AVTCP Case Report #1
Case Log #62
Bacterial Pneumonia Secondary to *Bordetella bronchiseptica*
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Signalment: Canine, Cavalier King Charles Spaniel, 8-week-old, female

Presenting Complaint: Holly presented for wheezing, coughing, nasal discharge, and lethargy.

History: Holly was adopted from a breeder in California on May 31, 2012 and was transported to the east coast with her owners via airplane. Since that time her owners have noted mucoid nasal discharge, sneezing, and congestion. She was seen by her veterinarian and a diphenhydramine trial was attempted with no improvement. Although Holly was initially playful and lively, over the past several days she had become lethargic. She was brought back to the veterinarian who noted a hacking cough and increased lung sounds on physical examination. The patient was transferred to a facility with 24-hour monitoring for hospitalization due to suspicion of pneumonia.

Holly was known to reside with another older puppy in the home that had not shown signs of illness. She had reportedly received her "first vaccine" from the breeder. Aside from the diphenhydramine trial recommended by a veterinarian, she had not received any other medications prior to admission. Her routine diet was Blue Buffalo® Freedom Puppy™.

Physical Exam Findings/Observations: Holly appeared quiet, but alert and responsive (QAR). She weighed 1.88kg, temperature (T) was 101.8°F, heart rate (HR) was 132 bpm, and respiratory rate (RR) was 42 breaths per minute with increased effort. She had a body condition score (BCS) of 4/9 and her pain score was determined to be 1/4 on the Colorado State University (CSU) Canine Acute Pain Scale.

A small amount of mucopurulent discharge was present on the nares bilaterally. Mucous membranes (MM) were pink, with a capillary refill time (CRT) of 1-2 seconds. Deciduous teeth were present. Cough was elicited on tracheal palpation. Thoracic auscultation revealed no evidence of arrhythmia or murmur and lung fields sounded dull on the left side and harsh on the right side. No crackles or wheezes were appreciated. Holly had strong synchronous pulses. Peripheral lymph nodes were unremarkable.

Problem List/Differential Diagnosis: Holly's problem list included leukocytosis, hypoproteinemia, hypoglycemia, hypokalemia, hypotension, reduced oxygen saturation, and lethargy. Differential diagnoses included pneumonia secondary to infectious disease (e.g. *Bordetella bronchiseptica* or canine influenza) or – less likely – pneumonitis.

Diagnostic Approach: Initial blood work was performed by the referring veterinarian and abnormalities were largely consistent with the patient's age and systemic infection. CBC revealed leukocytosis, anemia, and possible

thrombocytopenia. Platelet clumping was observed on a blood smear review and this was found to be inconsistent with the automated platelet count. Hypoproteinemia, hypoalbuminemia, hypoglobulinemia, hypoglycemia, hyperphosphatemia, increased alkaline phosphatase, decreased creatinine, and hypokalemia were found on biochemical analysis.

Holly was admitted to the hospital for diagnostics and treatment. Thoracic radiographs were taken and were consistent with pneumonia. The patient was hypotensive (systolic BP of 100 mmHg via Doppler) and oxygen saturation via pulse oximetry (SPO_2) ranged from 95-97%. The patient's blood glucose (BG) was 204mg/dL and electrolyte analysis revealed hyponatremia (136 mEq/L, reference range 141-156). An endotracheal wash was discussed with the owners and was authorized. Holly was administered butorphanol (a partial agonist opiate[1]) 0.2mg/kg = 0.4mg IV twenty minutes prior to the procedure. For ten minutes prior to induction she was preoxygenated via mask. A total of 3.7mg/kg of propofol (short-acting injectable anesthetic[2]) (7mg or 0.7mL) was administered IV and the patient was intubated with a 4mm sterile endotracheal tube. Two endotracheal washes were performed. During the first wash 5mL NaCl 0.9% was flushed down the endotracheal tube and manually aspirated. 3mL was used during the second wash and was also manually aspirated. Holly was extubated approximately five minutes later and recovered uneventfully. Endotracheal wash samples were processed and submitted for fluid analysis/cytology and aerobic culture and sensitivity. Fluid analysis results received a few hours later indicated suppurative septic inflammation with bacterial colonies of rods.

Treatment Plan: Holly was treated with intravenous fluids. This included 100mL/kg/24h (NaCl 0.9% + dextrose 2.5% + KCl 20mEg/L at 8ml/hr) and hydroxyethylstarch (HES) at 12mL/kg/24h (1mL/hr) IV. Her orders also included ampicillin sulbactam (potentiated aminopenicillin[3]) 20 mg/kg = 40mg IV q8h and oxygen support (40%). BG, BP via Doppler and SPO_2 were monitored q6h, and RR/effort was evaluated q2h. She also received intermittent saline nebulization. Holly began eating Hill's® puppy formula™ and was urinating regularly. The patient was stable in oxygen overnight.

On day 2, supportive care was continued. Holly was eating well and her dextrose constant rate infusion (CRI) was to be decreased over the course of the day and ultimately discontinued. BG monitoring would be performed q6h. With the exception of dextrose, IV crystalloid and colloid therapy was continued. Ampicillin sulbactam was discontinued and enrofloxacin (broad spectrum fluoroquinolone antibiotic[4]) 10mg/kg = 19mg IV q24h (0.84mL diluted1:4 with NaCl 0.9%, slow push) and doxycycline (a tetracycline antibiotic that is effective

against *B. bronchiseptica*[5]) 5mg/kg = 10mg PO q12h were instituted for more complete coverage and appropriate treatment for pneumonia secondary to *Bordetella bronchiseptica* (presumptive). Oxygen supplementation was continued and nebulization and gentle coupage was ordered q6h. BP via Doppler and pulse oximetry (SPO_2) were monitored q6h, and respiration rate and effort was evaluated q2h.

On day 3, Holly appeared to be overall slightly improved and QAR, but a bit more depressed. Her weight was 1.86kg, T 100.8°F, HR 124bpm, RR 44bpm, and she was normotensive. Respiratory effort was slightly increased, MM pale pink, and CRT 1-2 seconds. Mild ocular discharge and dried crusting was present around the nares, but no nasal discharge was apparent. She was still sensitive on tracheal palpation and occasionally had a productive cough or sneeze. Thoracic auscultation revealed fine crackles, increased bronchiovescular sounds bilaterally, and an occasional wheeze.

Although the patient ate during the previous day, she did not eat overnight. Due to the patient's recent inappetance and slight depression a BG was checked (40mg/dL). 1.5mL of dextrose 50% diluted 1:1 with NaCl 0.9% was administered slowly IV. The patient immediately looked brighter, and when hand fed, ate slightly less than ¼ can of warmed Hill's® Puppy™ mixed with Hill's® a/d™. The BG was checked again 2 hours later and was 200mg/dL. Future BG monitoring would continue at q6h. Crystalloid therapy was changed to NaCl 0.9% with KCl 20 mEq/L and Dextrose 1.25% at the same rate (8mL/hr IV). HES was continued at 1mL/hr IV. All other treatments remained unchanged. The patient continued to urinate throughout the day and had two slightly loose bowel movements. Dependent on patient improvement, Holly was planned to be weaned from oxygen and dextrose supplementation overnight or the following day.

Holly was much improved on day 4 and appeared bright, alert, and responsive. Her weight was 1.84kg, T 100.6, HR 100bpm, and RR 40. A mild amount of clear mucus was present around the left nares. Thoracic auscultation revealed increased bronchiovescular sounds, but no crackles, wheezes, or cough were noted. The patient's respiratory effort was normal to slightly increased when excited.

Due to patient improvement, IV fluid therapy (including dextrose supplementation) and oxygen support would be slowly reduced over the next eight hours in preparation for discharge. Enrofloxacin was changed to PO administration (22.7mg PO q24h), but all other monitoring and treatments would continue until patient discharge that evening.

Final Diagnosis: Pneumonia secondary to *Bordetella bronchiseptica* was confirmed via aerobic bacterial culture.

Outcome: Holly was discharged to her owners on day 4 of hospitalization and the pneumonia has since resolved.

Conclusion/Case Summary: Holly responded well to antibiotic therapy and supportive care. She was advised to continue the oral doxycycline (10mg PO q12h) and enrofloxacin (22.7mg PO q24h) until directed otherwise. The owner was advised that it may be necessary to change antibiotics based on the finalized aerobic culture and sensitivity, but this did not turn out to be necessary. The duration of antibiotic therapy would be largely based on radiographic resolution of her pneumonia and it would be likely that she would need to continue antibiotic therapy for 4-6 weeks. Follow up radiographs were scheduled for 10 days after discharge.

Holly was discharged with Hill's®a/d™. This diet was to be continued for 3-5 days, depending on her appetite and recovery. After that time, if her appetite was appropriate she was to be transitioned to a diet more appropriate for her lifestage. The basal energy requirement (BER) formula for animals weighing less than 2kg is BER = 70 x $(kg)^{0.75}$. Using this formula, Holly's BER is 112.4kcal/day. Until growing dogs (post-weaning) reach 40% of their projected body weight, their maintenance energy requirement (MER) should be calculated as 2 x BER, or 2 x 112.4 = 224.8kcal/day[6]. Hill's®a/d™ diet contains 180kcal/can, therefore Holly would eat approximately 1¼ cans of a/d™ divided between 3-4 feedings per day.

In addition to the medication and diet recommendations, it was also recommended to place her in a hot, steamy bathroom for 10-15 minutes or small room with a humidifier two the three times per day. Vaccinations were to be postponed until she was recovered.

The owners were recommended to monitor Holly for lethargy, inappetance, vomiting, diarrhea, coughing, or nasal discharge. Respirations in particular were to be monitored for increased rate, effort, or noise.

Discussion: *Bordetella bronchiseptica* is small, gram-negative, motile coccobacillus that is considered normal flora in humans, dogs, and pigs[7]. It is one of the most common causative agents for canine infectious respiratory disease complex (CIRDC). It is considered highly infectious and can be transmitted via aerosolization or direct contact. Shedding of the bacteria can occur for up to 14 weeks after clinical resolution of signs. Once out in the environment it can potentially survive for weeks, but can be inactivated by a variety of common disinfectants.[8]

Clinical signs include lethargy, ocular/nasal discharge, inappetance, and cough. Signs are usually apparent 3-5 days after exposure and a dry hacking cough can linger for up to three weeks. Most cases are self-limiting, but severe cases may develop pneumonia. Immunocompromised pets are more likely to develop significant disease[8]. Pediatric animals are considered at risk due to their immature immune system[9].

Pneumonia is the inflammation of the lung parenchyma and is often accompanied by airway inflammation.[7] Development can be due to infectious agents (i.e., bacteria, virus, protozoa, parasites, or fungi) or non-infectious agents (aspiration, lipid, or smoke inhalation). Bacterial pneumonia is the most common form in small animals and often involves more than one causative bacteria.[9,10] Clinical signs are variable dependent on the severity of disease. Lethargy, anorexia, exercise intolerance, and moist cough are often noted, and bacterial pneumonia patients may be febrile. Postural adaptations, dyspnea, and cyanosis can be observed in more significantly affected pets.[8]

Physical examination findings include tracheal irritation and tracheal palpation may elicit a cough. Patients are often dehydrated secondary to anorexia and the associated fluid loss due to increased respiratory effort. Thoracic auscultation may reveal wheezing or crackles and decreased to absent lung sounds over consolidated areas. Pulse oximetry may be decreased to normal. Diagnosis may be based on radiographic evidence including alveolar, bronchial, and/or interstitial patterns, alveolar infiltrates, or lung lobe consolidation. However, radiographic changes may not be apparent until 24-48 hours after emergence of clinical signs. Laboratory abnormalities are largely dependent on the etiology and severity of the pneumonia. Arterial blood gas analysis may be helpful in determining the severity of disease and response to treatment.[9]

Treatment is largely dependent on isolation of the causative agent. This is accomplished by obtaining samples via transtracheal or endotracheal wash, bronchioalveolar lavage, or fine needle aspiration of lung tissue. Samples may be submitted for fluid analysis, cytology, or identification and sensitivity.[9,10] Until results are finalized broad spectrum antibiotics with respiratory distribution are ideal. Treatment protocols combining an aminopenicillin or a first generation cephalosporin with a fluoroquinolone or aminoglycoside will provide appropriate antibiotic coverage pending results. Antibiotic therapy should continue 1-2 weeks past the resolution of clinical signs and radiographic evidence of pneumonia.[9,10] If the patient requires hospitalization for treatments such as fluid therapy or oxygen supplementation, isolation procedures should be instituted.[8] IV fluid therapy may be necessary to restore losses and provide maintenance for hydration. Proper hydration is necessary for proper airway moisture and respiratory secretions. Supplemental oxygen is dependent on the severity of disease. Patients with an oxygen saturation < 90% or PaO2 < 60mmHg would benefit from supplementation. Saline nebulization (recommended to thin respiratory secretions) followed by coupage (assists secretion clearance) is often instituted in these patients.[8,9] Stable patients can also go for short walks which aids in the loosening of debris and removal of secretions.[8]

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Appendix

June 12, 2012 – Radiology

Findings:

5 images of the thorax.

There is a moderate patchy bilateral alveolar pattern at the lungs with a peri-hilar distribution. The cardiac silhouette and pulmonary vasculature are normal in size, shape and position with vertebral heart score of approximately 10.1, within limitation of mild border effacement. There are no signs of pleural effusion. The trachea is normal. There is variable mild gas at the esophagus. The esophagus is not dilated. The skeletal structures are normal. There are a few punctate mineral opacities at the cranial abdomen, considered incidental material at the large bowel. The cranial abdomen is otherwise remarkable.

Assessment:

Bilateral moderate alveolar pattern with patchy peri-hilar distribution. Given the age of the patient and history provided, a pneumonia is the primary differential. This is often a result of kennel cough . Other unlikely differentials include hemorrhage, eosinophilic pneumonitis, fibrosis and non-cardiogenic edema of undetermined etiology. There are no appreciable signs of cardiac enlargement and congestive heart failure is considered extremely unlikely. The mild gas at the esophagus is attributed to transient effects of aerophagia. Consider bronchial alveolar lavage for cytology and culture or recheck exam in 5 to 7 days following trial therapy for pneumonia [sooner if clinical signs do not improve or deteriorate].

June 14, 2012 – Cytology

Test Requested	Results	Reference Range	Units
WBC (FLUID)			
WBC	1.0		$10^3/\mu L$
RBC (FLUID)			
RBC	0.003		$10^6/\mu L$
PROTEIN (FLUID)			
Protein	<1.0		g/dL
COLOR			
Color	Colorless		
APPEARANCE			
Appearance	Hazy		
SPECIFIC GRAVITY			
Specific Gravity	1.005		
CYTOLOGY			
Cytology			

CLINICAL INFORMATION:
Pet acquired just 10 days ago with congestion and wheezing noted since then. Pet is now coughing, with thoracic radiographs consistent with pneumonia and WBC of 43,000/ul.

SOURCE:
Endotracheal wash, 3 submitted slides, 4 prepared direct smears and cytospins

DESCRIPTION/MICROSCOPIC FINDINGS/COMMENTS:

Microscopic Description:
Smears consist of thick mucus, bacterial colonies (rods), and sheets of nondegenerate to degenerate neutrophils with occasional respiratory epithelial cells, macrophages, and lymphocytes. Neutrophils often contain short bacterial rods.

Microscopic Findings: Marked septic suppurative inflammation

Comment:
Findings indicate bacterial pneumonia. These smears are teeming with bacteria. Recommend bacterial culture and sensitivity testing to identify these organisms and determine the appropriate antimicrobials.

June 14, 2012 – Culture

AEROBIC CULTURE & MIC	#1	#2	#3	#4
Source:	Etw			
Preliminary #1	06/15/2012			
Organism #1				
Bordatella bronchiseptica				
Heavy growth				
SENSITIVE TO:				
DOXYCYCLINE				
AZITHROMYCIN				
Preliminary #2	06/16/2012			
Final Report	06/17/2012			

MIC ORGANISM #1	MIC(UG/ML)	TEST RANGE	INTERPRETATION
Organism #1			
Bordatella bronchiseptica			
Amikacin	<=8	8-32	S
Amoxicillin	N/A	2-16	R
Ampicillin	N/A	2-16	R
Cephadroxil	>=8	4-8	R
Cefazolin	>=8	4-8	R
Cefoxitin	>=32	8-16	R
Cefpodoxime(Simplicef)	>=8	2-8	R
Ceftiofur	>=8	2-8	R
Cephalexin	>=8	4-8	R
Clavamox	<=2	2-8	S
Cefovecin	>=8	2-8	R
Enrofloxacin (Baytril)	<=0.5	0.5-2	S
Gentamicin	<=2	2-8	S
Marbofloxacin (Zeniquin)	<=1	1-2	S
Potentiated Sulfonamide	>=1	0.5-1	R

Suggested Dosing Guidelines based on MIC Results:

Amikacin: 15 mg/kg IV or SC q24h
Amoxicillin: 22 mg/kg PO q8h
Ampicillin: 40 mg/kg SC or IV q6h
Amoxicillin / clavulanic: 13.75 mg/kg PO q12h
Enrofloxacin: 5 mg/kg PO q24h
Gentamicin: 6 mg/kg IV or SC q24h
Marbofloxacin: 2.75 mg/kg PO q24h