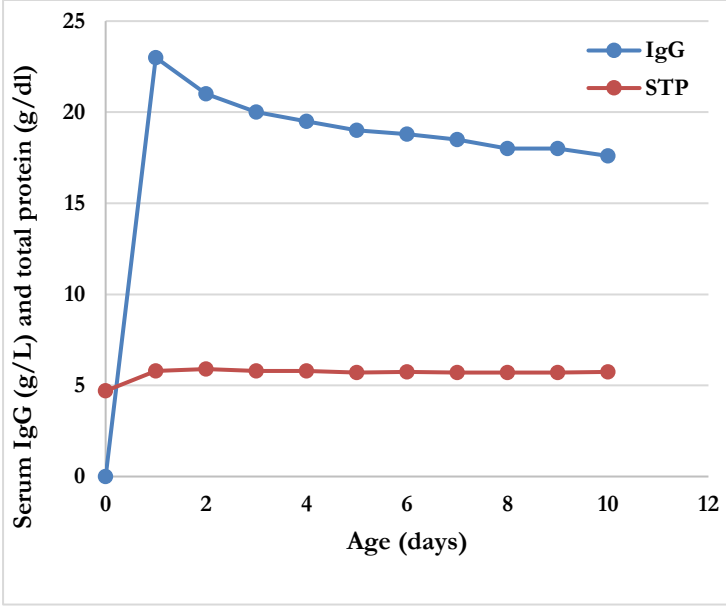

Figure 1. Serum IgG and total protein concentrations in calves from 0 to 10 d of age. Adapted from Wilm et al., 2018.

Summary

This very practical research gives some guidelines regarding the use of refractometry for estimating serum IgG concentrations in newborn calves. These data suggest that, within 9 days, the relationship between serum IgG and STP is adequate and can be used to predict the extent of passive immunity in newborn calves.

References

Murphy, J. M., J. V. Hagey, and M. Chigerwe. 2014. Comparison of serum immunoglobulin G half-life in dairy calves fed colostrum, colostrum replacer or administered with intravenous bovine plasma. Vet. Immunol. Immunopathol. 158:233–237.

Quigley, J. D., T. M. Hill, L. L. Deikun, and R. L. Schlotterbeck. 2017. Effects of amount of colostrum replacer, amount of milk replacer, and housing cleanliness on health, growth, and intake of Holstein calves to 8 weeks of age. J. Dairy Sci. 100:9177–9185.

Wilm, J., J.H.C. Costa, H. W. Neave, D. M. Weary, and M.A.G. von Keyserlingk. 2018. Technical note: Serum total protein and immunoglobulin G concentrations in neonatal dairy calves over the first 10 days of age. J. Dairy Sci. 101:6430–6436.

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