

Why Equine Colostrum Should be Analyzed and Relevance to Foal Serum IgG Levels-Mini Review

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Abstract

Examination of maternally derived colostrum antibodies via a brix reader in the early postpartum period and prior to the foal nursing is essential. Foals are born immunologically naïve and receive their protection via ingestion of maternal colostrum. Some studies have shown that colostrum antibody concentration is correlated to foal immunoglobulin levels, whereby neonatal ingestion of good quality colostrum in adequate quantities is essential to confer adequate protection to the foal. Testing of foal serum immunoglobulin levels is another critical step attending veterinarians must do in the early postpartum period. Foals that have low immunoglobulin levels tested at 12 hours of life, can be supplemented with banked colostrum administered via nasogastric while the newborn's intestinal mucosa is able to absorb these large immunoglobulin molecules. This gut adaptation closes around 24 hours of life, after which if the foal is tested and found to have low serum immunoglobulin levels, only parenteral administration of plasma can be performed.

Keywords: Colostrum; Immunoglobulin; Foal; Passive transfer; Colostrometer

Abbreviations: IgG: immunoglobulin G; FPT: Failure of Passive Transfer; NI: Neonatal Isoerytholysis

Introduction

There is an intrinsic link between the first milk, known as colostrum, produced by the mare and the resulting protective antibody levels of her newborn foal. Foals are born agammaglobulinemic and obtain their protective immunoglobulins via passive absorption after ingestion of antibody-laden colostrum [1]. The single most important factor affecting newborns born immunologically naïve in the first four weeks of life, is the ingestion of adequate quantities of maternally derived colostrum immunoglobulins [2]. Colostrum is a yellow, viscous secretion produced due to hormonal changes in the last two to four weeks of gestation. Maternal immunoglobulins are sequestered and concentrated in the colostrum from her own serum antibodies [3].

Colostrum is a rich complex, containing minerals, fats, carbohydrates and most importantly protective antibodies (immunoglobulins) [4]. The average colostrum immunoglobulin concentration in the mare is over 3,000mg/dL, with excellent colostrum exhibiting immunoglobulin concentrations of greater than 6,000mg/mL [5]. The production of colostrum declines significantly within the first 24 hours postpartum [6]. The highest quality of colostrum (in terms of immunoglobulin levels) is produced in the first twelve hours postpartum [7]. During gestation, due to the type of placenta in the mare (epitheliochorionic placentation), there is no transfer of antibodies across the placenta to the developing fetus [8]. In the early postpartum period (the first 24 hours), the foal has specialized intestinal cells, which actively and indiscriminately absorb large molecules, such as immunoglobulins, via a process known as pinocytosis [9]. The ability of the intestinal mucosa to absorb these large molecules declines significantly over the first 24 hours of life. Maximum absorption of colostrum

IgG is within the first 8 hours of life [10]. During this period these specialized enterocyte cells of the intestinal mucosa, are replaced by mature cells, unable to absorb these large immunoglobulins [11].

By far the most common immunoglobulin in colostrum is immunoglobulin G (IgG-G) with smaller amounts being IgG-M and IgG-A [12]. The ingestion of these protective immunoglobulin by the foal is known as passive transfer. It is imperative that the newborn foal should obtain these colostral antibodies within the timeframe to allow passive absorption before the "closure of the gut" to these large immunoglobulins. If the foal fails to nurse adequately during this finite time frame, or should the colostrum have inadequate immunoglobulin levels, the foal will result in low levels of serum immunoglobulins predisposing the individual to neonatal disease, which can prove fatal. This condition is considered failure of passive transfer (FPT). Successful passive transfer to the foal can only occur when the foal ingests sufficient quantities of colostrum, as early as possible after parturition. Factors leading to FPT include premature lactation (secretion of colostrum prior to parturition), poor colostral quality, failure of the foal to nurse adequately/or not at all, older mares, and death of the mare in the early postpartum period. There are also a breed disparity in average colostral IgG concentrations, for instance thoroughbreds have one of the lowest colostral IgG levels (mean 2,354 mg/dL) [13] whereas draft horses have one of the highest (mean 10,540mg/dL) [14].

During the first four weeks of life, immune protection of the foal comes from maternally derived IgG [15]. The highest concentration of colostral IgG is in the first liter of colostrum produced [16]. It has been shown that if the foal nurses within 2 hours of birth, IgG in the foal's serum become detectable around 6 hours, and peak between 12 and 18 hours of life [17]. Colostrum IgG levels become negligible around 12 hours postpartum, if the foal has nursed. The importance of maternally derived colostral IgG and foal IgG levels is demonstrated in one study that found foals with FPT (serum IgG <4mg/dL), 50% of foals become ill, resulting in 50% dying, whereas foals that demonstrated serum IgG levels >8mg/dL only 5% become ill [18]. The attending individuals at the foaling should visually observe the foal nursing. Foals often will make suckling noises without actually being latched onto the teat; therefore, it is imperative to visually confirm the foal has latched on (Figure 1).

Testing of colostrum

Examining maternal colostrum in the early postpartum period and prior to foal nursing, can aid in determining the quality of the colostrum. In the horse there is a correlation of IgG concentration in colostrum, the amount of colostrum consumed and the resulting IgG serum levels of foals. Studies have shown that 67% and 45% of foals receiving low or mediocre colostrum, respectively, have FPT. The easiest and most convenient method to analyze colostral IgG concentrations is via a qualitative assessment using a sugar (Brix) refractometer. Low levels of IgG in colostrum will have a lower amount of light scatter and therefore a lower reading. Whereas colostrum with high colostral IgG will cause more light scatter and therefore a higher reading. Measuring the appropriate

concentration of IgG in colostrum via this method will be invaluable in determining whether the attending veterinarian needs to provide adjunct therapy. Low quality colostrum will most likely result in the foal requiring additional colostral support, such as nasogastric tubing with thawed-frozen banked colostrum. The brix refractometer can also be utilized in banking only the highest quality colostrum.



Figure 1: It is important for individuals who attend foalings, to visually confirm foals are latched onto the mare's teat during nursing.

Testing of foal serum IgG

Most foals, ingesting adequate quantities of colostrum with adequate IgG concentration, will obtain serum IgG levels of 800mg/dL or greater. Foal serum levels of IgG between 400 and 800mg/dL is considered partial FPT, whereas levels of 400mg/dL or less is considered true FPT. Foals that have serum IgG of 800mg/dL or greater are considered to have adequate protection and no further intervention is required. Foals that exhibit serum IgG levels of 400mg/dL or less, will require immediate intervention. Timing of serum testing is paramount and will dictate the therapy the attending veterinarian may initiate. It is in the author's opinion that the opportune time to test serum IgG levels in foals around 12 hours of age. This time point allows sufficient time for the foal to nurse. If a low serum IgG level is recorded at this time point, the attending veterinarian can administer banked colostrum via nasogastric tube, placed directly into the foal's stomach. At approximately 12 hours of life, the intestinal mucosa is still able to absorb these large immunoglobulins. It is recommended to repeat serum IgG testing in another 12-24 hours post nasogastric tubing with banked colostrum, to ensure the adequate serum IgG levels have been met. If the foal's serum IgG has been tested after 24 hours after birth, the intestinal mucosa will no longer be able to absorb these large molecules, and the only option open to the attending veterinarian is to administer IgG parenterally. SNAP® Foal IgG test is a rapid ELISA test and can be performed using whole blood or plasma. This is a stall-side test, with ease of use and a quick turnaround. The results are displayed as either less than 400mg/dL, between 400 and 800mg/dL and greater than 800mg/dL.

Laboratory examination of foal serum IgG concentration is usually performed via a ZnSO₄ turbidity test. This is a rapid test and gives an exact value. This can be extremely useful for the attending veterinarian. Strong, vigorous, foals in a clean environment with an IgG level of 700mg/dL may require nothing more than close monitoring and re-testing serum levels at 24 hours (as serum IgG level will in most cases continue to rise in that intervening period). If utilizing a stall-side IgG test such as the SNAP® Foal IgG test, would only indicate a reading between 400 and 800mg/dL and therefore therapy must be initiated as there would be no way via this test to establish where in that range the serum IgG level falls (Figure 2).

BIOte		Submitted By: EXAMPLE	
Equine	EXAMPLE	Lab Reference	SP2201161
Owner	EXAMPLE	Date Sampled	02/03/2022
Veterinary Surgeon	EXAMPLE	Report date	02/03/2022
Clinical Pathology-Biochemistry			
IgG	10.28	g/L	

Figure 2: Example IgG report of an foal's IgG serum level tested via the ZnSO₄ turbidity test. Note that an exact value will be reported which can aid the veterinarian in making clinical decisions. Note the result is given as g/L as opposed to mg/dL. Report courtesy of Biote Veterinary Laboratories, Salisbury, United Kingdom.

Dealing with FPT

Frozen banked equine colostrum is a useful tool at the deposition of attending veterinarians when facing FPT in our neonate population. It is recommended on medium to larger size horse breeding farms to collect and store (bank) colostrum. It has been shown in the majority of mares, that between 250 and 500ml of colostrum can safely be banked without negatively affecting IgG levels to the nursing foal. Mares should be routinely tested for NI antibodies, and mares testing positive, should not be used for colostrum banking. The colostrum collected should be stored at -20 °C, ideally utilized within 12 months, but no more than 18 months, as the colostral quality will continue to slowly deteriorate. Bank frozen colostrum should be slowly thawed in luke-warm water. Never microwave or utilize excessively hot water, as this will denature the colostral immunoglobulins. Foals tested after the gut closure to absorption of the large immunoglobulins (after 24 hours of life), foals with FPT will have to be treated intravenously with fresh plasma, ideally from hyperimmunized individuals. When plasma from non-hyperimmunized individuals is used, IgG can be variable and may require several liters to be administered to get adequate levels of protection to the foal. Frozen hyperimmunized plasma which is commercially available can be utilized in these situations. This is the most commonly available source of plasma for most attending veterinarians. For veterinary practices that deal with a number of foaling mares, it is recommended to have a number of these products on hand during the foaling season. One liter administered intravenously is usually sufficient to raise the foal's serum IgG to acceptable levels.

Discussion and Concluding Remarks

Evaluating colostral antibody levels via a colostrometer (brix reading) is essential in the early postpartum period prior to the foal nursing. This will give an indication to the likely serum IgG levels the foal should obtain. Should the colostral antibody level be low (poor) on the colostrometer would indicate that the foal is likely to need adjunct therapy, such as administration of thawed-frozen banked colostrum or parenteral plasma supplementation. Visual confirmation that the foal is latched onto the teat and nursing is also essential, as most foals will make noises that they are nursing without being latched onto the teat. Examination of the foal's serum IgG level around 12 hours of life is recommended. If the IgG level is low at this stage of life, supplementary colostrum can be given via nasogastric tubing. If the foal's IgG serum level is evaluated after 24 hours, the window for enteral colostral supplementation would have passed, leaving the only option to be parental plasma administration. Examination of foal IgG levels can easily be done via a stall-side test such as SNAP® Foal IgG Test, or via laboratory testing. Laboratory testing via the ZnSO₄ turbidity tests can be obtained within approximately one hour and gives an exact IgG level. This will aid the attending veterinarian in making clinical decisions. If possible, colostrum should be collected and stored at

-20 °C for potential future use.

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