She's so Fluffy She Almost Died

by

Maryanna M. Hudson

Mississippi State University

College of Veterinary Medicine

Class of 2022

Clinicopathologic Conference

January 14, 2022

Advisor: Jennifer Beam, DVM

Introduction:

Aspiration pneumonia is a common cause of disease in young calves that are weak and fail to thrive. Bottle fed individuals are at higher risk of developing illness due to their predisposition to aspirate their milk-based diets. Proper nutrition in young bovines is paramount in ruminal development, which allows nutrient intake to be utilized to reach energy requirements for maintenance and growth. Emaciated states can occur quickly in compromised young animals and can leave them more prone to developing disease and complicating therapeutic plans. Concurrent disease, such as parasitism, can further complicate treatment protocols and increase recovery time.

History and Presentation:

Nala, an approximately 5-month-old female miniature Scottish Highland calf, was obtained by her owner from a petting zoo at approximately 1 month of age. At this time, Nala was fed from a bottle. Her owners attempted to continue bottle feedings but discontinued feeding milk shortly after bringing her home due to suspected aspiration. At this time, Nala was eating a hay blend but not interested in eating grain. Nala's condition waxed and waned during her time with her new owners. Approximately 1 week before presentation, she began having diarrhea. Her referring veterinarian preformed a fecal flotation and prescribed a 5-day course of Strongid. Two days after finishing this treatment regiment, Nala was unable to rise and still experiencing diarrhea. Due to her decline in health, additional care from Mississippi State CVM was recommended.

Nala presented to MSU-CVM Food Animal Emergency Services on November 18, 2020. Upon presentation, she was depressed but alert. An exact body weight was not obtained due to scale malfunction; however, it was estimated that she weighed approximately 60 pounds. Her body

condition score was determined to be 1/9 based on an adult beef bovine scale. Her body temperature, pulse and respiratory rates were slightly elevated with values of 102.3 ºF, 60 beats per minute and 44 breaths per minute, respectively. No crackles, wheezes, murmurs or arrhythmias were appreciated upon cardiothoracic auscultation. One ruminal contraction per minute was appreciated with moderate strength and her sclera were mildly injected. A slight skin tent was noted, and she was determined to be approximately 5-8% dehydrated. She was sternally recumbent; however, she could stand with assistance and was interested in eating hay provided by her owners and a small amount of calf starter. During her physical exam, she produced a loose green stool that was given a fecal score of 1/5. The remainder of her physical examination was within normal limits.

Diagnostic Approach:

Initial diagnostics performed on emergency presentation were aimed to determine the cause of Nala's weakness and diarrhea. A fecal sample was obtained, revealing 613 Trichostrongyle type and 2 Trichuris ova per gram of feces. A complete blood count was preformed revealing a mild leukocytosis (13.57 X 10^3/uL, reference range: 4.00-12.00 X 10^3/uL) with moderate neutrophilia (6920.7/uL, reference range: 600.0-4000.0/uL) and moderate monocytosis (2442.6/uL, reference range: 0.0-800.0/uL), moderate anemia (4.40 X 10^6/uL, reference range: 5.00-11.00 X 10^6/uL), slightly decreased hemoglobin concentration (6.5 g/dL, reference range: 7.1-12 g/dL), slightly decreased hematocrit (20.1%, reference range: 25.0-45.0%), mildly decreased packed cell volume (21.0%, reference range: 25.0-45.0%), moderately low plasma protein (4.5 g/dL, reference range: 6.0-8.0 g/dL) and critically elevated fibrinogen (1000 mg/dL, reference range: 100-600 mg/dL), indicating a source of underlying disease separate from the intestinal parasites. Nala's blood chemistry revealed a metabolic acidosis with an anion gap of 8 mmol/L (reference

range: 11-27 mmol/L), moderately decreased creatinine (0.40 mg/dL, reference range: 1.00-2.10 mg/dL), severely increased AST (238 U/L, reference range: 64-76 U/L), slightly decreased total protein (5.1 g/dL, reference range 7.0-8.9 g/dL), severely low albumin (1.3 g/dL, reference range 2.4-3.7 g/dL), moderately decreased cholesterol (31 mg/dL, reference range: 78-142 mg/dL) and electrolyte abnormalities of moderately decreased calcium (8.5 mg/dL, reference range: 9.7-12.4 mg/dL), moderately decreased phosphorus 2.6 mg/dL, reference range: 4.0-7.1 mg/dL), and slightly decreased magnesium (1.3 mg/dL, reference range: 2.0-2.8 mg/dL) with a slightly decreased osmolarity (260 mOsm/kg, reference range: 270-300 mOsm/kg). The results of the fecal eggs per gram explained the cause of Nala's chronic diarrhea, but the other blood work derangements, specifically the severely elevated fibrinogen level, electrolyte abnormalities, anemia and low albumin, suggested additional causes of underlying disease.

To rule out a BVD infection, a snap test was performed on plasma, yielding a negative result.

On November 19th, a pen side ultrasound of Nala's lungs was performed to investigate additional causes of disease (other than parasitism). A moderate left-sided pleural effusion with diffuse comet tails and bilateral cranioventral consolidation were appreciated. Thoracic radiographs revealed a patchy alveolar pulmonary pattern with boarder effacement, a lobar sign, and air bronchograms. A diffuse, mild, unstructured pulmonary pattern was also appreciated. The ventral aspect of the cardiac silhouette also showed boarder effacement. The pathology appreciated on ultrasound and radiographs is most likely attributed to infectious etiologies. Given Nala's history, these findings were most consistent with aspiration pneumonia. A bronchoalveolar lavage (BAL) and/or transtracheal wash (TTW) was considered as means to obtain fluid from the pulmonary tissues to determine what microbes were causing disease and as

means to initiate appropriate antimicrobial therapy. These diagnostics were not performed due a to a lack of stability in the patient's condition.

Aspiration pneumonia is typically diagnosed with these imaging modalities. Radiographic examination reveals a characteristic alveolar lung pattern that is highly suggestive of aspiration [9, 10, 16]. A leukocytosis with neutrophilia following aspiration is also a common feature found on bloodwork [9, 4, 19]. Determining the exact pathogen causing infection in aspiration pneumonia cases is based on transtracheal washes or bronchoalveolar lavages where sterile fluids are placed into the airway and then collected for culture and antimicrobial sensitivity [2].

In patients that succumb to these types of infection, postmortem examination reveals frothy aspirated contents that can be found in the trachea and bronchi, along with areas of dark brown discoloration and emphysema within the lungs [9]. Particulates of aspirated material, typically dark brown to black in color, can also be appreciated within the lungs [9].

Pathophysiology:

In bovines, aspiration pneumonia is due to the inhalation of foreign material, commonly in large amounts and most often liquid in form [9]. Causes of aspiration center around drenching of crude oils, medications, passage of a stomach tube for liquid medication administration, or a poor suckle reflex in neonates or bottle-fed individuals [9, 16]. In Nala's case, aspiration likely resulted from bottle feeding, especially since she had bouts of weakness previously. Once inhaled, these particles penetrate to the level of the alveoli and settle into dependent portions of the lungs causing aspiration pneumonia [9, 3]. This type of lung disease is characterized by inflammation and necrosis with severity depending on the type and volume of material aspirated and the way the aspirate settles in the lungs [9, 14].

Most individuals with aspiration pneumonia present with clinical signs of coughing and dyspnea, characterized by head and neck extension and/or oral breathing; however, clinical signs can range from chronic coughing with low-grade infections to acute apnea with rapid asphyxiation in more severe infections [9, 16]. Some animals will exhibit purulent nasal discharge, most commonly bilaterally, and pyrexia [9]. On thoracic auscultation, increased tracheal sounds, harsh lung sounds, along with crackles and wheezes are appreciated most notably over the cranioventral lung field [9]. Thoracic radiographs with an alveolar pattern, most appreciated in the cranioventral lung lobes, is diagnostic for aspiration pneumonia [9]. Isolation of microbes through transtracheal wash or bronchoalveolar lavage allows for a more specific diagnosis of the pathogen causing the pneumonia and investigation of antimicrobial sensitivity studies [2].

Surprisingly, Nala only showed mild signs related to pneumonia. Her slightly increased respiratory rate, elevated body temperature, weight loss and emaciation lead to suspicion of a chronic pneumonia. The severity of this pneumonia was masked until diagnostic imaging revealed the severe pathology in the lungs; including consolidation and pleural effusion.

Nala's switch from exclusive bottle feeding to consuming only hay and forage likely contributed to her overall poor health condition and waxing and waning clinical signs, even prior to presentation. While bovines are ruminant species, young calves must be treated as functional monogastric animals [6]. At birth, all four components of the ruminant digestive system are present; however, the rumen occupies only 25% of stomach volume and does not begin to grow until the animal reaches approximately 2-3 weeks of age [6, 15]. In this growth period, milk bypasses the rumen, reticulum, and omasum and is deposited directly into the abomasum by the esophageal groove when suckling [6]. The rudimentary reticulo-rumen and developing abomasal and intestinal enzymes allow calves to operate as functional monogastrics on milk-based diets [6,

12]. There are four principle mechanisms important in ruminal development: the establishment of a microbial ecosystem, initiating solid food intake, fermentation processes, and absorptive mechanisms [6]. The earlier dry feed is introduced to the developing rumen, the earlier microbial development can occur, leading to increased ruminal metabolic activity [11]. The ingestion of dry feeds, especially grain, provides the microbial end products involved in stimulating ruminal epithelium development [8, 13]. Roughage ingestion helps stimulate the development of the reticulo-rumen in weight, tissue thickness, and papillae development [18]. By approximately 12 weeks of age, the relative mature size of the reticulo-rumen system is reached if proper calf nutrition for development is provided, including milk or milk replacer, dry grains, and roughage [6]. With Nala's abrupt discontinuation of milk-based feedings and the ingestion of only roughage, it is likely that an under-developed rumen contributed to her poor body condition and overall poor health state.

In addition, Nala's internal parasite infection served as a compounding disease that further complicated and hampered her normal physiologic functions. Trichostrongyle infections are common in ruminants and can also be appreciated in horses and swine [1]. Eggs are passed in feces and enter the environment [1]. This is the diagnostic stage, where fecal samples can be used for fecal flotation to isolate and identify the ova of these parasites [1]. The eggs then hatch and mature to the L3 larvae state where they become infective [1]. Ruminants ingest the mature larvae as they graze infected pastures, establishing an infection [1]. Once in the host, the prepatent period for these parasites is approximately 2-4 weeks in duration, while the nematodes migrate to live in the abomasum [1]. Clinical signs of a Trichostrongyle type infection result from parasitic gastroenteritis (PGE) and include weight loss; watery, green diarrhea; a decreased appetite; dehydration; pale mucous membranes; and a roughened haircoat [1].

Treatment and Management:

Common therapies to combat aspiration pneumonia include broad spectrum antibiotic coverage, nebulization, flow by oxygen supplementation, and non-steroidal anti-inflammatory drug administration such as flunixin meglumine [9]. These treatments are continued for at least 7 days, typically 14 days, in cases of uncomplicated aspiration pneumonia [9]. The prognosis for aspiration pneumonia cases is guarded. Prompt, appropriate, and judicious use of appropriate therapies is the most effective way to successfully treat respiratory disease in calves [9, 17, 7].

In young calves, an emaciated body condition can develop in days and is exacerbated by the presence of increased demand, such as diarrhea, fever, healing from surgery, or insufficient nutrient intake [5]. To avoid reaching a state of emaciation, calves with increased catabolic demands due to various calfhood ailments are treated with parenteral nutrition (PN) [5]. The most common conditions requiring PN support are chronic diarrhea and emaciation, both of which were present in Nala's case [5]. In calves with severe illness, it has been shown that PN allows them to maintain their weight and even gain weight in some cases [5]. Based on previous studies, parenteral nutrition has shown to be most effective when combined with enteral nutrition in calves [5]. Luckily for Nala, her appetite remained steady and even increased throughout most of her stay in the hospital. This made it possible to combine both PN and enteral feeding, setting her up for the most favorable outcome and recovery.

Typical PN for cattle combines the administration of a solution containing 50% dextrose and 5% crystalline amino acid solution providing a caloric to nitrogen ratio of 112:1 [5]. A 10% lipid emulsion is often administered along with the dextrose and amino acids to enhance the caloric density but also to decrease the solution's osmolality, reducing the risk of secondary phlebitis [5]. Typically, PN is provided for 3-13 days [5]. In Nala's case, the discontinuation of the PN

relied on her ability to consume enough water, grain, and roughage to meet the energy requirements for maintenance.

Treatment and control of Trichostronglye-type parasites include a system of anthelmintic administration and environmental control. Anthelmintic resistance is common with these particular parasites and administration of anthelmintics drugs should be used sparingly [1]. Methods to develop and maintain refugia and use environmental control methods such as pasture rest and rotation, multi-species grazing, resistant breed selection and reduced stocking rates should be used as a first line of defense [1].

Case Summary:

For emergency stabilization on presentation, Nala was given CMPK gel orally to begin correcting her electrolyte derangements, Safegard (fenbendazole) and Albon (sulfadimethoxine) orally and Dectomax (doramectin) subcutaneously to treat her intestinal parasitism, and Endosorb orally as an anti-diarrhea medication. Broad spectrum antimicrobial coverage with procaine penicillin G (PPG) and Nuflor (florfenicol) was initiated based on the leukocytosis and increased fibrinogen from her CBC.

The diagnosis of aspiration pneumonia was made the following day after a pen-side thoracic ultrasound and thoracic radiographs were performed. Nala's treatment regime following diagnosis consisted of finishing the courses of parasiticides (Safegard and Albon) and continuation of antimicrobial therapies (PPG and Nuflor).

The day after diagnosis, Nala was found laterally recumbent and unresponsive in her pen. She was hypothermic with a body temperature of 97.0 ^{o}F and hypoglycemic with a blood glucose too low to read on the pen-side glucometer. An intravenous (IV) catheter was placed and Hetastarch

was administered for fluid resuscitation. She was given multiple boluses of 50% dextrose solution IV to raise her blood glucose. Bair huggers, heating pads, warm packs, and blankets were used for active warming. A 10% dextrose in LRS solution was administered as a constant rate infusion to regulate her blood glucose with monitoring every 4 hours and adjustments to the concentration of dextrose made accordingly. An iStat NOVA was preformed revealing a hyponatremic (132.3 Mmol/L, reference range: 140-150 Mmol/L), hypokalemic (2.56 Mmol/L, reference range: 3.9-4.9 Mmol/L), hypochloremic (108.5 Mmol/L, reference range: 109-120 Mmol/L) metabolic acidosis with decreased pCO2 (29.2 mmHg, reference range: 35.0-38 mmHg), increased pO2 (187.8 mmHg, reference range: 49.0-67.0 mmHg), negative base excess (-3.6 Mmol/L), and moderately decreased bicarbonate (20.6 Mmol/L), moderately decreased hematocrit (20%, reference range: 35-50%), and slightly decreased ionized calcium (1.22 Mmol/L, reference range: 1.25-1.50 Mmol/L). Additionally, she was known to be severely hypoalbuminemic since presentation. To combat her critically low albumin, Nala received 4 plasma transfusions from fresh frozen donor plasma. Due to her emaciated body condition, lack of nutrient stores, and weakness causing her to be unable to eat, supplemental nutrition was inevitable. Nala was given a constant rate intravenous infusion of amino acid and dextrose solutions. Nursing and catheter care were provided every 4 hours: catheter flushing to check for patency; rotating to prevent sore formation; and assisting to stand, eat, and drink. Nala's respiratory rate and effort were closely monitored around the clock to avoid fluid overload with intravenous supplementations.

The IV dextrose support and amino acid nutrition continued for a total of 9 days. Throughout her stay, Nala was also maintained on PPG (44,000 IU/kg, subcutaneously every 24 hours) and Nuflor (40 mg/kg, subcutaneously every 96 hours). Occasional loose stools were treated with

Probias, orally, and pantoprazole, subcutaneously, was used to help prevent gastric ulcer formation. Repeat bloodwork, fecal eggs per gram, and thoracic radiographs were used to monitor her progress and ensure she was responding to therapy. A BAL or TTW was not performed during her stay because the antimicrobial therapies that were previously initiated resulted in a positive response to treatment, and the results of this diagnostic likely would not change the treatment plan.

During Nala's time in the hospital, she also received Ultra Boss (permethrin) transdermally for external parasites, multiple physical therapy sessions, and three acupuncture sessions. Nala regained the ability to stand and walk without assistance and consume water, hay, and grain. Nala's dextrose and amino acid supplementations were discontinued, and her IV catheter was removed once she began eating consistently.

She remained in the hospital until she could consume an adequate amount of grain, hay, and water to meet nutrient requirements for both maintenance and growth. Nala was discharged on December 11, 2020, after 24 days in the hospital. Instructions for at home care included approximately 2-3 months of continued antibiotic therapy (a continuation of PPG and Nuflor administration) to treat her chronic pneumonia and suspected lung abscessation. Her owners were instructed to closely monitor her for any signs of weakness, lethargy, difficulty breathing, or diarrhea and were warned the path to continued healing would be long and laborious. Monitoring Nala's hay and grain consumption were also paramount aspects to her recovery.

A recheck was performed approximately 3 weeks after her discharge. At this time, a fecal eggs per gram was performed and results were within normal limits. Recheck thoracic radiographs revealed a persistent multifocal alveolar pulmonary pattern, most prominent in the perihilar region of the right middle lung lobe and caudal subsegment of the left caudal lung lobe. Overall,

Nala's condition was improved, but persistent pneumonia was still present as expected. Her owners were instructed to continue the PPG and Nuflor antimicrobial therapies for four more weeks. After finishing her course of treatment, Nala's owners reported her behavior as that of a normal happy and healthy calf.

Conclusion:

Overall, proper calf rearing aids in preventing disease later in life. Assuring adequate colostrum intake, proper vaccinations, parasite mitigation, and proper nutrition sets the stage for a healthy growing individual. While aspiration pneumonia is common in young bovines; especially weak individuals fed from a bottle; its treatment protocol is extensive and difficult, resulting in a guarded prognosis. Ensuring grains, roughages, and milk-based diets are available for young ruminants allow for proper rumen maturation and development and assists individuals in the transition period from functioning as a monogastric to using all aspects of their ruminant digestive system. Multiple ongoing disease processes can contribute to more severe derangements in blood electrolyte, white blood cell, and acute phase protein values. Prompt and appropriate therapies are needed to give affected individuals the best chance at survival. The use of unconventional medicine, such as physical therapy and acupuncture, may aid in slowing disease progress and hasten the healing process.

References

1. Ballweber, L. R. Gastrointestinal Nematode Infections in Cattle. In: Smith, B. P., Van Metre, D. C., Pusterla, N., Flemming, S. eds. *Large Animal Internal Medicine*. 6th ed. St. Lousis: Elsevier, 2020; 1676-1680.
2. Capnik, S. F., White, B. J., Lubbers, B. V., Apley. M. D., DeDonder, K. D., Larson, R. L., Chitko-Mckown, C. G., Harhay, D. M., Kalbfleisch, T. S., Schuller, G., Clawson, M. L. Comparison of the diagnostic performance of bacterial culture of nasopharyngeal swab and bronchoalveolar lavage fluid samples obtained from calves with bovine respiratory disease. *American Journal of Veterinary Research* 2017; (78) 3:350-358
3. Constable, P.D., Hinchcliff, K.W., Done, AH, & Grunberg, W. In: Sanders, W. B., eds. *Veterinary Medicine*: *A textbook of the diseases of cattle, horses, sheep, pigs and goats.*11th ed. Philadelphia: Saunders Elsevier, 2017; 892-893.
4. Dhillon, K.S., Kaur, S.J., & Gupta, M. A case report on aspiration pneumonia in a cow. *Journal of Entomology and Zoology Studies* 2020; 8:186-188.
5. Divers, T. J., Sweeney, R. W., Galligan, D. Parenteral Nutrition in Cattle. *The Bovine Practitioner* 1986; 22 pp. 56-57
6. Govil., Ydav, D.S., Nayak, S., Baghel, R.P.S., Yadav, P.K., Malapure, C.D., Thakur, D. Feeding management for early rumen development in calves. *Journal of Entomology and Zoology Studies* 2017; 5 (3):1132-1139.
7. Joshi, V., Gupta, V.K., Dimri, U., Kumar, O.R.V., Sharma, D.K., & Bhanuprakash, A.G. Assessment of nebulisation of sodim ceftiofur in the treatment of calves naturally infected with bovine respiratory disease. *Tropical Animal Health and Production* 2017; 49: 497-501.

8. Greenwood, R. H., Morrill, J. L., Titgemeyer, E. C., Kennedy, G. A. A new method of measuring diet abrasion and its effect on the development of the fore stomach. *Journal of Dairy Science* 1997; 80:2534-2541.
9. Kaliappan, S., Elumali, V., Subramanian, S., Ramasamy, R., Premkumar, R., Shanmugam, K. Clinico-pathological Evaluation of Aspiration Pneumonia in Cattle. *Ind J Vet Sci and Biotech* 2021; 10:21887.
10. Kogan, D.A., Johnson, L.R., Jandrey, KE, & Pollard, R.E. Clinical, clinicopathologic and radiographic findings in dogs with aspiration pneumonia: 88 cases (2004-2006). *Journal of the American Veterinary Medical Association* 2008; 233: 1742-1747.
11. Li, R. W., Conner, E. E., Li, C., Baldwin, R. L., Sparks, M. E. Characterization of the rumen microbiota of pre-ruminant calves using metagenomic tools. *Environmental Microbiology* 2012; 14:129-139.
12. Longenbach, J. I., Heinrichs, A. J. A review of the importance and physiological role of curd formation in the abomasum of young calves. *Animal Feed Science and Technology* 1998; 73:85-97.
13. Nocek, J. E., Heald, C. W., Polan, C. E. Influence of ration physical form and nitrogen availability on ruminal morphology of growing bull calves. *Journal of Dairy Science* 1984; 67:334-343.
14. Poulsen, K.P. Aspiration pneumonia in large animals. In: *eBook Merck Veterinary Medicine Manual*. 10th ed. Whitehouse Station: Merck and Co, 2010.
15. Sato, T., Hidaka, K., Mishima, T., Nibe, K., Kitahara, G., Hidaka, Y., *et al*., Effect of sugar supplementation on rumen protozoa profile and papillae development in retarded growth calves. *Journal of Veterinary Medicine Science* 2010; 72:1471-1474.

16. Shakespeare, A.S. Aspiration lung disorders in bovines: A case report and review. *The South African Veterinary Associatio*n 2012; *83*:1-7.

17. Smith, B.P. In: Mosby, eds. *Large Animal Internal Medicine*. 4th ed. St. Louis: Elsevier, 2009; 659.

18. Van Soest, P. Nutritional Ecology of the Ruminant. 1997.

19. Venkatesakumar, E., Vijayakumar, G, Balasubramaniam, GA, & Rajeswar, J.J. (2020). Tracheobronchoscopic evaluation of bacterial pneumonia in cattle. *Journal of Animal Research* 2020; 10:383-388.