Joint Pathology Center
Veterinary Pathology Services

WEDNESDAY SLIDE CONFERENCE 2025-2026

Conference #24 29 April 2026

CASE I:

Signalment:

9 years, castrated male, domestic shorthair, *Felis catus*, cat

History:

The cat had a history of respiratory disease diagnosed as asthma. The respiratory disease had gotten worse for two weeks prior to death. The cat had an episode of respiratory distress the evening it was taken to an emergency clinic. When placed in the carrier to be transported to the emergency clinic, the cat become extremely agitated, distressed, and was thrashing in the carrier. The cat's thrashing in the carrier eventually stopped, and the cat was dead on arrival at the emergency clinic.

Figure 1-1. Heart, cat: The myocardium of the left ventricle and interventricular septum of the heart were diffusely thickened with a small slit-like left ventricular lumen (*Photo courtesy of* New Mexico Department of Agriculture Veterinary Diagnostic Services , https://www.nmda.nmsu.edu/nmda-homepage/divisions/vds/)

Figure 1-2. Trachea, cat: The cranial 1/3 of the ventral and lateral aspects of the trachea were thickened by a light tan and firm mass that was firmly attached to both the right and left lobes of the thyroid gland. (*Photo courtesy of* New Mexico Department of Agriculture Veterinary Diagnostic Services, https://www.nmda.nmsu.edu/nmda-homepage/divisions/vds/)

Gross Pathology:

The cat was in good body condition with mild postmortem decomposition. There were small amounts of blood in the mouth, larynx, trachea and esophagus. The cranial 1/3 of the ventral and lateral aspects of the trachea were thickened by a light tan and firm mass that was firmly attached to both the right and left lobes of the thyroid gland (Figure 1).

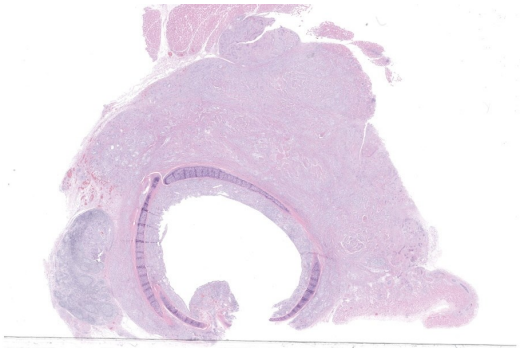

Figure 1-3. Trachea, cat: A neoplasm transmurally infiltrates the wall of the trachea and extends into the adjacent skeletal muscle and lymph node. (HE, 8X).

The right and left lobes of the thyroid gland were enlarged. The lungs were congested, heavy and wet. The heart was enlarged and weighed 24.0 grams. The myocardium of the left ventricle and interventricular septum of the heart were diffusely thickened with a small slit-like left ventricular lumen (Figure 2). The myocardium of the right ventricle of the heart was variably thickened.

Laboratory Results: There was no additional testing performed.

Microscopic Description:

The mucosal epithelium of the grossly affected trachea is multifocally eroded to ulcerated. The eroded and ulcerated tracheal mucosa is covered by a coagulum of fibrin, cellular debris and neutrophils. Where it is intact, there is multifocal squamous metaplasia of the tracheal mucosal epithelium (not present in every slide) (Figure 3). Clusters and trabeculae of neoplastic squamous epithelial cells suspended in a proliferative fibrovascular stroma variably thicken the submucosa deep to the intact tracheal mucosal epithelium (Figure 4). There are small numbers of clusters that have clear centers filled with variable amounts of cellular and necrotic debris resembling tubules. The neoplastic cells are round to polygonal with distinct cell borders, lightly eosinophilic cytoplasm and a large round nucleus. There is mild cellular and nuclear pleomorphism. There are three mitotic figures per ten high power fields. There is multifocal necrosis of the tracheal cartilage rings (not present in every slide). The peritracheal fat and skeletal muscle contain a large invasive mass of neoplastic squamous epithelial cells that encircle the right and left vagus nerves (not present in every slide). The neoplastic cells are arranged in clusters and trabeculae suspended in a dense and proliferative fibrovascular stroma. There are foci of necrosis in the mass. The cervical lymph nodes in the area contain neoplastic cells (not present in every slide) (Figure 5).

Contributor Comment:

Neoplasia of the trachea in cats is rare with most reports of neoplasia in the upper respiratory tract being in the larynx rather than the trachea.[1,2,3,4,5,6] The most commonly reported tracheal neoplasms in cats are lymphoma and carcinomas.[1,3] The reported tracheal carcinomas in cats include adenocarcinoma, squamous cell carcinoma, seromucinous carcinoma, tracheobronchial neuroendocrine carcinoma and carcinoma.[1,3] Squamous cell carcinomas were the most common tracheal carcinoma in one study of tracheal neoplasia in cats, but lymphoma was the most com-

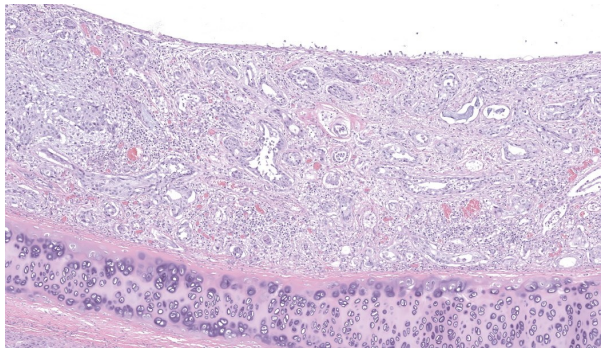

Figure 1-4. Trachea, cat: The tracheal submucosa is expanded by nests and tubules of nonkeratinizing epithelium on a dense fibrous stroma. (HE, 140X).

mon tracheal neoplasia.[3] Tracheal neoplasia tends to occur in middle age to older cats with median ages reported as 9 years and 12 years of age.[1,3] In one study, more female cats had tracheal neoplasia than male cats.[3] In the same study, Siamese cats were predisposed to develop tracheal lymphoma.

Domestic longhair cats were predisposed to develop tracheal lymphoma and adenocarcinoma. However, there are so few cats with reported tracheal neoplasia that these findings may not be accurate.

Cats with tracheal neoplasia typically have nonspecific clinical signs of airway obstruction including dyspnea, wheezing, coughing, gagging, and stridor.[1,3,4,5] These clinical signs are not specific for tracheal neoplasia and are common with a variety of respiratory diseases including feline asthma, which was the initial diagnosis for the respiratory disease in this cat.[4,5] Because they are rare and the clinical signs are not specific, the diagnosis of tracheal neoplasia is often not made until the disease is advanced.[1,3] Thus, cats diagnosed with tracheal neoplasia often have short survival times with reported overall median survival times of 15.5 days and 121 days with therapy.[3] In this case, the diagnosis of tracheal neoplasia was not made until the postmortem examination. The cat also had hypertrophic cardiomyopathy that based on the clinical history was likely to have contributed greatly to the death of the cat with the potential development of a fatal cardiac arrhythmia.

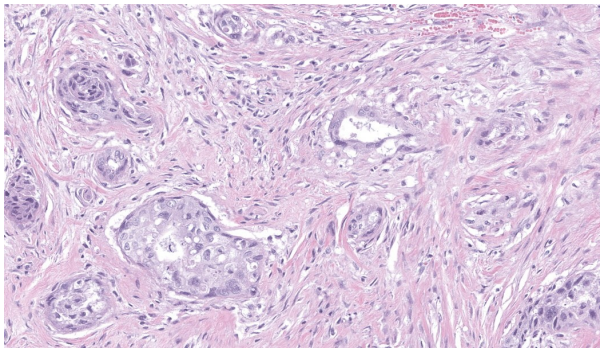

Figure 1-5. Trachea, cat: The neoplastic cells infiltrate the adjacent mediastinal tissue. is expanded by nests and tubules of non-keratinizing epithelium on a dense fibrous stroma. (HE, 348X).

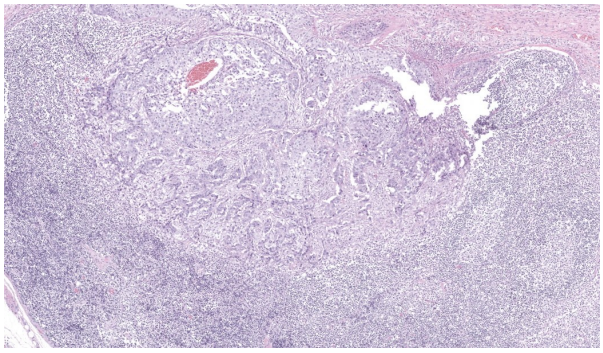

Figure 1-6. Mediastinal lymph node, cat: Neoplastic cells form nests and tubules within the paracortex and sinuses of a mediastinal lymph node. (HE, 98X)

Contributing Institution:

New Mexico Department of Agriculture Veterinary Diagnostic Services

https://www.nmda.nmsu.edu/nmda-homepage/divisions/vds/

JPC Morphologic Diagnosis:

Trachea: Adenosquamous carcinoma.

JPC Comment:

This year's 24th conference was moderated by Dr. Francisco Carvallo, a respiratory and infectious disease expert from the Virginia-Maryland College of Veterinary Medicine and a first-time moderator for the WSC! Following an excellent pre-conference lecture on the specifics and updated terminology of interstitial pneumonia, participants were treated to a respiratory-focused conference that opened with this surprisingly controversial case!

Diagnoses amongst participants on the pecise origin of this tumor (from the mucosal epithelium or the submucosal glandular

epithelium were varied due to the significant formation of tubules and acini by this neoplasm with only rare individual cell dyskeratosis. An Alcian blue stain was underwhelming due to significant background staining of tracheal mucus and ground substance, but there were some neoplastic acini that contained strongly Alcian blue-positive luminal material, indicating that neoplastic cells may be producing mucin. Additionally, the neoplastic cells lacked immunoreactivity for p63 and p40, making a diagnosis of squamous cell carcinoma less likely. Based on the morphology of the neoplasm and the suggestive results of the Alcian blue stain, the JPC decided on a diagnosis of adenosquamous carcinoma. Adenosquamous carcinoma is a rare, aggressive epithelial neoplasm that demonstrates both malignant squamous epithelial differentiation and a malignant glandular component within the same tumor.[7] Adenosquamous carcinomas tend to be highly infiltrative in the organs in which they arise and carry a poor prognosis.[7]

This neoplasm induced an impressive desmoplastic response in the surrounding connective tissue. Dr. Carvallo reviewed the pathogenesis of desmoplasia with conference attendees, talking through tumor cell signaling leading to activation of "cancer-associated fibroblasts" (CAFs) within the tumor microenvironment. Activation of CAFs induces signal transduction of pro-growth pathways that upregulate profibrotic genes, leading to production and remodeling of the extracellular matrix (ECM).[1] The increased density of the ECM can physically impede the delivery of therapeutic drugs, make it more difficult for T lymphocytes and NK cells to access the tumor (immune evasion), and enable tumor growth via sequestration of growth factors.[1] Additionally CAFs promote angiogenesis and epithelial-to-mesenchymal transition (EMT) to facilitate migration, invasion, and metastasis.[1]

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CASE II:

Signalment:

Cat, domestic shorthair, 12 years-old, neutered male.

History: The cat was euthanized and the body was transferred to the necropsy service without any medical history.

Gross Pathology: The body was well preserved. The animal was in good body condition with abundant fat. About 150 ml of a latescent thoracic effusion (suspected chylous effusion) was present and associated to a white diffuse and moderate thickening of the pleura with occasional strands of fibrin (suspected chronic fibrosing pleuritis, fig 1). No obvious cardiac anomaly was observed but alterations due to euthanasia with barbiturates prevented an optimal gross examination of the heart. Pulmonary lobes were slightly rounded and had a slightly thickened pleura. The left cranial pulmonary lobe was twisted at approximatively 180° around its hilus (lung lobe torsion), and was markedly and diffusely red, with blood oozing after sectioning (venous infarction) (fig. 2).

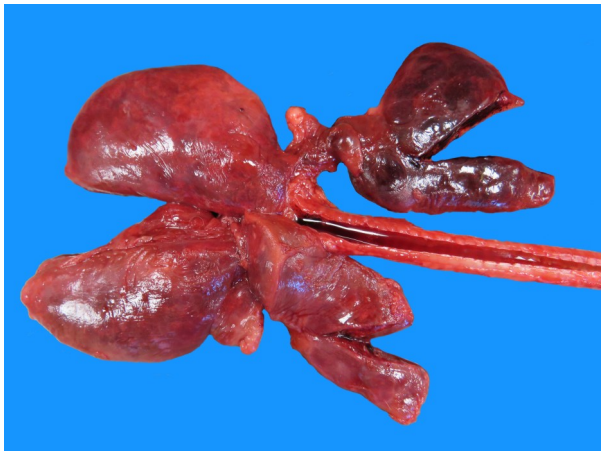

Figure 2-1. Lung, cat: The left cranial pulmonary lobe was twisted at approximatively 180° around its hilus (lung lobe torsion), and was markedly and diffusely red, with blood oozing after sectioning (venous infarction) (*Photo courtesy of* Unité d'Histologie et d'Anatomie pathologique, Ecole Nationale vétérinaire d'Alfort (EnvA). https://www.vet-alfort.fr/)

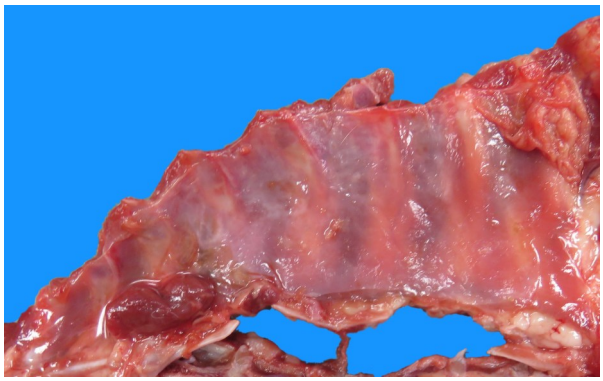

Figure 2-2. Lung, cat: There is moderate thickening of the pleura with occasional strands of fibrin (suspected chronic fibrosing pleuritis) (*Photo courtesy of* Unité d'Histologie et d'Anatomie pathologique, Ecole Nationale vétérinaire d'Alfort (EnvA). https://www.vet-alfort.fr/)

Other organs did not show significant gross lesions.

Laboratory Results:

Cytological analysis of the effusion was performed:

- gross aspect: lactescent (persistent after centrifugation)
- cellularity: 1380 nucleated cells per mm^3;
- protein concentration: 45 g/l (determined by refractometry)
- cells: numerous small lymphocytes and fewer foamy macrophages and neutrophils. No neoplastic cells or infectious agent were identified.

In cats, these findings are suggestive of a chylous effusion and/or an effusion secondary to cardiac insufficiency (although no gross cardiac anomaly was observed). Cholesterol and triglycerides concentrations were not assessed.

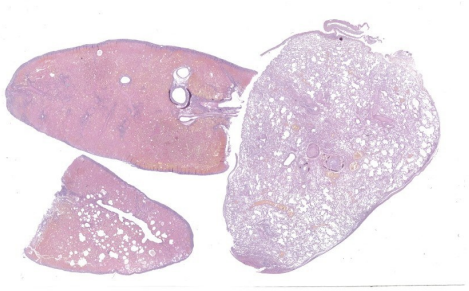

Figure 2-3. Lung, cat: Three sections of lung (two from the left cranial lobe and one from the left caudal lobe (at right) are submitted for examination. (HE, 10X)

Microscopic Description:

Heart (not submitted): No significant histological findings

Lungs: Three sections are submitted. Two are from the left cranial lobe (twisted lobe), the third one is from the left caudal lobe. Sections from the left cranial lobe show extensive and severe alveolar hemorrhages and marked vascular congestion. Alveolar walls are often diffusely eosinophilic with loss of basophilia (necrosis).

The left caudal lobe section shows occasional foci of fibrin exudation within the alveoli**.**

All three sections show a moderate to marked thickening of the pleura by a fibrovascular tissue, resembling granulation tissue, containing a variable amount of mature collagen and occasionally covered with fibrin. The underlying pleural tissue shows a slight to moderate infiltration with lymphocytes.

Prussian blue stain is negative on all sections.

Contributor's Morphologic Diagnosis:

Lungs :

Left cranial lobe: acute, severe, diffuse hemorrhagic necrosis (venous infarction) secondary to lobe torsion

Left caudal lobe: acute, minimal, multifocal, fibrinous alveolitis

Left cranial and caudal lobes: Chronic, moderate to marked, diffuse fibrinous and fibrosing pleuritis

Contributor's Comment: This case is a nice example of lung lobe torsion secondary to a chylothorax. Chylous effusions are composed of chyle. Chyle is a chylomicron-rich lymph fluid originating from the intestinal lacteals and circulating through the intestinal and mesenteric lymphatic vessels, the cisterna chyli and the thoracic duct that ultimately terminates in the left external jugular vein or jugulo-subclavian angle.[10,14] Chyle has a typical opaque white, milky (lactescent) to slightly pink color that persists after centrifugation. Cytologically, it is mainly composed of small lymphocytes and fewer foamy macrophages. Neutrophils may be present following repeated thoracocenteses. Chylous effusion can be confirmed biochemically by measurement of triglycerides and cholesterol concentrations in the effusion and in the serum: triglyceride concentration is typically higher in the effusion compared

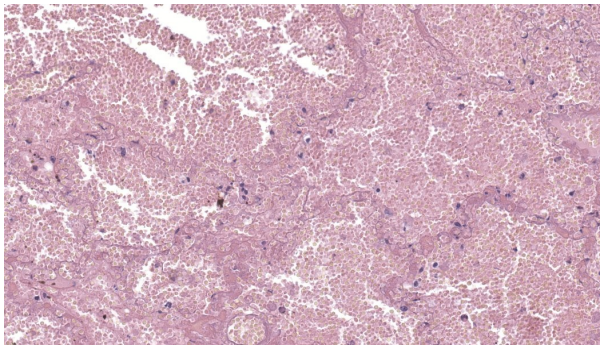

Figure 2-4. Lung, cat: High magnification of intra-alveolar hemorrhage and septal necrosis. (HE, 574X)

to serum, whereas the reverse is true for cholesterol concentration.[14]

The majority of chylous effusions are in the thorax (chylothorax). Most chylothorax are idiopathic, as suspected in this case.[10,14] Known causes of chylothorax are traumatic rupture of the thoracic duct, cardiomyopathy, right-sided heart failure, vena caval thrombosis, heart worms (dirofilariasis), thoracic neoplasia (thymoma, lymphoma, lymphangiosarcoma) or inflammatory lesions that cause obstruction of the thoracic duct.[6,10,14] Lung lobe torsion is also reported to cause chylothorax although the real sequence of events is not always clear in affected animals (see later).[12,14] Chyloabdomen is much less common than chylothorax. A study reported that almost half of chyloabdomens in dogs and cats occur in association with chylothorax and that in these cases the most common underlying cause is neoplasia.[5]

Although chyle is considered to be non-irritant, chronic chylothorax may lead to pleural fibrosis (fibrosing pleuritis), especially in cats, as illustrated in this case.[2,13,14] Macroscopically, lungs may be shrunken, rounded, and covered by a thick pleura.[2] This may lead to reduced pulmonary expansion and dyspnea even with minimal residual effusion.[2,10]

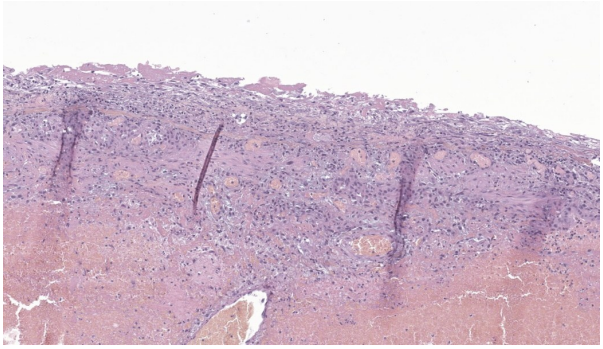

Figure 2-5. Lung, cat: There is marked thickening of the pleural surface by maturing granulation tissue, fibrous tissue and an overlying mat of fibrin. (HE, 221X)

In lung lobe torsion, affected lobes are deeply congested due to compression of veins at the site of torsion, preventing blood return to the heart and leading to severe congestion, hemorrhages and necrosis (venous infarction).[9] The compression does not affect arteries that have a thicker wall and higher hydrostatic pressure. As a consequence, blood may still penetrate the tissue.

The treatment of choice for lung lobe torsion is surgery after medical stabilization of the animal. Of note, the affected lobe should not be untwisted in order to avoid the release by hypoxic tissues of inflammatory cytokines, endotoxins, hypoxanthine and free radicals, as in the phenomenon of ischemia-reperfusion.[3,8,9]

Pleural effusion is often present in association with lung lobe torsion.[10,12,14] The effusion varies in nature (transudate, chyle, exudate, blood). There seems to be a debate regarding the pathogenesis of these effusions because some consider it to be a cause while others see it as a consequence of the lobe torsion.[8,12,14] Both cases might happen. In the present case, the lung torsion appears to be a recent event based on the lack of hemosiderin in the hemorrhagic parenchyma. On the contrary, the fibrosing pleuritis suggests that the chylothorax is chronic and should therefore be considered as the most likely cause for the lung lobe torsion in this cat.

Torsions can affect other organs such as hepatic lobes (pigs, cats, dogs, horses, rabbits), testes (horses, dogs), urinary bladder (dogs), uterus (especially in mares and cows) and caecum (cattle).[4,14] Hepatic lobe torsion has recently been described in three dromedary camels.[7]

Contributing Institution:

Unité d'Histologie et d'Anatomie pathologique, Ecole Nationale vétérinaire d'Alfort (EnvA). France

https://www.vet-alfort.fr/

JPC Morphologic Diagnosis:

1. Lung: Alveolar necrosis and hemorrhage, regionally extensive, severe (lobar torsion).
2. Lung, pleura: Pleuritis, fibrosing, chronic-active, diffuse, moderate.

JPC Comment:

The WSC has not seen a lung lobe torsion case since 1983! This second case also proved challenging and resulted in a variety of diagnoses from participants. There were some features on the slide that contributed to the confusion, including a lack of thrombosis, very little inflammation, and minimal fibrin within the lung coupled with significant edema and pleural changes (mesothelial hyperplasia, fibrosis, and fibrin). The primary supporting finding for the diagnosis of lung lobe torsion was the abundant congestion, intra-alveolar hemorrhage, and multifocal septal necrosis. The pleural changes threw participants for a loop when settling on a diagnosis. The changes were indicative of an acute-on-chronic process which, as mentioned by the contributor in their write-up, can occur with chronic chylothorax.[2,13,14] However, another primary cause for pleuritis in cats that was not tested for in this particular case is feline infectious peritonitis (FIP).[1] Although there were other features of FIP lacking in this case, it is always something to keep on the differential list for cases of pleural effusion of any kind in feline patients.[1]

A crucial contributor to the pathogenesis of lung lobe torsions is the dual blood supply to the lung, which has low and high-pressure systems. The pulmonary circulation, the low-pressure system, is where gas exchange occurs in the lung.[11] The bronchiolar circulation is the high-pressure system responsible for providing oxygen to the lung tissue itself.[11] When a lung lobe torsion occurs, the low-pressure system collapses, leading to venous infarction and coagulative necrosis of the alveoli.[9] The high-pressure system continues to pump oxygenated blood, leaving the bronchioles relatively intact.

Dr. Carvallo wrapped up this case with a discussion on a rarely mentioned topic in the lungs: the lymphatic circulation.[9] The lung does have a significant lymphatic network that drains from the interstitium to the mediastinal lymph nodes and back into the venous circulation. Lymphatic vessels are present throughout the parenchyma and subpleural spaces, but are absent within the alveolar capillary beds. They extend only as far as the respiratory bronchioles and alveolar ducts, leaving the gas exchange surfaces free of additional structures. However, in disease states, lymphatics can sprout in the alveolar interstitium, highlighting the need for a fine balance in disease between drainage of excess fluid, proteins, cells, etc. and ensuring adequate gas exchange can still occur.

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CASE III:

Signalment:

12-day-old, male, Pit bull, *Canis familiaris*, canine

History: This was the fourth puppy from the litter to develop sudden-onset dyspnea and die within hours over the past week. All the affected puppies were in excellent body condition. The dam was obtained from a county shelter, and no medical history was available. Only one puppy was submitted for postmortem examination.

Gross Pathology: The lungs were mottled dark to light red, non-collapsing, rubbery, and wet on cut section. The right middle lung lobe sank in formalin. The liver contained multifocal, pinpoint (<1.0 mm) pale red to tan foci scattered throughout all lobes. Bilaterally, both kidneys had multifocal to coalescing hemorrhagic foci (0.1–0.2 cm in diameter) within the cortex, which extended

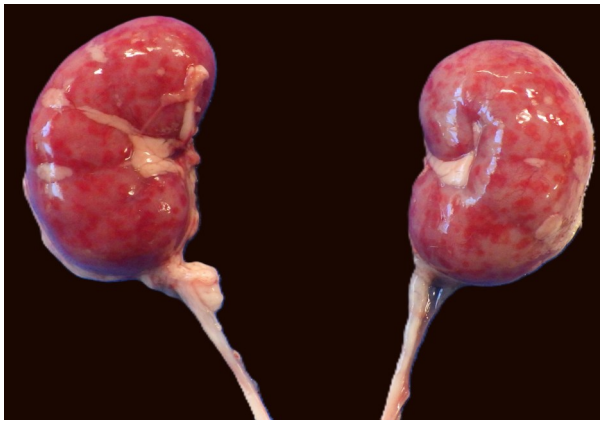

Figure 3-1. Kidneys, puppy. Distributed randomly throughout the cortex are numerous, 1-2.0 mm, red, foci. (*Photo courtesy of:* Midwestern University College of Veterinary Medicine, Diagnostic Pathology Center, https://www.mwuanimalhealth.com/diagnostic-pathology-center)

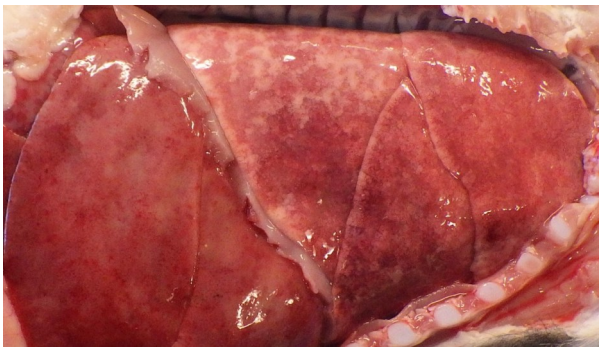

Figure 3-2. Lung and liver, puppy. Lung and liver, dog. The lungs are diffusely rubbery, firm, and fail to collapse. Throughout all liver lobes are numerous, subtle, multifocal, randomly distributed pinpoint (<1.0 mm) red to tan foci. (*Photo courtesy of:* Midwestern University College of Veterinary Medicine, Diagnostic Pathology Center, https://www.mwuanimalhealth.com/diagnostic-pathology-center)

into the corticomedullary junction on cut section.

Microscopic Description:

Kidney: Multifocally throughout the section, involving approximately 40% of the parenchyma, primarily within the cortex and extending to the corticomedullary junction, there are variably sized areas of necrosis. Affected tubules and occasional glomeruli are pale and eosinophilic, with loss of differential staining and absent to karyorrhectic nuclei, accompanied by interstitial hemorrhage and edema. Rarely, individual epithelial cell nuclei contain a single, round, eosinophilic intranuclear inclusion body that marginates the chromatin.

Lung: Multifocally throughout the section, alveolar septa are frequently and variably expanded, up to fourfold, by abundant fibrin, necrotic cellular debris, and very low numbers of neutrophils. Adjacent alveolar spaces contain similar material, along with small amounts of hemorrhage and foamy macrophages. Rarely, small eosinophilic intranuclear inclusion bodies are present within macrophages and pneumocytes at the margins of necrotic areas. The interstitium surrounding bronchi and the tunica adventitia of arteries is often expanded by a moderate amount of clear space (edema).

Contributor's Morphologic Diagnosis: Kidney, liver, brain, and lung: Nephritis, hepatitis, encephalitis, and interstitial pneumonia, necrotizing, multifocal, marked, with rare eosinophilic intranuclear inclusion bodies.

Contributor's Comment:

Canine herpesvirus type 1 (CHV-1) is an enveloped, double-stranded DNA virus in the *Alphaherpesvirinae* subfamily of the *Herpesviridae* family. First identified in the 1960s, it remains a significant cause of perinatal mortality in dogs.[2,4] The virus replicates most efficiently at subnormal body temperatures (34–36°C), which helps explain why neonatal puppies, who cannot yet regulate their body temperature well, are particularly susceptible. CHV-1 is inactivated at temperatures above 40°C, underscoring the importance of external heat support in managing suspected cases.[4]

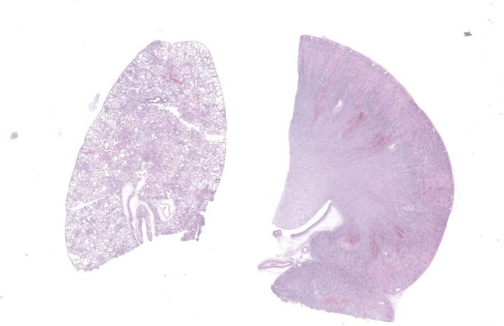

Figure 3-3. Lung and kidney, puppy: A section of lung and liver are submitted for examination. At subgross magnification, the lung is hypercellular with multifocal alveolar consolidation. There are multifocal areas of hemorrhage within the kidney and clusters of hypereosinophilic tubules. (HE, 10X)

The clinical course of infection is strongly age-dependent. Typically, puppies less than three weeks of age are at risk, often developing a fulminant, systemic infection characterized by viremia, multisystemic necrosis, and high mortality. In contrast, older puppies and adult dogs typically develop localized infections affecting the upper respiratory tract, eyes, or genital mucosa.[3,4] Infection during pregnancy in a naive bitch can result in fetal loss, abortion, or neonatal death. Surviving dogs may become latent carriers, harboring the virus in sensory ganglia with potential for reactivation during periods of stress, illness, or immunosuppression.[2,3]

Transmission in neonates occurs in utero, during passage through the birth canal, or postnatally via oronasal secretions from the dam or littermates. Fomites and caretakers may also contribute. In older dogs, aerosol transmission is more common. After local replication in the nasal mucosa and tonsils, the virus spreads to regional lymph nodes and subsequently disseminates to visceral organs and the central nervous system via infected leukocytes.[2,4]

The incubation period ranges from 6 to 10 days, and affected litters may experience mortality rates approaching 100% within a week of onset. Clinical signs include crying,

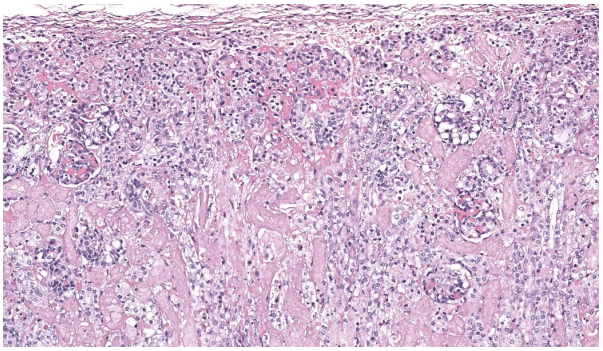

Figure 3-4. Kidney, puppy. Clusters of proximal convoluted tubules have undergone coagulative necrosis. (HE 311X)

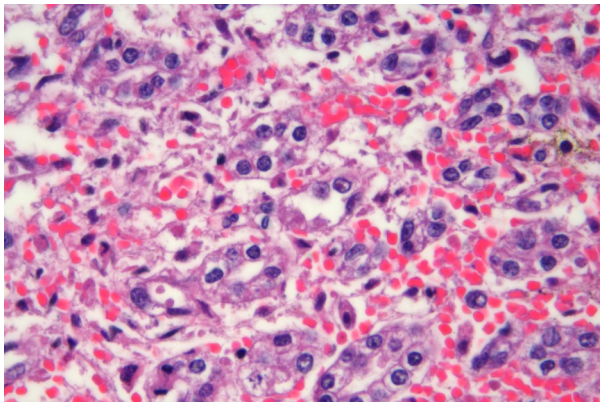

Figure 3-5. Kidney, puppy: Tubular epithelial cells at the edge of necrotic foci rarely contain an eosinophilic intranuclear inclusion body (arrow). (HE, 630X) (*Photo courtesy of:* Midwestern University College of Veterinary Medicine, Diagnostic Pathology Center, https://www.mwuanimalhealth.com/diagnostic-pathology-center)

anorexia, abdominal pain, hypothermia, and ataxia; some puppies may die suddenly with minimal premonitory signs.[3]

At necropsy, affected neonates often show characteristic gross and microscopic lesions, including multifocal hemorrhage and pallor in the liver, kidneys, lungs, spleen, and gastrointestinal tract, typically with minimal inflammation. Enlarged lymph nodes and nonsuppurative meningoencephalitis are also common. These findings are considered highly suggestive of systemic CHV-1 infection in puppies less than three weeks old.[3,4]

Contributing Institution:

Midwestern University College of Veterinary Medicine
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https://www.mwuanimalhealth.com/diagnostic-pathology-center

JPC Morphologic Diagnosis:

1. Kidney: Nephritis, necrotizing, acute,

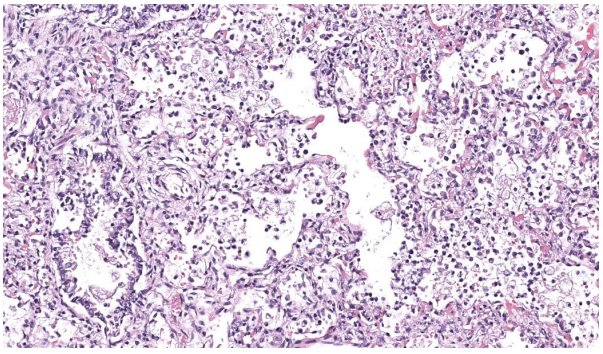

Figure 3-6. Lung, puppy: Alveolar septa are diffusely expanded by edema inflammatory cells, and cellular debris. Alveoli contain varying amounts of edema fluid, fibrin, alveolar macrophages, and cellular debris. There is multifocal necrosis and loss of airway epithelium, which often contain refluxed alveolar contents. (HE, 361X)

multifocal, moderate, with rare intranuclear viral inclusions.

2. Lung: Pneumonia, necrotizing, acute, multifocal to coalescing, moderate, with rare intranuclear viral inclusions.

JPC Comment:

What a classic case! The contributor provides a thorough, well-written comment on this entity that has been seen several times throughout the years of the WSC due to its continued relevance. Dr. Carvallo made a point to mention how pathologists should use all the clues at their disposal to help them gather as much information as possible. In this case, the size of the organs was sufficiently small that one could assume they were from a very young animal. Most would diagnose the changes in the lung as consistent with an interstitial pneumonia, but Dr. Carvallo stated that the preferred term in current veterinary literature would be "interstitial lung disease." This term is currently being added into the pathology lexicon as a broad term for cellular damage +/- leukocyte infiltration that mainly targets the interstitium, including the alveolar septa and adjacent bronchioles.[1] The term "interstitial pneumonia" is now being classified as a subtype of interstitial lung disease characterized by an increased number of leukocytes thickening the alveolar septa and vascular adventitia as seen with such diseases as ovine progressive pneumonia (OPP), porcine reproductive and respiratory syndrome (PRRS), sepsis, or parasitic larval migrations.[1]

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CASE IV:

Signalment:

3-year-old intact male Rocky Mountain bighorn sheep (Ovis canadensis canadensis).

History:

One of a group of 17 rams from a provincial park. Over a period of ~1 month several rams were observed coughing and 5 were found dead. Several animals within this group were collared allowing monitoring of movements and recovery of carcasses. Movement monitoring revealed recent proximity to a flock of domestic sheep. At the time of euthanasia, this individual appeared lethargic and had been observed coughing. This animal was euthanized by gunshot to the head and submitted for necropsy to allow for further evaluation of respiratory disease for herd management. The carcass was stored outside in -20°C temperatures for ~12 hours prior to necropsy examination.

Gross Pathology:

At necropsy examination, the distal trachea contained a small volume of stable tan foam. Approximately 20% of both left and right cranial lung lobes were firm, dark pink and well-demarcated from the surrounding parenchyma (Figure 1). On cut section, these areas exuded frothy white fluid and thin sections sank slightly in formalin before floating to the surface. Within the caudodorsal lung lobes there were ~5 indistinct multifocal firm nodules that ranged in size from 0.3 to 1.0 cm in diameter. On cut section these nodules were pale tan and merged with the surrounding parenchyma (Figure 2). Similar lung lesions were observed in other necropsied sheep from this cohort. One of the additional sheep also had unilateral suppurative mucoid yellow white fluid within the nasal passages and sinuses with diffuse reddening and slight thickening of the associated mucosa.

Laboratory Results :

Bacterial Culture Results: Lung grew 2+ *Bibersteinia trehalose*

PCR Results: *Mycoplasma ovipneumoniae* detected in lung tissue and by nasal swabs and confirmed through sequencing. Lung tissue was negative for bovine parainfluenza 3 virus, ovine progressive pleuropneumonia virus (Maedni Visna) and bovine respiratory syncytial virus.

Microscopic Description:

Two distinct patterns were observed within the examined sections of lung. Within caudodorsal regions (not apparent in submitted sections), there were large multifocal foci of mild histiocytic inflammation associated with nematodes of various life stages (adult, larval and eggs) (Figure 4 and 5). Adult

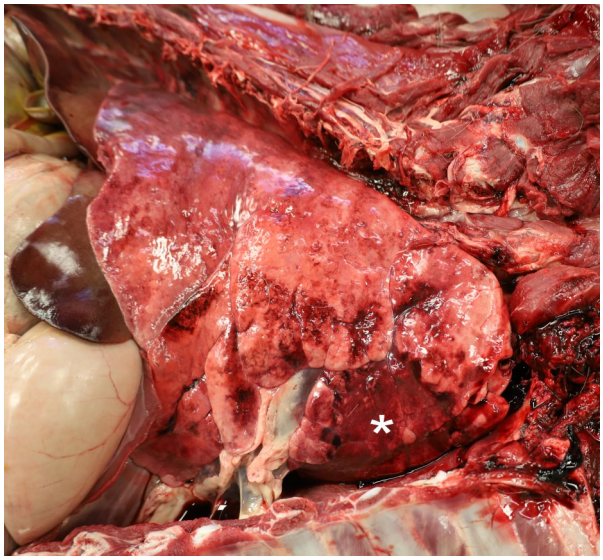

Figure 4-1. Lung, bighorn sheep. Approximately 20% of both left and right cranial lung lobes were firm, dark pink and well-demarcated from the surrounding parenchyma. (*Photo courtesy of*: Diagnostic Services Unit (DSU), University of Calgary. https://vet.ucalgary.ca/; https://vet.ucalgary.ca/departments-units/dsu/home)

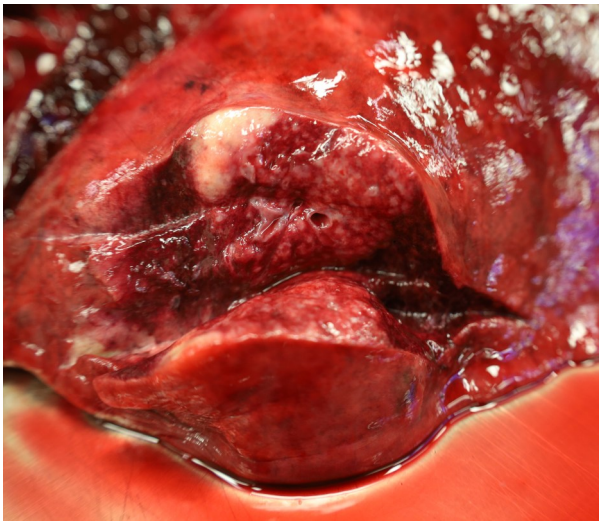

Figure 4-2. Lung, bighorn sheep. Within the caudodorsal lung lobes there were ~5 indistinct multifocal firm nodules that ranged in size from 0.3 to 1.0 cm in diameter. On cut section these nodules were pale tan and merged with the surrounding parenchyma Diagnostic Services Unit (DSU), University of Calgary. https://vet.ucalgary.ca/; https://vet.ucalgary.ca/departments-units/dsu/home)

nematodes are ~80 mm in diameter and characterized by a thick outer eosinophilic cuticle, pseudocoelom, gastrointestinal tract lined by cuboidal epithelium with a brush border and reproductive tract that is often paired. Larvae are coiled and ~15 mm in diameter. Eggs are ~50mm in diameter and surrounded by a clear capsule containing eosinophilic granular material and variable numbers of nucleated cells. Nematodes fill the alveoli and are associated with small numbers of histiocytes, lymphocytes, and plasma cells. Lymphocytes and plasma cells sometimes form small aggregates or cuffs around blood vessels. Rare adult nematodes are observed within the larger airways. Minimal inflammation extends into the surrounding parenchyma.

The second pattern (apparent in the submitted sections), observed within cranioventral sections of lung, is marked inflammation targeted towards small and large airways. Small terminal airways are most markedly affected and contain large numbers of luminal neutrophils. The surrounding respiratory epithelium is often hyperplastic and occasionally necrotic with sloughing into the airway lumen. Surrounding alveoli contain large numbers of luminal histiocytes with fewer neutrophils and occasionally are lined by cuboidal type II pneumocytes. There are rare multifocal areas of fibrin exudation into airways. Larval parasites resembling those described above are frequently seen individually within alveoli. Larger airways are often only minimally affected. Occasionally the lumen of smaller airways is compressed by nodular submucosal aggregates of inflammation (Figure 6). There are multifocal areas of acute hemorrhage throughout the lung (gunshot euthanasia associated).

Contributor's Morphologic Diagnosis:

Lung: Moderate, subacute, neutrophilic and histiocytic bronchopneumonia with epithelial hyperplasia

Lung, caudodorsal lobes: Mild, chronic multifocal histiocytic pneumonia with abundant intralesional nematodes and mild BALT hyperplasia

Contributor's Comment:

Histologic examination of the lungs confirmed a moderate bronchopneumonia as well as a mild lung worm infestation within the caudal lung lobes. A mild lymphoplasmacytic tracheitis was also present. Lung worms are ubiqui-

tous in this bighorn sheep population and are most likely *Protostrongylus stilesi*, although *P. rushii* are also observed. Bacterial culture of the lung grew a mixed population including 2+ *Bibersteinia trehalose*, a bacterial respiratory pathogen capable of causing bronchopneumonia in bighorn sheep. PCR testing of the lung was positive for *Mycoplasma ovipneumoniae* (Movi). Due to the potential for cross reaction with other *Mycoplasma spp*. sequencing was also performed for confirmation. Lung tissue was also tested and was negative for common respiratory viruses including parainfluenza 3 virus, ovine progressive pleuropneumonia virus (Maedni Visna) and bovine respiratory syncytial virus. Due to the small size of this herd, the history of other animals coughing, and the potential for transmission to a larger nearby group of ewes and lambs, culling of the remaining rams was initiated. The majority of the additional rams that were necropsied exhibited bronchopneumonia similar to that already described.

Epizootic outbreaks of pneumonia have been a population limiting problem in bighorn sheep likely since the early 20th century and the expansion of humans and domestic small ruminants west across North America.[3] Although pneumonia was recognized early as an important disease in wild bighorn sheep, and outbreaks were known to occur following exposures to domestic small ruminants, determining a definitive etiology took many years. Often, multiple potential respiratory pathogens were detected and therefore bighorn sheep pneumonia was discussed as a disease complex.[1] Associated etiologies that were explored included lungworms (both *P. rushii* and *P. stilesi*), leukotoxin producing members of the *Pasteurellaceae* family (*Mannheimia haemolytica*, *Bibersteinia trehalose* and *Pasteurella multocida*) and *Mycoplasma ovipneumoniae*. Viral respiratory pathogens including parainfluenza virus 3 and respiratory syncytial virus were also occasionally detected, but less commonly.

Advanced molecular techniques and careful experimental infections eventually lead to the identification of Movi as the most significant and essential pathogen in epizootic pneumonia of bighorn sheep.[2] Within domestic small ruminants, Movi is known as a cause of generally mild chronic bronchopneumonia in lambs, also known as atypical pneumonia or chronic non-progressive pneumonia.[9] Movi can affect several non-domestic species of the *Caprinae* subfamily including bighorn sheep, Dall's sheep, mountain goats and muskox, and is often carried in the nasal passages of healthy domestic sheep and goats. [5,10] Outbreaks in bighorn sheep can often be traced to contact with domestic small ruminants, more often sheep than goats. Movi associated outbreaks in bighorn sheep occur in two distinct forms. The first introduction of a novel strain of Movi to a naïve population leads to a slowly

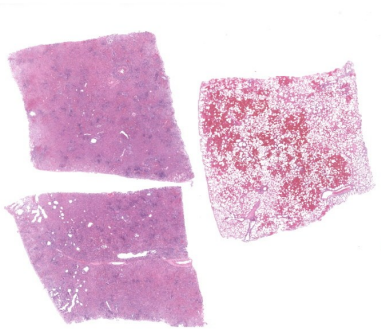

Figure 4-3. Lung, bighorn sheep. Three sections of lung are submitted for examination, with two of three being diffusely consolidated. (HE, 10X)

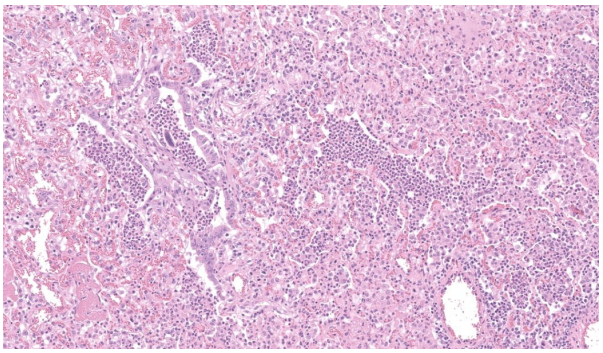

Figure 4-4. Lung, bighorn sheep. Diffusely alveoli and airways are filled with large numbers of neutrophils admixed with varying amounts of fibrin, edema and cellular debris. There are rare larval nematodes within both. (HE, 249X)

progressing pneumonia that affects all age classes and often results in high morbidity and mortality rates of 30-90%.[1] Reported clinical signs include coughing, nasal discharge, head shaking and ear drooping. The resultant pneumonia is frequently made more severe by secondary bacterial involvement often with members of the *Pasteurellaceae* such as the *Bibersteinia trehalose* observed in this case. Recurring outbreaks in subsequent years affect primarily lambs due to transmission from carrier ewes, and lead to low lamb recruitment and poor population growth. The outcome of infection in a population can be quite variable depending on complex interactions between host immunity, bacterial strain and environmental factors. Currently there are no vaccines or antibiotic therapies that have been found to be effective. [4]

Movi pneumonia bears some resemblance to the atypical pneumonia of pigs caused by *M. hyopneumoniae* and shares several histologic and pathogenic features with other members of the *Mycoplasma* genus. *Mycoplasma spp.* target and destroy the cilia of airways impeding mucocilliary clearance and predisposing the lungs to secondary bacterial infection.[1] Characteristic histologic features include hyperplasia of bronchiolar and alveolar epithelium, lymphoid (BALT) hyperplasia around airways and blood vessels, bronchiolar mucous metaplasia and more chronically, formation of distinct hyaline scars.[7] Hyaline scars are a unique feature that bear some resemblance to bronchiolitis obliterans observed in chronic bovine pneumonias, including those with *Mycoplasma bovis*. Hyaline scars are described as nodular broad-based accumulations of brightly eosinophilic poorly cellular material below the respiratory epithelium that result in compression and distortion of the airway lumen.[9] Unfortunately, depending on chronicity, many cases, including the current one, lack these characteristic histologic features and PCR testing and sequencing is necessary to confirm the diagnosis. In addition to bronchopneumonia, other Movi associated lesions include tracheitis, rhinitis, sinusitis and otitis media. [1]

Management of these outbreaks requires an adaptive approach and can be quite challenging depending on the timing of detection and many other factors. [4] Preventative management should focus on minimizing contact between bighorn sheep and domestic small ruminants. In first incursion outbreaks, or when only a small herd is affected, complete

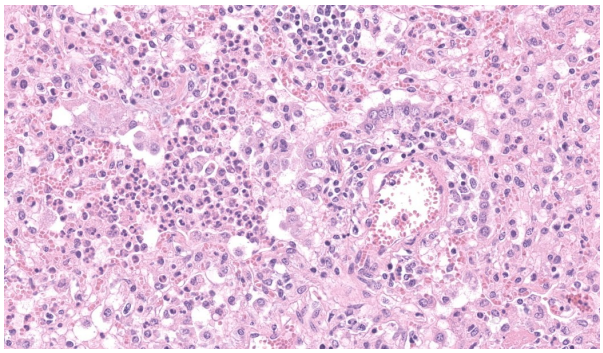

Figure 4-5. Lung, bighorn sheep. Higher magnification of the ninfalmmatory exudate. There is scattered type II pneumocyte hyperplasia. (HE, 594X)

depopulation may be an effective strategy given the short survival of the bacteria in the environment; Movi bacteria persist for only minutes outside of the host.[4] In more chronically affected populations, management may focus on testing and removal of carrier individuals. In this particularly outbreak, culling of the small affected herd seems to have been effective in preventing spread to the surrounding populations.

Contributing Institution:

Diagnostic Services Unit (DSU) within the Faculty of Veterinary Medicine, University of Calgary.

https://vet.ucalgary.ca/

https://vet.ucalgary.ca/departments-units/dsu/home

JPC Morphologic Diagnosis:

Lung: Bronchopneumonia, suppurative and histiocytic, subacute, diffuse, marked, with mild BALT hyperplasia, early obliterating bronchiolitis, and numerous metastrongyle larvae.

JPC Comment:

This case was an excellent example of a real-world diagnostic case with multiple pathogens. This contributor provided a fantastic comment on *Mycoplasma ovipneumonae* (Movi) and *Bibersteinia trehelosi*, as well as gave an honorable mention to the ubiquitous lungworms *Protostrongylus spp*, in their write-up. Movi is the #1 infectious disease of Bighorn sheep.[1] In cases of "bighorn sheep pneumonia", Movi is frequently the primary initiator of outbreaks and lays the foundation for a polymicrobial pneumonia.[1]

Bibersteinia trehelosi, previously *Pasteurella trehelosi*, is a common nasal commensal that is opportunistic in cases of bighorn

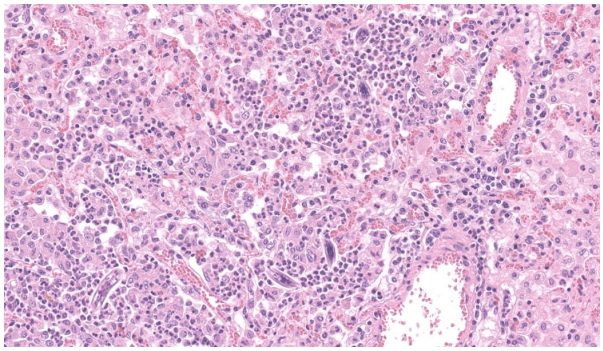

Figure 4-6. Lung, bighorn sheep. There are scattered cross- and tangential sections of nematode larva within the alveolar exudate. (HE, 471X)

sheep pneumonia.[1,6] It is best known for its role in systemic pasteurellosis in 4-9mo lambs and is also considered one of the pathogens within the ovine respiratory complex.[6]

Participants discussed the potential identity of the nematodes and considered *Dictyocaulus filaria, Muellerius capillaris, or Protostrongylus spp*. *Dictyocaulus spp* were quickly ruled out as they are larger lungworms that usually reside in the upper airways.[8] *Muellerius capillaris* was similarly discounted as they tend to accumulate in subpleural nodules.[8] *Protostrongylus spp*, however, are small and tend to disperse diffusely throughout the pulmonary parenchyma, as seen in this case.[8]

The lungs here also highlighted nice examples of early obliterating bronchiolitis (also representing the continuing evolution of terminology, having been previously referred to as "bronchiolitis obliterans"), characterized by organizing aggregates of fibrin that are covered by bronchiolar epithelial cells within bronchiolar lumens.

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