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# Effects of Calf Age and Dam Age on Circulating BVDV II Antibody Levels Prior to Vaccination in Angus Weanling Calves

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**Abstract**
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**RFR-A10123**

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## Introduction

Newborn calves passively acquire antibodies from their dams via consumption of colostrum immediately after birth. Colostrum quality and quantity may differ by dam age affecting the amount of circulating maternally derived antibodies. The objective of this study was to evaluate if there are differences in calf titers of maternal antibodies based on age of dam and age of calf. This knowledge is important for determining vaccination strategies because passively acquired antibodies for bovine viral diarrhea virus I and II (BVDV) have been shown to block the ability of calves to develop their own specific immune response to BVDV.

## Materials and Methods

*Cattle resource.* This project utilized 1,012 purebred American Angus cattle from the Iowa State University breeding project at the ISU McNay Research and Demonstration Farm. Calves were born from 2007–2009 in both spring and fall seasons. There were 137 and 197 calves in 2007 fall and spring seasons, 139 and 215 calves in 2008 fall and spring seasons, and 104 and 220 calves in 2009 fall and spring seasons, respectively. Ten mL jugular blood samples were collected at two time points: a) pre-vaccination (three weeks prior to initial vaccination) and b) at initial 5-way virus vaccination (Figure 1) using vacuum blood collection tubes, stored at 4°C overnight, and centrifuged for serum collection. Serum was separated from the red blood cells and stored at -20°C until analysis. Antibody levels of BVDV II were analyzed using a viral neutralization (VN) assay. Virus neutralizations were performed in replicates of 5, and serum was diluted 1:2 with a beginning dilution of 1:4. The base 2 log of the highest dilution of calf serum able to neutralize the virus was reported as the titer score.

*Statistical analysis.* Using SAS version 9.2, mean ages and titer scores for pre-vaccination and initial titers (Table 1), correlations between titer levels and age, and prediction of pre-vaccination and initial titer levels were evaluated using Proc GLM. The GLM models used:

$$Pre-vaccinationTiter_{ijklm} = \mu + g_k + d_l + b_m + a_m + y_i * s_j + e_{ijklm}$$

$$InitialTiter_{ijklm} = \mu + g_k + d_l + b_m + a_m + y_i * s_j + e_{ijklm}$$

Where y*s=year by season, s=season, g=gender, and d=dam age (years) were fit as class effects. Covariates of b=birth weight (lbs) and a=age (days) were also fit. The error term ($e_{ijklm}$) is assumed to be normally distributed with mean=0 and variance=$\sigma_e^2$. These models identify factors potentially associated with passive antibody acquisition (gender, dam age, birth weight, year * season) and passive antibody decline (calf age) within the same model.

## Results and Discussion

Pre-vaccination and initial titers were evaluated as two (highly related) measures of passively acquired antibody levels. It is expected that acquired passive immunity will erode over time. Therefore, later in life it is assumed that initial titer is then a reflection of maternally transferred antibodies that remain in calves when a vaccination protocol would be implemented. Thus, after accounting for animal age, animals with higher titer scores are assumed to have obtained more passive antibodies immediately after birth. Correlations presented were significantly different from zero at $P<0.05$. Age of dam was positively correlated with both pre-vaccination and initial titer levels at 0.60 and 0.53, respectively. Calf age was negatively correlated with pre-vaccination titer and initial titer at -0.63 and -0.62, respectively. However, weight at titer collection correlations were -0.23 and -0.36 with pre-vaccination titer and initial titer, respectively, which indicates that calf age is a better indicator than calf weight for maternal antibodies that remain in the circulatory system and for when maternal antibodies might have reached a level low enough to prevent blocking of specific antibody response.

Based on the statistical model, pre-vaccination titer is significantly influenced ($P<0.05$) by calf age, birth weight, dam age, and year*season class. There is a significant difference of maternally transferred antibodies in two to five year old dams, however, a significant difference in maternal transfer in five-year-old and older dams is not observed. Furthermore, as calves get older, maternal titer decreases by 0.025 units per day of age. Initial titer was significantly ($P<0.05$) influenced by year by season, calf age, and age of dam. Consistent with maternal titer, there is a significant difference between dam ages for initial titer levels. This trend of younger dams transferring fewer antibodies is seen in dams until five years old for both pre-vaccination and initial titers (Figure 2). Age of calf was also significant, with older calves having less circulating maternal antibodies than younger calves. To evaluate the age effects, calf ages were blocked into 21-day periods, with a total of 7 such 21-day groups. LSMeans estimates of titers for pre-vaccination and initial titer levels from the analyses were graphed, as calf age significantly affects the pre-vaccination and initial titer (Figure 3).

In conclusion, calves from younger dams received fewer maternal antibodies. Calf age appears to be closely related to the degradation of maternal antibodies, with older animals having fewer maternal antibodies remaining. With these two concepts in mind, it should be recognized that calves from younger dams would be susceptible to a BVDV type II infection at an earlier age because maternal antibodies have disappeared, and vaccination at an earlier age would be recommended for protection.

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**Table 1.** Mean values for the titer levels, calf age, and weight for the pre-vaccination and initial serum collections, which were collected 21 days apart. Mean values and standard deviations (SD) for the spring versus fall season.

| | N | Titer score | SD | Age | SD | Weight | SD |
|---|---|---|---|---|---|---|---|
| Pre-vaccination | 615 | 4.36 | ±2.24 | 99.06 | ±26.57 | 276.25 | ±67.47 |
| Initial | 1,012 | 3.05 | ±2.25 | 133.17 | ±30.44 | 326.52 | ±84.55 |
| Spring-born | | | | | | | |
| Pre-vaccination | 303 | 2.86 | ±1.57 | 114.81 | ±21.69 | 292.23 | ±72.62 |
| Initial | 632 | 2.03 | ±1.83 | 148.82 | ±24.55 | 359.39 | ±80.89 |
| Fall-born | | | | | | | |
| Pre-vaccination | 312 | 5.82 | ±1.78 | 83.66 | ±21.38 | 260.63 | ±58.02 |
| Initial | 380 | 4.74 | ±1.82 | 107.15 | ±19.54 | 271.85 | ±58.12 |

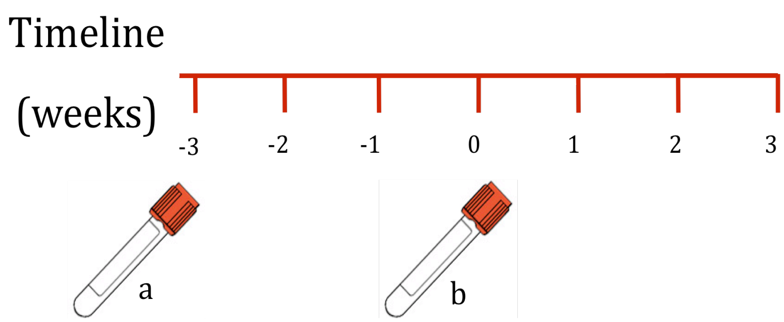


**Figure 1.** The collection tubes identify the two serum collection time points. a) pre-vaccination antibody level (n=615) and b) initial antibody level at the initiation of 5-way viral vaccination protocol (n=1,012).

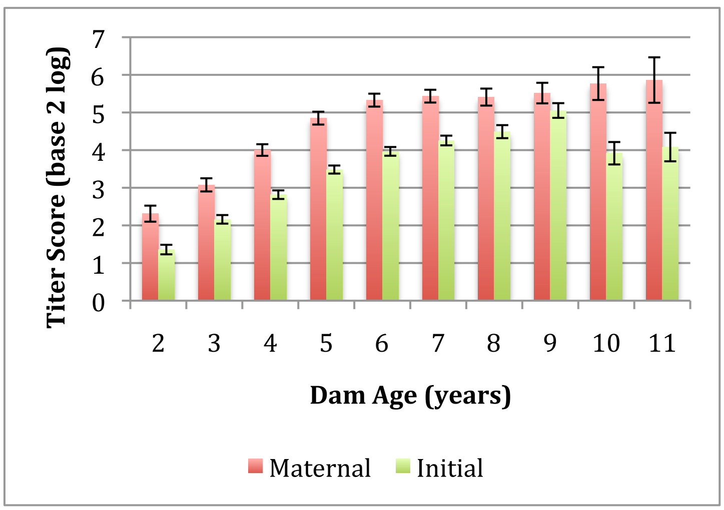


**Figure 2**. LSMean titer scores for dam age for pre-vaccination and initial antibody levels.

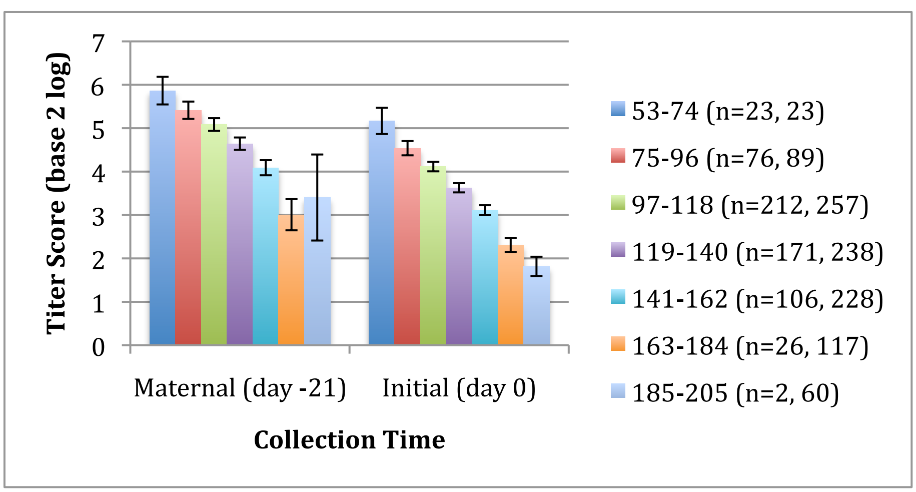


**Figure 3.** LSMeans for calves grouped by 21-day intervals of age for pre-vaccination and initial antibody titer comparison, with the number of samples listed for pre-vaccination titer and initial titer. The two titer time points were taken with a 21-day interval between collection, and the older calves show less circulating maternal antibodies at the beginning of the vaccination protocol (initial).