Hank's Greatest Failure

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Introduction

Failure of passive transfer is an occurrence in ruminants that has a prevalence of less than 30% in beef calves. Factors influencing failure of passive transfer include calf rejection by the dam, dystocia, mastitis, and failure of the dam to rise following birth. Ruminants have an epitheliochorial placenta that prevents the maternal blood circulation from connecting with that of the fetus. Therefore, preventing the exchange of blood products in utero.[6,11] For this reason, calves are born agammaglobulinemic.[6,11] In order for calves to receive adequate immunoglobulins, they must ingest an adequate amount of high quality colostrum soon after birth. Colostrum should be ingested within the first 24 hours of life. However, the greatest absorption of immunoglobulins occurs within the first 4 hours and decreases after.[8] The primary immunoglobulin in bovine colostrum is IgG. IgG is transported from the serum of the dam to the mammary gland 3 weeks prior to parturition.[11]

Calves that do not receive an adequate concentration of IgG via colostrum are predisposed to various disease processes. Common sequela to failure of passive transfer includes septicemia, umbilical infections, diarrhea, septic joints, and respiratory infections. Umbilical infections leading to septicemia can be seen in calves with failure of passive transfer or in unhygienic environments. The umbilical structures are important for providing circulation and disposal of waste to and from the fetus during gestation.[1] The umbilicus contains several important remnant structures after birth including the umbilical vein, two umbilical arteries, and the urachus. All associated structures can become infected with umbilical infections. The urachus is responsible for draining the bladder of the fetus while in utero. The umbilical arteries are responsible for removing blood depleted of oxygen from the fetus. [1] These arteries become the lateral ligaments of the bladder following birth.[1] The umbilical vein delivers oxygen rich

blood to the fetus via the liver and becomes the falciform ligament following birth.[1] Infection involving the structures of the umbilicus can lead to liver abscesses and infections of the bladder.[1] While umbilical infections are often seen following failure of passive transfer, FPT is not a requirement for an umbilical infection to occur. Proper calving environment and dipping the navel in solutions such as 2% Chlorohexidine and 7% tincture of Iodine help prevent umbilical infections from occurring. Proper husbandry is paramount for reducing the incidence of preweaning morbidity and mortality in calves, especially diary calves. For the purpose of this case presentation, the topics of failure of passive transfer and umbilical infections will be explored.

History and Presentation

Hank, a 14-day old Brangus bull calf presented to MSU CVM Food Animal Department on March 17th, 2020 for decreased appetite, lethargy, and a 14-day history of diarrhea. Hank was born March 3rd, 2020 when he became an orphan after losing his mother to a uterine prolapse following calving. Hank received 2 quarts of unknown colostrum replacement on March 3rd and again the following morning. He was maintained on milk replacer and electrolytes prior to presentation.

Upon physical examination, Hank was quiet, alert, and responsive. He was underconditioned with a body condition score of 3/9 and weighed 88lbs. His vital parameters were within normal limits with a heart rate of 128 beats per minute, a temperature of 103.5 F, and a respiratory rate of 32 breaths per minute. No wheezes, crackles, murmurs or arrhythmias were noted on cardiothoracic auscultation. His navel was inflamed, enlarged, and painful on palpation. His joints had no evidence of heat or swelling on palpation. Yellow diarrhea was present around his tail and anus. He was determined to be approximately 8% dehydrated due to a

skin tent and sunken eyes bilaterally. He also had mildly injected sclera in both eyes, which was suggestive of septicemia.

Diagnostic Approach

Following Hank's physical examination, blood was drawn for a packed cell volume and total protein. His PCV and total protein values were 39% and 4.2 g/dL, respectively. An ultrasound of Hank's abdominal cavity and umbilicus revealed an umbilical abscess that did not appear to communicate with his abdominal cavity, however an umbilical hernia was suspected. Gas and fluid filled intestines with normal motility were also noted on abdominal ultrasound. A blood glucose measurement was also obtained with a reading of 37 mg/dL. Based on Hank's ultrasound, he was diagnosed with an extra-abdominal umbilical abscess and a suspected umbilical hernia. While Hank's age at presentation made it difficult to definitively diagnose him with failure of passive transfer, his history, clinical presentation, and lab work points to a suspected diagnosis of FPT, likely predisposing him to an umbilical infection.

There are many diagnostic approaches to diagnose failure of passive transfer. However, there are only a few diagnostic tests available to measure serum IgG concentration of a calf directly- radial immunodiffusion, ELISA, and near infrared spectroscopy.[5,11] However, direct tests, in general, are hard to do on the farm and may take up to 24 hours for acquire results. The most common diagnostic test is via refractometer to measure the total protein .[11] Measurements found using the total protein refractometer are closely correlated to measurements found using radial immunodiffusion.[10] While previous studies suggest that 8-10 g/L of serum IgG is adequate for passive transfer of immunity, new research shows that this concentration may not be adequate, especially in dairy calves.[10] A concentration of 24 g/L or greater has proven to significantly decrease preweaning morbidity and mortality in calves.[10] This concentration of IgG

correlates to a total protein of 6.0-6.3 g/dL.[10] Therefore, the theory that a measurement of 5.5 g/dL correlating to adequate passive transfer may be outdated. If proper husbandry is not maintained, calves may succumb to pathogens even though they received adequate colostrum.[10] In the dairy industry, proper management of colostrum is a strong component of calf health.[10]

A Brix refractometer has also been studied for use in assessing adequate passive transfer.[5] Brix refractometers can be used to evaluate colostrum quality and total protein concentration in serum from a calf.[2] The sensitivity and specificity of the brix compared to the total solids refractometer is very similar.[5] Another commonly used measurement to determine if a calf has received colostrum is GGT.[11] One study proved that serum GGT concentrations greatly increased in calves not long after ingestion of colostrum.[11] However, GGT has a shorter half-life than other proteins. This study also proved that calves who received colostrum via colostrum replacer did not have an increase in GGT.[11] Calves that have a concentration less than 50 IU/L of GGT during the first two weeks of life have not had adequate colostrum intake.[11] However, the correlation between GGT and failure of passive transfer has been shown to decrease after just three days. A GGT measurement can vary from cow to cow and is not the most accurate measurement.[11]

Sodium sulfite turbidity testing and zinc sulfate turbidity testing can also be used. However, both can be difficult to interpret.[11] Hemolysis and exposure to carbon dioxide may interfere with results of the zinc sulfate test. [11]

Umbilical infections are diagnosed via umbilical and abdominal palpation and/or ultrasound. The use of ultrasound can aid in determining the location of an infection and the structures involved. It is also a diagnostic tool useful in diagnosing umbilical hernias. An ultrasound should be used prior to any attempts to lance an extra abdominal umbilical abscess.

Omphalitis or infection of the umbilicus may be characterized as a thickened umbilical cord with hyperechoic regions indicating purulent material is present.[9] Infection of the umbilical vessels can be characterized by hyperechoic regions in the vessels and thickening of the junction of the cord and the vessels.[9] The bladder wall may also be thickened and hyperechoic in cases of urachal infections.[9] Anechoic areas representing fluid in the urachus can also be present in urachal infections.[9] In acute infections of the umbilical structures, thickening of the structures and hypoechoic, homogenous regions may be the only evidence of infection.[9]

Pathophysiology

There are multiple factors that influence the transfer of immunoglobulins including timing of ingestion, the amount of colostrum ingested, the concentration of immunoglobulins in the colostrum, the age of the dam, and the metabolic status of the calf.[2,11] In order to ensure adequate colostrum intake, the neonate should digest adequate colostrum within the first 12 hours of life.[11] Neonatal enterocytes have the ability to absorb macromolecules such as immunoglobulins during the first 24-36 hours of life.[11] This process occurs via exocytosis of immunoglobulins across the enterocyte into the lymphatics.[11] From the thoracic duct, immunoglobulins are then non- selectively absorbed into the circulatory system.[11] Glutamyltranferase (GGT) and other macromolecules are also absorbed.[11] In cattle, closure occurs near the 24-hour mark post calving.[11] However, if feeding of the neonate is delayed, closure of absorption may also be delayed.[11] The first 4 hours post calving yields the highest rate of absorption of immunoglobulins with a rapid decline occurring 12 hours post calving.[11] Therefore, calves that ingest colostrum soon after birth have higher serum IgG concentrations that those with delayed feeding. Esophageal feeders and bottles may be used to administer colostrum. The method of feeding does not affect the absorption of IgG.[3] However, feeding

colostrum through a bottle has several pros as opposed to feeding through an esophageal feeder. The suckle reflex stimulates the closure of the esophageal groove allowing milk to bypass the rumen and go straight to the abomasum. Esophageal feeders are more likely to cause esophageal trauma and aspiration pneumonia.

Quality of colostrum is paramount. A Brix refractometer can be used to determine the quality of colostrum. A sample that measures greater than 50 g/L is considered high quality. However, this is the minimum that a calf should intake. Previously it was thought that calves should ingest 3-4 liters of colostrum with a concentration of 50 g/L reaching 200 grams of IgG within the first six hours of life to ensure adequate immunoglobulin absorption. New studies show that feeding 300- 400 grams of IgG correlates with the new higher standard of serum IgG concentration and results in reduced morbidity and mortality.[10] There are several factors that influence the quality of colostrum including the parity of the cow and udder quality.[11] First lactation cows have a smaller volume of immunoglobulins compared to those of second or third lactations.[8] However, the practice of discarding first lactation milk is not practical.[11] Cows with signs of mastitis and other infections also have a decrease in quality of colostrum. One study was conducted to evaluate the quality of colostrum being fed and its effect on calf morbidity.[7] This study found that feeding colostrum with low levels of bacterial contamination lead to lower rates of morbidity and higher serum concentrations of IgG.[7] Pooling of colostrum also affects the quality by decreasing the concentration of immunoglobulins in the milk and should be avoided.[11]

Calves born following a dystocia may be born with metabolic or respiratory acidosis due to trauma experienced.[2] This is caused by decreased oxygen delivery to the fetus during birth resulting in anaerobic glycolysis and the formation of lactate.[2] Several studies have shown that hypoxic calves have decreased IgG absorption.[11] These studies also proved that hypoxic calves

are also less likely to nurse in adequate time for colostrum absorption.[11] The vigor of a calf is a huge necessity for proper colostrum intake and IgG absorption. [7]

Umbilical abscesses may be evident by a swelling of the umbilicus or by draining debris present.[1] Calves may wall off umbilical abscesses without significant damage or infection to surrounding structures.[1] However, if infection reaches the remnant structures more severe clinical signs may be observed.[1] For example, calves with an abscess of the urachus may experience pollakiuria due to the infection not allowing the bladder to completely express leaving an urge to still urinate.[1] Abscessation or infection of the umbilical vein may lead to hepatic abscesses or septicemia.

While Hank's hernia could be described as a simple hernia where no remnant structures were infected at the time of surgery and only omentum was protruding through the hernia, not all repairs may be as simple. The umbilical vein can be ligated and removed during surgery if there is no infection. However, if there is infection of the umbilical vein (omphalophlebitis), marsupialization of the vein to the body wall allowing for drainage and flushing of the vessel may be required. In cases of an infected urachus, the urachus and the attached apex of the bladder must be resected

Treatment and Management

Hank's owner elected to donate him to the calf rearing project following his diagnosis of omphalitis and suspected FPT. Survival of failure of passive transfer and subsequent comorbidities is reliant upon proper treatment and husbandry.

On 3/17/20, An intravenous catheter was aseptically placed in Hank's right jugular vein. He was started on Ringer's solution with 2.5% dextrose at a rate of 233 ml/hr. In addition to the

Ringer's solution with 2.5% dextrose, a 10-milliliters bolus of glucose was administered to correct his hypoglycemia. He received a 20 ml/kg plasma transfusion, as well. Whole blood can be used if plasma is not available.[8] However, the dose should be increased for whole blood.[8] Hank was initially administered Penicillin at 44,000 IU/kg subcutaneously, Excenel at 2 mls/ 100 pounds subcutaneously, and Banamine at 1.1 mg/kg intravenously in an attempt to treat his umbilical abscess medically.

Several attempts to feed Hank were made throughout the day without success. Hank was fed via bottle/ bucket. A subsequent glucose was taken later the night of 3/17 with a reading of 86 mg/ dL (61mg/dL- 102 mg/dL). The following morning another packed cell volume and total protein were obtained reading 34% and 4.4 g/dL, respectively. Hank was maintained on 8 pounds of milk replacer daily, Banamine for 3 days, Excenel for 5 days, and Procaine Penicillin G for 10 days. Physical exams were performed every 4 hours, initially, then moved to twice daily. Intravenous fluids were continued at a constant rate infusion of approximately 200 ml/hr for 2 days with a decrease to maintenance on the third day. His fluids were then decreased to 1-liter bolus every 4 hours due to improvement in his hydration status.

On March 21, 2020, five days following presentation, Hank's IV catheter was pulled. Later that day, he developed watery diarrhea. He was given four pints of hydralyte twice daily for 3 days until his diarrhea resolved. While Hank was hospitalized, multiple areas of hair loss were noted on all four feet. Betadine scrub and distilled water were used once a day for 5 days to treat Dermatophilus congolensis, presumptively. Due to Hank still being administered Penicillin, no other antibiotics were added at this time. Throughout his stay, Hank's umbilicus gradually decreased in size. On March 23rd, an umbilical hernia large enough to fit three fingers (3 cm) was identified. On palpation of the umbilicus, there appeared to be a small amount of

intestines passing through the body wall. Another ultrasound of Hank's umbilicus was performed. Intestinal strangulation through the body wall could not be appreciated on ultrasound. At this time, a complete blood count and chemistry panel were submitted. Hank's total protein was moderately low at 4.4 g/dL (7.0-8.9). His albumin was mildly decreased at 2.3 g/dL (2.4-3.7). The remainder of his bloodwork was within normal limits.

On March 26th, Hank's milk intake was increased to 11 pounds a day. Another pack cell volume and total protein were obtained reading 30% and 5.6 g/ dL, respectively. On March 27th, Hank was determined to be stable enough to undergo surgery to repair his umbilical hernia. He was clipped and prepped for a high-volume caudal epidural using five milliliters of Lidocaine via the hanging drop technique. He was sedated with 0.05 mg/kg of Butorphanol and 0.025 mg/kg of Xylazine intravenously. Hank was positioned in dorsal recumbency. His abdomen was clipped from xiphoid to pubis and prepared with 4% Chlorhexidine and alcohol. A local block around the umbilicus was performed using lidocaine and the surgical field was prepped with 4% Chlorhexidine and alcohol again and sterily draped. Hank received 2.5 mg/kg of Ketamine intravenously and 2.5 mg/kg intramuscularly. A u-shaped skin incision was made around the prepuce allowing for lateral retraction of the penis. An elliptical incision was then made around the umbilicus into the skin. The subcutaneous tissue and fascia were incised, and a stab incision was made into the abdomen on the right of the umbilicus. All umbilical structures were palpated and observed for any signs of infection. The umbilical vein was healthy with no signs of infection and was ligated. The umbilical hernia was located, and the edges were removed. What was left of the walled off umbilical abscess and surrounding tissue was removed. The abdominal wall was closed along with the subcutaneous tissue and skin, in a routine three-layer closure. Hank recovered from surgery uneventfully.

Case Outcome

Hank's umbilical abscess was medically treated to a small enough size that his umbilical hernia could be palpated. Once discovered, he underwent surgery to repair his umbilical hernia. Hank's surgery was uncomplicated. A castration was also performed while he was under heavy sedation. Hank recovered without any complications. Following several days in the hospital for observation, Hank was transported to his new home. In conclusion, adequate absorption of high-quality colostrum paired with proper husbandry and colostrum management (in dairy calves), is necessary for the health of all calves preweaning. In the beef production industry, calves who experience failure of passive transfer have poorer production in the feed lot, weaning weight, and average daily gain.[6,10] They are also more likely to succumb to respiratory pathogens than those who received adequate passive transfer.[6]

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