Half-life of porcine antibodies absorbed from a colostrum supplement containing porcine immunoglobulins

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ABSTRACT: Absorption of immunoglobulins (Ig) at birth from colostrum is essential for piglet survival. The objective was to evaluate the half-life of antibodies absorbed in the bloodstream of newborn piglets orally fed a colostrum supplement (CS) containing energy (fat and carbohydrates) and IgG from porcine plasma. Viable piglets (n = 23; 900 to 1,800 g BW) from 6 sows were colostrum deprived and blood sampled and within the next 2 h of life randomly allocated to either control group (n = 9) providing 30 mL of Ig-free milk replacer or a group (n = 14) receiving 30 mL of CS by oral gavage. Piglets were transported to a Biosafety Level 3 facility (Centre de Recerca en Sanitat Animal, Spain) and fed Ig-free milk replacer every 3 to 4 h for 15 d. Survival, weight, plasma IgG content by radial immunodiffusion (RID), and antibodies against porcine circovirus type 2 (PCV2), porcine parvovirus (PPV), porcine reproductive and respiratory syndrome (PRRS), Mycoplasma hyopneumoniae (Mhy), and swine influenza virus (SIV) were determined by specific ELISA before treatment administration, at 24 h, and weekly for 56 d. Clinical symptoms were not observed for either group. Mortality index was lower (17 vs. 38%; P < 0.02) and BW higher (17.7 vs. 15.3 kg; P = 0.035) for pigs supplemented with CS than piglets in the control group. At 24 h postadministration, the CS group had a plasma IgG mean of 7.6 ± 0.06 vs. 0.14 ± 0.03 mg/mL for the control group. The IgG levels in the CS group decayed until day 21 when de novo synthesis of IgG was detected in 25% of piglets. Half-life of antibody concentration (HLAC) by RID was 6.2 d. In the CS group, efficiency of PCV2 and PPV antibody transfer was high. For PCV2, all animals remained positive by day 56 and the calculated HLAC was 17.7 d. For PPV, 72.7% of piglets were ELISA positive by day 35 and HLAC was 12.0 d. For PRRS, all piglets remained positive by day 14 and the calculated HLAC was 11.9 d. For Mhy and SIV the calculated HLAC were 8.4 and 3.0 d. In summary, half-life of antibodies derived from blood plasma in the bloodstream of newborn piglets varied from 3.0 to 17.7 d. The study also confirm that antibodies derived from porcine plasma were well absorbed and can be an useful tool for providing protection against several or specific pathogens and can be a good alternative to formulate CS for newborn piglets.

Key words: antibodies, half-life, immunoglobulin G, neonatal piglets, porcine plasma

INTRODUCTION

Adequate absorption of immunoglobulins (Ig) at birth from colostrum is basic for piglet survival because the piglet is born with low reserves of Ig and energy. Absorption of Ig from colostrum decreases rapidly after birth; therefore, an adequate supply of Ig is crucial for newborn piglets. In low birth weight piglets or weak piglets with low viability, the ingestion of good quality colostrum may be limited and thereby increase the risk of mortality or future immune incompetence. The absorption of IgG can be as good from colostrum supplement (CS) containing energy and Ig derived from porcine plasma as from sow colostrum (Bikker et al., 2010; Campbell et al., 2012); however, survival of circulatory antibodies absorbed from porcine plasma fed in a CS to newborn piglets is unknown. Therefore, the objective of this study was to evaluate the half-life of antibodies absorbed in the bloodstream of newborn piglets orally fed a CS containing energy (fat and carbohydrates) and IgG from porcine plasma.
MATERIALS AND METHODS

The experimental protocol met the standards for animal experiments and was approved by the Committee for Animal Experiments of Universitat Autònoma de Barcelona.

Animals and Treatments

Viable piglets (n = 23; 900 to 1,800 g BW; Landrace × Large White × Duroc) from 6 pharmacologically induced and individually attended sows were colostrum deprived at delivery, dried, and allocated to sterilized boxes. Boxes were transported outside the farm where piglets were ear tagged, blood sampled, and randomly allocated to 2 experimental groups. Within the first 2 h of life, piglets were randomly allocated to either a control group (n = 9) that were provided 30 mL of Ig-free milk replacer (Nutriben Natal 900G; Alter Pharma Nutriben, Madrid, Spain) or a group (n = 14) that received 30 mL of CS by oral gavage using a gastric catheter (Kendall catheter 10French from Tyco Healthcare UK Ltd., Hampshire, UK). The CS was reconstituted to 42% wt/wt (84 g powder plus 116 g distilled water preheated to 39°C) by vigorous shaking. Within a time span of 5 to 6 h after farrowing, piglets were transported in warm and dry conditions to a Biosafety Level 3 facility at Centre de Recerca en Sanitat Animal (Spain) and housed on a floor heated plate and fed Ig-free liquid milk replacer every 3 to 4 h for 15 d.

The control treatment was used to establish a group that did not receive any IgG source to determine when these animals were able to produce their own immunity. Additionally, these piglets served as sentinel in case of any infection in the experimental box.

Measurements and Analyses

Survival, individual piglet weight, and blood were obtained at birth, 24 h later, and weekly during 8 wk. Blood samples were taken from the jugular vein, allowed to clot for 2 h at room temperature, and refrigerated at 4°C overnight. Serum was separated by centrifugation at 600 × g for 15 min, aliquoted to 5 samples, and stored at −80°C until analysis.

The IgG content was analyzed using the radial immunodiffusion (RID) technique with modifications proposed by Mancini (Bikker et al., 2010). The samples of serum and CS diluted at 10% were also analyzed to determine antibodies against porcine circovirus type 2 (PCV2) by immunoperoxidase monolayer assay (IPMA) technique (Rodríguez-Arrioja et al., 2000), porcine parvovirus (PPV) by ELISA Kit INGEZIM 11.PPV.K1 (Ingenasa, Madrid, Spain), porcine reproductive and respiratory syndrome (PRRS) by ELISA Kit IDEXX Herd-Chek PRRS X3 (IDEXX Laboratorios, Barcelona, Spain), Mycoplasma hyopneumoniae (Mhy) by ELISA Kit IDEXX Herd-Chek Mhyo (IDEXX Laboratorios, Barcelona, Spain), and swine influenza virus (SIV) by ELISA Kit INGEZIM 1.1.FLU.K1 (Ingenasa, Madrid, Spain).

Statistical Analysis

Animal weights and Ig levels were analyzed by repeated measures ANOVA using the Tukey-Kramer for multiple comparisons or alternatively the GLM procedure (NCSS and PASS; Statistical Systems, Kaysville, UT). For treatment of parametric data, the individual animal was considered the experimental unit. Statistical differences were considered significant when \( P < 0.05 \).

Nonparametric data on mortality proportions were analyzed by chi-square test and Yates correction. Half-life of absorbed Ig were calculated from the log (IPMA titers) or natural log regression of mean plasma Ig concentration by RID or ELISA optical density vs. time.

RESULTS AND DISCUSSION

Clinical symptoms were not observed for either group. Mortality index was lower for the first month (0 vs. 38%; \( P < 0.001 \)) and overall period (17 vs. 38%; \( P < 0.02 \)). The BW was higher (17.7 vs. 15.3 kg; \( P = 0.035 \)) for pigs supplemented with CS than the control group. At
24 h postadministration, the CS group had a plasma IgG mean of 7.6 vs. 0.14 mg/mL for the control group ($P < 0.05$; Figure 1). The IgG levels in the CS group decayed until day 21 when de novo synthesis of IgG was detected in 25% of piglets; however, de novo synthesized IgG did not reach a similar level to day 1 until day 35. In both groups, maximum IgG levels were achieved between day 49 and day 56. Half-life of antibody concentration (HLAC) by RID was calculated to be 6.24 d.

In the CS group, efficiency of PCV2, PPV, and PRRS antibody transfer was high. For PCV2 antibody, all animals remained positive until day 56 and HLAC was 17.7 d (Figure 2). For PPV, 72.7% of piglets were ELISA positive by day 35 and HLAC was 12.0 d. For PRRS, 100% of piglets were positive by day 14 and HLAC was 11.9 d. Transfer of antibodies for Mhy and SIV in reference to antibody levels in CS was low. Calculated HLAC for Mhy and SIV antibodies were 8.4 and 3.0 d and by day 14 the percentage of animals with these antibodies was 33 and 0%, respectively. The uptake and half-life of porcine supplemented antibodies varied by antibody with greater absorption and duration for PCV2, PPV, and PRRS than SIV or Mhy.

The IgG concentrations in piglets at 24 h of age ranged from 18.7 to 39.0 mg/mL and then decreased gradually to 6.3 mg/mL at days 36 to 40 (Bourne, 1973). However, these pigs had access to continued ingestion of colostrum during first 24 h with an estimated intake of 200 to 300 mL (Le Dividich et al., 2005); therefore, their value in blood is higher than in our study in which we only provided 30 mL of IgG during the first 2 h of age. Bikker et al. (2010) provided a CS or sow colostrum similarly as used in the present study and reported similar IgG values. According to Curtis and Bourne (1971), the half-life of colostral IgG was 14 d, which was higher than the present study, although we obtained similar half-life for certain antibodies such as PCV2, PPV, or PRRS as reported for colostral antibodies.

In conclusion, half-life of antibodies derived from blood plasma in the bloodstream of newborn piglets varied from 3.0 to 17.7 d depending on the specific antibodies analyzed. Furthermore, antibodies derived from porcine plasma are well absorbed and can be useful to provide protection against several or specific pathogens and can be a good alternative to formulate CS for newborn piglets.

**LITERATURE CITED**


