Canine Intestinal Lymphangiectasia

Jonsey A. Thomas

Clinicopathologic Conference

February 10, 2017

Advisors: Alyssa M. Sullivant, DVM, MS, DACVIM

& Katie Cooley-Lock, DVM, MS

Introduction:

Protein-losing enteropathy (PLE) is a syndrome that can result from various gastrointestinal (GI) disorders and is characterized by the abnormal loss of protein, particularly albumin, through the GI mucosa at such high extent that the loss cannot be compensated by liver synthesis, resulting in hypoalbuminemia.[1] Various disease conditions are associated with PLE, with the major causes in adult dogs being inflammatory bowel disease (IBD), alimentary tract lymphoma (LSA), intestinal fungal infections (i.e., histoplasmosis and pythiosis), and intestinal lymphangiectasia (IL).[3] Intestinal lymphangiectasia is characterized by the dilation of lymphatic vessels, which causes leakage of protein, lipid, and lymphocyte rich lymph into the intestinal lumen. This can occur as a primary disorder of which lymph flow is decreased due to insufficient amount of lymphatic vessels, or secondary to any disease condition that increases hydrostatic pressure in the lymphatic vessels of the digestive tract.[2] IL is a common cause of PLE, however it is uncommon in the general canine population and is rare in cats.[4]

Case History:

Samson, an approximately 5 year old, male neutered, Great Pyrenees, was presented to Mississippi State University College of Veterinary Medicine Internal Medicine Service on August 11, 2016 due to an approximately 8 week history of vomiting, diarrhea, lethargy, and anorexia. Samson was adopted about one year ago after being found and had since been a working dog who primarily guarded chicken coops. He was up to date on core vaccinations. Onset of clinical signs began approximately 8 weeks prior to presentation to MSU-CVM (around June 24, 2016) after Samson went missing for one day and returned with severe vomiting and diarrhea. He was taken to his regular veterinarian where Coccidia were diagnosed via fecal flotation, therefore, therapy was initiated. Showing no signs of improvement, nearly two weeks

later (around July 8, 2016), Samson returned to his veterinarian. He was hospitalized for a few days and therapy was initiated with metoclopramide, tylosin powder, metronidazole, and probiotics.

Samson failed to improve with hospitalization and was therefore referred to Louisiana State University Veterinary Teaching Hospital on July 15, 2016, where he was diagnosed with severe panhypoproteinemia and hospitalized for a full diagnostic workup. A serum chemistry panel revealed severe hypoproteinemia (total protein 2.8g/dL), hypoalbuminemia (1.3g/dL), hypoglobulinemia (1.5g/dL), hypocholesterolemia (68mg/dL), hypocalcemia (7.7mg/dL) and mild hypomagnesemia (1.3mg/dL). A complete blood count (CBC) resulted within normal reference intervals with the exception of a mild elevation in segmented neutrophils (13.5K/µL). Urinalysis revealed 2+ protein and many calcium oxalate dihydrate crystals. A urine protein: creatinine ratio was within normal limits (0.2). Abdominal ultrasound revealed generalized small intestinal mucosal hyperechogenicity and mild peritoneal effusion. Samson was maintained in ICU over the weekend on intravenous Normosol-R fluids (44mL/kg/day), hetastarch fluids (15mL/kg/day), maropitant (1mg/kg IV q24h), and pantoprazole (10mg/kg IV q12h). July 18, 2016 Samson underwent an upper and lower GI endoscopy to obtain biopsy samples. With results of histopathology and a gastrointestinal panel pending, Samson was discharged July 19, 2016 with maropitant, omeprazole, and recommendation to be fed a bland diet. Histopathology revealed moderate mucosal edema with no evidence of inflammation or neoplasia. Texas A&M University gastrointestinal panel revealed deficiencies in cobalamin (less than 150ng/L) and folate (4µg/L). Pancreatic lipase immunoreactivity was moderately elevated (347µg/L), and Trypsin-Like Immunoreactivity (TLI) was within normal reference interval.

Samson remained home for about one week following discharge from LSU; however, due to continual decline he was taken to another veterinarian on July 27, 2016. Vital parameters were within normal limits on physical exam, however he was noted to have a thin body condition, pale mucous membranes, hindlimb edema, and ascites. CBC revealed a mild to moderate anemia (hematocrit 25%) and marked leukocytosis (43.5K/µL) of predominately segmented neutrophils (39K/µL). Serum chemistry panel exhibited continual presence of panhypoproteinemia (albumin 1.5g/dL, globulin 1.3g/dL), hypocholesterolemia (52mg/dL), and hypocalcemia (7.3mg/dL), all at a severity similar to previous bloodwork at LSU. A snap 4DX test resulted positive for Ehrlichia antibody; therefore, doxycycline (10mg/kg PO q12h) and a tapering course of prednisone (0.5mg/kg PO q12h for 3 days, 0.5mg/kg PO q24h for 3 days, then 0.5mg/kg PO q48h for 3 doses) were initiated for suspected tick-borne disease while a comprehensive tick PCR panel was submitted. Samson was hospitalized for approximately two weeks, during which time he primarily consumed only chicken sandwiches and chicken nuggets. CBC, serum chemistry panel, and a GI panel were repeated August 2, 2016 with results comparable to previous bloodwork with the exception of a mild leukocytosis (19.3K/µL) with neutrophilia (14.6K/µL), eosinophilia (1.4K/µL), and a marked reduction in cholesterol (36mg/dL). The following day results from the comprehensive tick PCR panel returned positive for Ehrlichia DNA. Samson's condition severely worsened August 4, 2016, so a whole blood transfusion of 250mL was given after which he became bright and alert with a pronounced appetite. His improvement only persisted roughly 24 hours, and this was the last meal Samson consumed, with the exception of small amounts of canned Purina EN, until presentation to MSU-CVM (on August 11, 2016). Results from the GI panel revealed low cobalamin (less than 150ng/L) and folate (2.2µg/L) therefore vitamin B12 (3000µg IM), folate (10mg/kg PO q24h),

omeprazole (1mg/kg PO q12h), and FortiFlora were added to the treatment plan on August 8, 2016. Attributable to continual decline despite hospitalization, Samson was referred to MSU-CVM.

Case Presentation:

Upon presentation to the College of Veterinary Medicine, Samson was quiet, but alert and responsive. His vitals revealed a moderate tachycardia at 156 beats per minute, tachypnea at 44 breaths per minute, and temperature within normal limits at 100.6 degrees Fahrenheit. His physical exam revealed a body condition score of 2/9, with a weight of 40.4kg. Mucous membranes were pink with a capillary refill time of less than two seconds. Thoracic and cardiac auscultation revealed decreased bronchovesicular sounds ventrally while abdominal palpation exposed a profound fluid wave. Upon rectal exam, tan to gray feces with a clay-like appearance was noted. Hindlimb pitting edema around the hocks was observed bilaterally. An aFAST scan revealed moderate ascites with mild fibrin and flocculent material. The thoracic cavity showed bilateral pleural effusion with the right side more severely affected, as well as marked presence of fibrin strands and tags between the pericardium and diaphragm. CBC presented mild anemia (PCV 31%) and serum chemistry panel indicated severe panhypoproteinemia (albumin 1.1g/dL, globulin 1.4g/dL), mild hypocalcemia (8.1g/dL), marked hypomagnesemia (0.9mg/dL), and hypocholesterolemia (87mg/dL). Clotting times were within normal limits and urinalysis revealed a small amount of calcium oxalate crystals. A baseline cortisol was submitted resulting in cortisol below detectable levels (less than 1.0µg/dL), hence an ACTH stimulation test was performed resulting in an elevated cortisol (6.0µg/dL) thereby ruling out hypoadrenocorticism. Feces were collected for fecal flotation, Giardia antigen ELISA, and Campylobacter culture, all of which were negative. Additionally, a rectal scrape was submitted for cytology with no

significant findings, and an aerobic culture and sensitivity and anaerobic culture of fecal material resulted in heavy growth of gram positive and negative enteric flora with faint growth of *Clostridium perfringens*. A Histoplasma antigen enzyme immunoassay (EIA) on urine was submitted and resulted negative.

A thoracocentesis was performed due to increased respiratory rate and effort as well as for diagnostic purposes, yielding 60mL from the right thoracic cavity, with the fluid being a modified transudate (protein 2.0g/dL, nucleated cells 61/µL). The low yield obtained was due to the large amount of fibrin strands hindering fluid outflow. An abdominal ultrasound was performed revealing diffuse thickening of the small intestine (up to 5.5mm) as well as a patchy muscularis layer with mild speckling of the mucosa. A MILA jugular catheter was placed and thoracic radiographs concluded it to be in appropriate position.

Repeat endoscopy was recommended due to the significant risk of surgical biopsies in the presence of marked hypoalbuminemia. Two enemas were performed and corn oil was given 12 hours prior in preparation for an upper and lower GI endoscopy. Samson was hospitalized in ICU on intravenous fluid therapy PlasmaLyte (20mL/kg/day) and Vetstarch (30mL/kg/day), methadone (0.5mg/kg IV q6h), ondansetron (0.5mg/kg IV q8h), and doxycycline (10mg/kg PO q12h). Overnight, Samson's SPO2 began to decline and worsening of his pleural effusion was noted. Thoracocentesis was attempted; however, due to the abundance of fibrin strands within the thoracic cavity, no fluid was aspirated. In order to make the patient more comfortable, an abdominocentesis was performed removing one liter of a pure transudate fluid (protein less than 2.0g/dL, nucleated cells 55/µL). A nasal cannula was placed in the right nostril to provide supplemental oxygen and the patient appeared to rest comfortably afterwards.

The following day (August 12, 2016), repeat bloodwork was submitted to assess the patient's stability for general anesthesia. A CBC revealed a moderate anemia (PCV 24%) and a serum chemistry panel was equivalent to prior values with slight decrease in same parameters (albumin 0.8g/dL, globulin 1.1g/dL, cholesterol 70mg/dL, calcium 7.2mg/dL, and magnesium 0.7mg/dL). Due to his severe hypoalbuminemia, Samson was administered a canine albumin transfusion (total of 100mL) and was induced under general anesthesia for endoscopy. An upper and lower GI endoscopy was performed obtaining biopsy samples from the gastric fundus and pylorus, duodenum, and colon. While under anesthesia, the patient had an esophagostomy tube and two bilateral chest tubes placed. The left chest tube was aspirated to yield 72mL fluid and 10mL air, while the right chest tube aspirated 2460mL fluid. Radiographs were obtained to check placement of the three tubes, and Samson recovered uneventfully from anesthesia. A urinary catheter was placed to monitor fluid production. The patient returned to ICU and was maintained on intravenous fluid therapy PlasmaLyte (35mL/kg/day) and Vetstarch (40mL/kg/day), Unasyn (30mg/kg IV q8h), metronidazole (10mg/kg PO q12h), pantoprazole (1mg/kg IV q24h), maropitant (1mg/kg IV q24h), and the medications previously described. Aspirin (2mg/kg PO q24h) was initiated for thromboembolism prophylaxis. The patient's nutritional energy requirements were calculated and a diet plan was initiated at ⅓ total energy requirement, to be increased by ⅓ q24h over the next three days. Hill's canned low fat i/d (349kcal/can) was the diet selected due to the low fat content (8.3% dry matter). Samson was offered ⅓ can (116kcal) q6h which he readily consumed.

The patient was monitored closely over the weekend, during which he maintained a moderate appetite. Endoscopic biopsies were finalized August 15, 2016 and Samson was

definitively diagnosed with severe lymphangiectasia and eosinophilic inflammatory bowel disease (IBD).

Pathophysiology:

Intestinal lymphangiectasia is dilation of lymphatic vessels that leads to leakage of lymphatic contents into the intestinal submucosa, lamina propria, and lumen. Lymphatic dilation can arise as a primary or secondary disorder. Primary forms are generally idiopathic in origin; however, congenital malformation of lymphatic vessels has been described.[4] Intestinal lymphangiectasia more frequently presents secondary to another disease process that causes increased hydrostatic pressure in the lymphatic vessels.[2] This can occur as a result of severe inflammation, infection, or neoplasia due to lymphatic obstruction or extensive infiltration of mesenteric lymph nodes or intestinal mucosa.[4] Less commonly, increased venous hydrostatic pressure can lead to lymphatic congestion progressing to IL and can therefore exist as a sequela of congestive heart failure or pericardial effusion.[4]

Despite the etiology, increased pressure in intestinal lymphatics leads to impaired lymph drainage. This causes retention of chyle in the villi lacteals and lymphatics of the mesentery and intestinal walls, ultimately generating dilation of lacteals causing them to become fragile and easily ruptured. Ruptured lacteals leak chyle, rich in lymphocytes, lipid, and plasma proteins into the intestinal lumen, which is the cause of clinical signs and laboratory abnormalities associated with IL.[2] In cases of focal IL, these components may be digested and resorbed in distally unaffected areas of the GI tract.[4]

Plasma proteins lost in chyle include albumin, globulins, clotting factors, antithrombin III, and hormone-binding proteins.[4] Loss of protein, particularly albumin, results in decreased

plasma oncotic pressure, and when severe enough (albumin less than 1.5g/dL) can cause peripheral edema, ascites, and/or pleural effusion.[4] Additionally, hypercoagulability is a potential complication that may occur due to reduce plasma concentration of antithrombin III or increased thrombin-antithrombin complexes.[2] Some dogs with PLE develop thrombocytosis, and it should be noted that increased thrombin-antithrombin complexes have been identified in association with a platelet/albumin ratio above 240,000.[3]

In cases of chronic IL, lipogranulomas may form as a response to chronic leakage of lipid-rich chyle and lacteal rupture, generating a foreign body-type reaction.[5] Consequently, these granulomas can further impede lymph drainage, creating further intestinal protein loss.[3]

Clinical Presentation/Laboratory Testing:

Clinical signs of intestinal lymphangiectasia can be quite variable and many signs are nonspecific such as anorexia and lethargy. The most common clinical signs observed are diarrhea, vomiting, ascites, and weight loss. Although diarrhea is the most consistent presenting complaint, it does not occur in every case and lymphangiectasia should not be ruled out if other signs are indicative. Effusions or edema may be present due to hypoalbuminemia, with effusions typically being a pure transudate.[4] Tachypnea as a result of pulmonary thromboemboli has been the presenting complaint in some instances due to the potential of hypercoagulability.[3]

Laboratory abnormalities typically reflect the loss of lymph in the GI tract; however, there are no values specific for IL. Lymphopenia is the most suggestive abnormality on CBC. Other abnormalities that may be seen are results of chronic inflammation including anemia, neutrophilic leukocytosis, or thrombocytosis.[3] Hypoalbuminemia is the most consistent finding in dogs, and often hypoglobulinemia is present. Other serum chemistry abnormalities may be

hypocalcemia, hypomagnesemia, and hypocholesterolemia. Urinalysis and a urine protein: creatinine ratio are typically unremarkable but should be evaluated in the face of hypoalbuminemia to rule out protein losing nephropathy.[13]

Diagnostic Approach/Considerations:

Definitive diagnosis can be difficult and clinical signs are extremely variable, thus a thorough history, physical exam, and laboratory analysis are vital to rule out secondary gastrointestinal etiologies of hypoalbuminemia. Assays are available to identify intestinal permeability and absorptive function, but they involve measuring excreted radioactive labeled albumin or other compounds in feces and are limited to clinics able to either handle radioactive waste or with specialty cages able to separate feces from urine.[3] Measurement of fecal α_1-protease inhibitor (α_1PI) is a noninvasive assay to directly identify enteric protein loss.[1°] This molecule is of similar size to albumin and in normal dogs is not present in feces. However, when the intestinal mucosal barrier is compromised, fecal α_1PI is lost into the intestinal lumen at the same rate as albumin, and due to its inability to be digested, will remain in the feces and be an accurate method to quantify enteric albumin loss.[7]

Abdominal ultrasound can be valuable in identifying enteric pathology, especially in cases of segmented or focal lymphangiectasia in which some regions of the GI tract are unaffected. Ultrasound findings consistent with IL include focal or diffuse thickening of the small intestinal wall (especially of the duodenum and jejunum), indistinct wall layering, hyperechoic intestinal mucosa which may be striated or have speckles, hyperechoic mesentery, small bowel hypermotility, and peritoneal effusion.[11] Although ultrasound will not diagnose lymphangiectasia, it is useful to identify abdominal abnormalities and can help determine

whether endoscopy or surgery would be most beneficial for obtaining diagnostic intestinal biopsies.

There are numerous diagnostic abnormalities suggestive of IL, however histologic assessment of intestinal biopsies is the only means of a definitive diagnosis. Biopsies can be obtained via endoscope or exploratory laparotomy, and sampling methods are ultimately dependent on stability of the patient. Endoscopy provides direct visualization of the mucosa, which in some cases can show dilation of the lacteals in the villus tips. This can be enhanced by giving a small high-fatty meal (such as corn oil) 12 hours prior to procedure.[4] The disadvantage of endoscopy is the small size/thickness of these sections create a risk of attaining non-diagnostic samples. Furthermore, as IL can be a focal disease, affected intestine could be missed if present in regions inaccessible via endoscopy. Exploratory laparotomy to obtain intestinal biopsies can be superior due to ability to obtain full thickness samples, visualization of the abdominal organs, and ability to examine and palpate the entire length of intestine. Unfortunately, surgery is often not the safest option for patients with lymphangiectasia due to the most prevalent clinical finding of hypoalbuminemia.[3]

Treatment & Management:

Providing adequate nutritional support, treating intestinal lesions, providing oncotic support, and addressing complications are the four principal treatments of intestinal lymphangiectasia.[3] Dietary modification is the primary management technique.[3] The goal is to provide a high-energy density food that also has low-fat and high carbohydrate content.[2] Current recommendations are as follows (nutrients expressed on a dry matter basis): greater than 3.5kcal/g, less than 15% fat, greater than 25% protein, less than 5% fiber, and at least 87% digestibility for protein and 90% for fat and carbohydrates.[1] This can be achieved by feeding a

homemade diet of white turkey meat with potato, or feeding an ultra-low fat commercial diet. Dogs with IL often show a marked increase in serum albumin concentration within 7–14 days of starting an appropriate diet.[8]

Intestinal lesions occur due to ruptured lacteals and will, in turn, result with inflammation of the intestinal wall leading to the presence of lipogranulomas and edema, which exacerbates the occurrence of malabsorption.[5] Additionally, cases in which IL develops secondary to other disease processes such as with IBD or neoplasia, treatment of the primary disease is imperative. Immune-suppressive treatment with appropriate steroid dosages, azathioprine, or cyclosporine is the initial recommended therapy. In critical cases, it is suggested to initiate therapy with cyclosporine and a steroid concurrently.[2]

In severe cases of PLE, intravenous oncotic support may be necessary, especially prior to general anesthesia. Short term oncotic support can be provided by hydroxyethyl starches (no greater than 30 mL/kg/day).[2] Concentrated human albumin solutions or canine purified albumin are alternatives in critical cases to temporarily increase serum albumin concentrations.[2] Human albumin solutions are associated with inducing severe hypersensitivity reactions and should only be considered if necessary.[3]

Intestinal lymphangiectasia is a source of a number of potential complications, but preventative therapy can be initiated to decrease the risk. Hypercoagulability and thrombosis are of concern in hypoalbuminemic patients and at risk patients can begin heparin treatment combined with low dosage aspirin. Transfusion of fresh frozen plasma is another option to increase antithrombin III.[2] Vitamin and mineral deficiencies are common due to the impaired intestinal absorption. Hypocobalaminemia is a common complication suggestive of chronic distal small intestinal disease and has been found to predict a decreased prognosis and may

indicate patients refractory to treatment. When low, cobalamin supplementation is recommended and can be initiated prior to obtaining laboratory results.[13] Prolonged hypocalcemia and/or hypomagnesemia should be corrected via intravenous or oral supplementation. In addition, recurrent hypocalcemia may improve with parenteral vitamin D supplementation and should be considered as some dogs have vitamin D deficiency due to poor intestinal absorption.[6] Long term supplementation of these vitamins and minerals may be necessary.[2]

To summarize, treatment of IL should consist of four categories depending on disease severity. Dietary modification to an appropriate ultra-low fat diet is the most significant treatment. Immunosuppressive agents are initiated to decrease the inflammation in the GI tract and if present, to treat underlying disease (such as IBD or neoplasia). Providing oncotic support and supplementation of deficient vitamins and minerals, especially cobalamin, calcium, and magnesium, are essential to improve the patient's prognosis.

Case Outcome:

Following a definitive diagnosis of severe lymphangiectasia and eosinophilic inflammatory bowel disease, cyclosporine (5mg/kg PO q12h) and dexamethasone sodium phosphate (2mg/kg prednisone equivalent, IV q24h) were added to Samson's treatment plan. Due to disease severity and continual decline of plasma protein (albumin 0.6g/dL), total parenteral nutrition (TPN) was initiated with an amino acid supplement, Aminosyn (25mL/kg total). Unasyn was discontinued and Fortiflora (½ packet q12h) was added to the treatment plan. Nasal oxygen supplementation was discontinued, and the patient maintained an SPO2 between 92 and 97% and a respiratory rate between 28 and 56 breaths per minute over the subsequent 24 hours.

The following day (August 16, 2016) Samson was noted to be brighter with an intermittent appetite, and his stools improved to a soft-serve consistency. A magnesium sulfate CRI was initiated due to an unimproved hypomagnesemia (0.7mg/dL). Methadone was transitioned to Tylenol-4 for pain control due to panting that resulted from methadone. The left chest tube was pulled due to low fluid production and FAST scan was performed every six hours to monitor thoracic and abdominal effusion.

The urinary catheter was pulled August 17, 2016 due to the presence of blood in the catheter (presumed trauma). On August 18, 2016 Samson's colloid fluids were gradually decreased and discontinued within a 48 hour period. The magnesium sulfate CRI was discontinued August 19, 2016 due to a normal serum magnesium (1.9mg/dL). The following day Samson was transitioned from dexamethasone sodium phosphate to prednisone (2mg/kg PO q24h) and L-glutamate powder was added to his feedings. The right chest tube was pulled August 21, 2016 as a result of improved pleural effusion and completing 48 hours without requiring aspiration of fluid. Due to the development of phlebitis, the jugular catheter was pulled August 22, 2016. An additional catheter was not placed, and IV fluids were discontinued. The patient was transitioned to oral medications with the addition of mirtazapine as an appetite stimulate.

On August 25, 2016, Samson was dull compared to his previous demeanor. CBC revealed marked neutrophilia (43K/µL). Urine culture was submitted due to likelihood of UTI as a result of the urinary catheter and immunosuppression, but the culture was negative. Samson was started on an antibiotic (Clavamox, 14mg/kg PO q12h) to treat any potential underlying infection. The presence of peripheral edema continued to improve and his albumin gradually increased to 1.2g/dL. On August 26, 2016, Samson was still experiencing loose stool and

occasional diarrhea, as well as a decreased appetite; however, he was stable for discharge and went home with instructions to recheck bloodwork in one week.

The first week at home Samson did well with slight increase in appetite, although the majority of his feedings were still given via the E-tube. The next week Samson became increasingly lethargic with a rapid decline September 7, 2016. He developed diarrhea, increased respiratory effort, generalized petechiae, and began vomiting clear mucoid material, thus Samson returned to MSU-CVM ICU September 8, 2016. Bloodwork revealed severe neutrophilia (46K/µL), panhypoproteinemia (albumin 1.3g/dL, globulin 1.9g/dL), hypocholesterolemia (76mg/dL), hypocalcemia (7.2mg/dL), hypomagnesemia (1.0mg/dL), and mild elevation of PT (12.1seconds). Samson's bicavitary effusion had severely worsened, and it was suspected he had developed an infection of unknown origin. He was hospitalized for 22 days during which time treatment consisted of intravenous antibiotic therapy (Unasyn 30mg/kg q8h), dexamethasone sodium phosphate, and increased cyclosporine dose. Bilateral MILA chest tubes were placed and aspirin was discontinued due to the development of petechiae. Samson was started on Aminosyn for nutritional support and was transitioned to Vivonex, an oral amino acid supplement, following the TPN.

On September 12, 2016 a six-lead ECG revealed a second degree atrioventricular block presumed to be a result of increased vagal tone due to severe GI disease. The following day, prednisone was transitioned to budesonide (3mg/large breed dog PO q24h) and his right chest tube was removed due to patient preference. September 15, 2016, Samson developed extensive petechia and ecchymosis in his inguinal region. Two days later (September 17, 2016), Pseudomonas was cultured from the left chest tube site, so it was pulled and he was started on

enrofloxacin (10mg/kg IV q24h). Samson was discharged September 29, 2016 with instructions to recheck bloodwork in one week.

The remainder of Samson's rechecks were performed by his referring veterinarian. Over the next 1.5 months, Samson was weaned off all medications and was being maintained on a hypoallergenic diet (HA). He had been doing well until his owners went out of town. When they returned Samson's condition drastically declined and he passed away at home. Although intestinal lymphangiectasia carries a guarded to poor prognosis, Samson lived 4 months following his diagnosis.

References:

1. Hand MS, Thatcher CD, Remillard RL, Roudebush P, Novotny BJ. Protein-Losing Enteropathies. In: Davenport DJ, Jergens AE, Remillard RL. Small Animal Clinical Nutrition. 5th ed. Topeka: Mark Morris Institute, 2010; 1077-1083.

2. Dossin O, Lavoué R. Protein-losing enteropathies in dogs. Vet Clin North Am Small Anim Pract. 2011 Mar;41(2):399-418.

3. Willard M. Protein Losing Enteropathies, in Proceedings. Southwest Veterinary Symposium 2016.

4. Melzer KJ, Sellon RK. Canine Intestinal Lymphangiectasia. Compendium Continuing Education for Veterinarians. 2002 Dec; 24(12):953-961.

5. Watson VE, Hobday MM, Durham AC. Focal intestinal lipogranulomatous lymphangitis in 6 dogs (2008-2011). J Vet Intern Med. 2014 Jan-Feb;28(1):48-51.

6. Mellanby RJ, Mellor PJ, Roulois A, Baines EA, Mee AP, Berry JL, Herrtage ME. Hypocalcaemia associated with low serum vitamin D metabolite concentrations in two dogs with protein-losing enteropathies. J Small Anim Pract. 2005 Jul;46(7):345-51.

7. Heilmann RM, Parnell NK, Grützner N, Mansell J, Berghoff N, Schellenberg S, Reusch CE, Suchodolski JS, Steiner JM. Serum and fecal canine α1-proteinase inhibitor concentrations reflect the severity of intestinal crypt abscesses and/or lacteal dilation in dogs. Vet J. 2016 Jan; 207:131-139.

8. Willard M. Chronic Small Bowel Diarrhea: Low Albumin Does Not Necessarily Mean A Bad Ending, in Proceedings. Atlantic Coast Veterinary Conference 2010.

9. Okanishi H1, Yoshioka R, Kagawa Y, Watari T. The clinical efficacy of dietary fat restriction in treatment of dogs with intestinal lymphangiectasia. J Vet Intern Med. 2014 May-Jun;28(3):809-17.

10. Simmerson SM, Armstrong PJ, Wünschmann A, Jessen CR, Crews LJ, Washabau RJ. Clinical features, intestinal histopathology, and outcome in protein-losing enteropathy in Yorkshire Terrier dogs. J Vet Intern Med. 2014 Mar-Apr;28(2):331-7.

11. Pollard RE, Johnson EG, Pesavento PA, Baker TW, Cannon AB, Kass PH, Marks SL. Effects of corn oil administered orally on conspicuity of ultrasonographic small intestinal lesions in dogs with lymphangiectasia. Vet Radiol Ultrasound. 2013 Jul-Aug;54(4):390-397.

12. Larson RN, Ginn JA, Bell CM, Davis MJ, Foy DS. Duodenal endoscopic findings and histopathologic confirmation of intestinal lymphangiectasia in dogs. J Vet Intern Med. 2012 Sep-Oct;26(5):1087-92.

13. Berghoff N, Steiner JM. Laboratory tests for the diagnosis and management of chronic canine and feline enteropathies. Vet Clin North Am Small Anim Pract. 2011 Mar;41(2):311-28.

14. Soto S, Majó N, Lloret A, Pastor J, Sánchez CD, Marco A. Pathology in practice. Intestinal lymphangiectasia. J Am Vet Med Assoc. 2010 Dec 15;237(12):1377-1379.

15. Willard MD, Mansell J, Fosgate GT, Gualtieri M, Olivero D, Lecoindre P, Twedt DC, Collett MG, Day MJ, Hall EJ, Jergens AE, Simpson JW, Else RW, Washabau RJ. Effect of sample quality on the sensitivity of endoscopic biopsy for detecting gastric and duodenal lesions in dogs and cats. J Vet Intern Med. 2008 Sep-Oct;22(5):1084-9.

16. Nakashima K, Hiyoshi S, Ohno K, Uchida K, Goto-Koshino Y, Maeda S, Mizutani N, Takeuchi A, Tsujimoto H. Prognostic factors in dogs with protein-losing enteropathy. Vet J. 2015 Jul;205(1):28-32.