The Armed Forces Institute of Pathology
Department of Veterinary Pathology
WEDNESDAY SLIDE CONFERENCE
2004-2005

CONFERENCE 4
6 October 2004

Conference Moderator: LTC Dana Scott, DVM, Diplomate ACVP
Department of Veterinary Pathology
Armed Forces Institute of Pathology
Washington, DC 20306

CASE I – 04-19232-7 (AFIP 2936303)

Signalment: Four and a half year-old, castrated, male Vizsla, canine.

History: This dog had a history of chronic back pain (localized to the thoracolumbar junction) and generalized skin lesions (consistent with pyogranulomatous dermatitis /panniculitis on biopsy) for 9 months and was treated with cyclosporine, antibiotics and corticosteroid treatment with no clinical improvement. One week prior to death, the dog presented clinically with a head tilt and mild ataxia, but otherwise normal behavior and mentation. Medications were continued (prednisone, tetracycline, niacinamide, safflower oil for back pain and skin condition). About six days later, the dog became acutely anorexic and depressed in the morning, progressing to lateral recumbency by evening, and died.

Gross Pathology: The auricles, pericardium, epicardium and endocardium have numerous, multifocal to coalescing, pinpoint to approximately 0.5 cm in diameter, white to tan, firm, slightly raised foci (Fig.1). The foci are diffusely tan on cut section and extend approximately 2-3 mm into the myocardium.

Laboratory Results: *Aspergillus* sp. was cultured in small numbers mixed with heavy *Cladosporium* sp. growth (likely environmental contaminant).

Contributor's Morphologic Diagnosis: Severe, multifocal, pyogranulomatous myocarditis with intralesional septate fungal hyphae (*Aspergillus* spp.)

Contributor's Comment: Histologic evidence of fungal hyphal structures were found in the heart (Figs. 2, 3), brain, lungs, liver, adrenal glands, lymph nodes, kidney, adipose tissue, subcutaneous tissues and vasculature. The gross and histologic lesions in this dog are consistent with a severe, disseminated fungal infection. The histologic appearance of the fungal hyphae with hematoxylin & eosin and special fungal stains (GMS, PAS) is compatible with *Aspergillus* sp. (Fig. 4). The central nervous system

involvement and multiple organ failure resulted in clinical neurologic disease and ultimately led to this animal's demise. It was possible that the fungal infection occurred secondarily to chronic steroid-induced immune suppression and antibiotic therapy, and may not be associated with the inciting cause for the initial presenting complaint 9 months prior. The cause of the back pain was undetermined. There were no histologic indications of spinal cord lesions or fungal infiltration in sections from the thoracolumbar junction.

Aspergillus sp. is a saprophytic, ubiquitous mold that ordinarily occurs as an opportunist rather than a pathogen.[1] Two forms of aspergillosis have been described in dogs – localized infection of the nasal cavity and paranasal sinuses (primarily caused by *Aspergillus fumigatus* or *A. flavus*) and disseminated mycotic infection.[2] In dogs, disseminated aspergillosis is relatively rare. Most cases of aspergillosis have been reported in the German Shepherd Dog suggesting a possible inherent inability to mount an effective immune response against the organism.[2,3] In people, disseminated aspergillosis has been seen exclusively in immune suppressed or immune-deficient individuals; however, the same association has not been documented in infected dogs.[2] The use of corticosteroids and other immunosuppressive drugs may increase the susceptibility and incidence of systemic aspergillosis in treated dogs.[4]

AFIP Diagnosis: Heart: Epicarditis and myocarditis, necrotizing and granulomatous, multifocal to coalescing, marked, with vasculitis, and pigmented and non-pigmented fungal hyphae, Vizsla, canine.

Conference Comment: Mycotic diseases may be broken down into two groups: those caused by opportunistic fungi and those caused by primary pathogens associated with systemic "deep" mycoses.[5] Examples of both primary and opportunistic fungi are listed below:

<u>Opportunistic fungi infections</u>
1. Aspergillosis (*Aspergillus* sp.)
2. Zygomycosis
    - Mucorales: *Rhizopus* sp.
        - *Absidia* sp.
        - *Mucor* sp.
    - Entomophthorales: *Basidiobolus* sp.

<u>Primary pathogenic fungi infections</u>
1. Blastomycosis (*B. dermatitidis*)
2. Histoplasmosis (*H. capsulatum*)
3. Cryptococcosis (*C. neoformans*)
4. Coccidioidomycosis (*C. immitis*)

Conidiobolus sp.
3. Pythiosis (*Pythium insidiosum*)
4. Phaeohyphomycosis (*Cladosporium* sp.)

In the slides examined by conference attendees there are high numbers of non-pigmented fungal hyphae (Aspergillus sp.) and low numbers of pigmented fungal hyphae (Cladosporium sp.) with some sections containing a prominent vasculitis. As mentioned by the contributor, *Aspergillus* spp. are ubiquitous fungi. They are an important cause of disease in birds but are opportunistic pathogens in immunosuppressed domestic animals and humans. Typical gross findings include multifocal to coalescing pale nodules. Histologically, aspergillosis is characterized by fungal granulomas or pyogranulomas composed of a central area of necrosis containing hyphae that are 3-5 _m wide, with regularly septate parallel walls, and dichotomous acute angle branching, surrounded by variable numbers of neutrophils, lymphocytes, epithelioid macrophages, and fibroblasts. Many cases also demonstrate vasculitis.[6]

The pigmented fungal hyphae are consistent with *Cladosporium* sp. with 2-6 _m wide, long, closely septate hyphae with non-parallel walls, non-dichotomous branching, and occasional thick-walled vesicular swellings.[6] Phaeohyphomycoses are uncommon opportunistic infections caused by a number of dematiaceous (pigmented) fungi. *Cladosporium* spp. primarily affect dogs and cats with a predilection for the central nervous system, only occasionally causing systemic disease. Grossly, the granulomas may appear pigmented. Histologically, the fungal elements may be very pale to very dark depending on the amount of pigment. The pigment is melanin and generally stains with Fontana-Masson. As with other opportunistic mycoses, conformation of the etiology is based on concomitant demonstration of hyphae in tissue and culture of a morphologically compatible organism from properly obtained tissue specimens.[7]

Contributor: University of Illinois, College of Veterinary Medicine, Department of Veterinary Pathobiology, 2001 S. Lincoln Avenue, Urbana IL (http://www.cvm.uiuc.edu/vp)

References:

1. Jones TC, Hunt RD, King NW: Diseases caused by fungi. *In*: Veterinary Pathology, 6th ed., pp. 506-507. Williams and Wilkins, 1997
2. Watt PR, Robins GM, Galloway AM, O'Boyle DA: Disseminated opportunistic fungal disease in dogs: 10 cases (1982-1990). JAVMA **207**:67-70, 1995
3. Robinson WF, Connole MD, King TJ, Pitt JI, Moss SM: Systemic mycosis due to *Aspergillus deflectus* in a dog. Aust Vet J **78**:600-602, 2000
4. Pastor J, Pumarola M, Cuenca R, Lavin S: Systemic aspergillosis in a dog. Vet Rec **132**:412-413, 1993
5. Lopez A: Respiratory system, thoracic cavity, and pleura. *In*: Thompson's Special Veterinary Pathology, eds. McGavin MD, Carlton WW, Zachary JF, 3rd ed., pp.184-185. Mosby, St. Louis, MO, 2001

6. Chandler FW, Kaplan W, Ajello L: Color Atlas and Text of the Histopathology of Mycotic Diseases, pp.34-37, 92-95,144-157, 253-255. Year Book Medical Publishers, Inc., Chicago, IL, 1980
7. Foil CS: Miscellaneous fungal infections. *In*: Infectious Diseases of the Dog and Cat, ed. Greene CE, 2nd ed., pp. 426-428. W.B. Saunders Company, Philadelphia, PA, 1998

CASE II – CP04-1187-02 (AFIP 2938293)

Signalment: Six month-old, male, p53 -/- Background strain: C56BL/6;129SJ mouse.

History: The mouse was hunched, lethargic and had a rough hair coat.

Gross Pathology: The thymus was white, soft and markedly enlarged. There was a small, slightly dark, raised nodule in the heart.

Laboratory Results: None

Contributor's Morphologic Diagnoses: Thymic lymphoma; Cardiac hemangiosarcoma

Contributor's Comment: Multiple neoplasms are present. The thymus is effaced by a monomorphic population of densely packed sheets of lymphocytes. The cells have round to oval nuclei with finely dispersed chromatin and one prominent nucleolus. Individual cells have a small rim of cytoplasm and discernable cell borders. Anisokaryosis and anisocytosis are moderate. The mitotic rate is high, 8-12 per 400x field of view. Apoptotic cells are common, giving the mass a starry sky appearance. Focally in the intraventricular septum there is a multinodular poorly circumscribed proliferation of plump polygonal cells that line blood-filled spaces. Neoplastic lymphocytes can also be seen along the epicardium in some sections.

Mutation of the *p53* tumor suppressor gene occurs in a high percentage of human tumors including, colon, breast, lung and brain. In most cases the *p53* mutation is acquired in somatic cells. However, some individuals inherit a mutant *p53* allele and are predisposed to develop a malignancy when a "second hit" or loss of the normal allele occurs. This is referred to as Li-Fraumeni syndrome.

The *p53* protein (P53) is localized to the nucleus and functions to prevent the proliferation of cells with DNA damage due to irradiation, UV light, or mutagenic chemicals by way of repair or apoptosis. When damage occurs, P53 levels rapidly increase and arrest the cell cycle by transcription of *p21*, an inhibitor of cyclin dependent kinases that in turn prevent the phosphorylation of Rb, preventing entry into the S phase of the cell cycle. Transcription of *GADD45*, (Growth Arrest and DNA Damage) by *p53*, assists in DNA repair. If DNA damage is repaired, P53 activates

mdm2 whose product binds to and down-regulates *p53* releasing the cell cycle arrest. If DNA repair is unsuccessful, *p53* initiates apoptosis through *bax* and IGF-BP3. IGF-BP3 binds insulin-like growth factor receptor and *bax* antagonizes *bcl-2*.[3]

Mice deficient in *p53* are prone to the development of tumors. The tumor spectrum in *p53*-mutant mice includes thymic lymphoma (T-cell type), rhabdomyosarcoma, fibrosarcoma, hemangiosarcoma, teratoma, anaplastic sarcoma, osteosarcoma, lung adenocarcinoma, hair matrix tumor, leiomyosarcoma, and rarely brain tumors. Mice with a homozygous null mutation of *p53* have a higher incidence of lymphomas usually in the thymus. In mice with a heterozygous mutation, sarcomas predominate. Loss or decline of the wild type P53 activity has been demonstrated in tumors of *p53* heterozygotes. Mice homozygous for *p53* mutation have an accelerated rate of malignancy with the majority of the animals dying by six months of age. Occurrence of two distinct tumor types, like this case, is not uncommon. Lymphoma with a sarcoma or a teratoma is the most common observation.[1,2]

AFIP Diagnoses: 1. Thymus: Lymphoma, *p53* -/- C56BL/6;129SJ mouse, murine. 2. Heart, myocardium: Hemangiosarcoma.

Conference Comment: Not all sections contained the myocardial hemangiosarcoma and only some sections contained neoplastic lymphocytes within the epicardium.

The contributor provides a thorough overview of *p53* and its critical role in cell cycle modulation. Carcinogenesis is a multistep process at the phenotypic and genetic level. The fundamental changes in cell physiology that determine malignancy include: self-sufficiency in growth signals (proliferation without external stimuli, often due to oncogene activation); insensitivity to growth-inhibitory signals (especially transforming growth factor beta (TGFß) and direct inhibitors of cyclin-dependent kinases); evasion of apoptosis (often through inactivation of *p53*); defects in DNA repair; limitless replicative potential (associated with maintenance of telomere length); sustained angiogenesis (induced primarily by vascular endothelial growth factor (VEGF)); escape from immunity and rejection; and the ability to invade and metastasize.[4]

Simply put, a malignant neoplasm is the result of acquired (environmental) DNA damage that is not repaired or an inherited mutation in genes affecting DNA repair, cell growth or apoptosis. Regardless of the initiating events, the end result is a mutation in the genome of somatic cells leading to activation of growth-promoting oncogenes, inactivation of tumor suppressor genes, and/or alterations in genes that regulate apoptosis. The mutated cells then undergo unregulated cell proliferation and sometimes decreased apoptosis. Within this clonal expansion, there may be cells that undergo additional mutations, eventually resulting in tumor progression, invasion and metastasis.[4]

Contributor: St. Jude Children's Research Hospital, Dept. of Pathology, Room 5017C, 332 N. Lauderdale, Memphis TN

References:
1. Donehower LA, Harvey M, Slagle BL, McArthur MJ, Montgomery CA, Butel JS, Bradley A: Mice deficient for p53 are developmentally normal but susceptible to spontaneous tumours. Nature **356**(6366):215-221,1992
2. Jacks T, Remington L, Williams BO, Schmitt EM, Halachmi S, Bronson RT, Weinberg RA: Tumor spectrum analysis in p53-mutant mice. Curr Biol **4**(1):1-7, 1994
3. Cotran RS, Kumar V, Collins T: Neoplasia. *In*: Pathologic Basis of Disease, 6th ed., pp. 290-292. WB Saunders Company, Philadelphia, PA, 1999
4. Kumar V, Abbas AK, Fausto N: Neoplasia. *In*: Robbins and Cotran Pathologic Basis of Disease, 7th ed., pp. 288-290. Elsevier Saunders, Philadelphia, PA, 2005

CASE III – 423102 (AFIP 2938284)

Signalment: Eleven-month-old, spayed female, Cocker Spaniel, *Canis familiaris,* dog.

History: After an elective ovariohysterectomy in January 2004, the patient developed waxing and waning fevers with persistent neutrophilic leukocytosis. The dog was re-examined by the referring veterinarian in June 2004. A mass was identified in the patient's lower left abdominal quadrant, and a fine needle aspirate of the mass revealed suppurative inflammation. Exploratory laparotomy revealed an omentum-encased surgical sponge.

Gross Pathology: The mass was submitted as a surgical biopsy specimen. It was 6.5 cm x 5.5 cm x 3.5 cm, lobulated, firm, tan to pale brown and was covered by flecks of clotted blood. In the center of the mass there was entrapped surgical sponge material.

Laboratory Results: Abnormal hematology and serum biochemistry test results were as follows:
1. Leukocytosis (25.5 x 10^3/µl; Reference range - 6.0 to 14.3) with neutrophilia (20.4 x 10^3/µl; Reference range - 3.3 to 10.1) and monocytosis (1.4 x 10^3/µl; Reference range - 0.1 to 0.9)
2. Normocytic normochromic anemia
    - Low erythrocyte count - 5.50 x10^6/µl (Reference range - 5.8 to 8.9)
    - Low hemoglobin – 12.7 g/dl (Reference range - 14.3 to 21.1)
    - Low hematocrit - 37.8% (Reference range - 41.7 58.1)
    - Normal Mean Corpuscular Volume - 68.7 fl (Reference range - 63.2 to 76.8)
    - Normal Mean Corpuscular Hemoglobin Concentration - 33.6 g/dl (Reference range - 32.4 to 38.4)
3. Hypoalbuminemia (3.0 g/dl; Reference range - 3.1 to 4.2)
4. High serum alkaline phosphatase (202 Units/liter; Reference range - 7 to 128)
5. Low serum alanine aminotransferase (14 Units/liter; Reference range – 21 to 97)

There was scant growth of beta hemolytic *Streptococcus* serotype group G on aerobic culture.

Contributor's Morphologic Diagnosis: Adipose tissue, omentum**:** Marked chronic regionally extensive pyogranulomatous omentitis with intralesional surgical sponge material (gossypiboma).

Contributor's Comment: The technical term for a surgical sponge accidentally left inside a patient's body is "gossypiboma." The word is derived from the Latin word *Gossypium* for cotton and the Swahili word *boma* for *"place of concealment"*.[3] Retained surgical sponges seem to be fairly common in human surgical practice and a higher incidence of retained laparotomy sponges has been reported in association with gynecological procedures.[1,3] Intraperitoneal "forgotten" foreign bodies tend to create adhesions and become encapsulated, with or without an accompanying bacterial infection.[1] Clinical presentations for patients with a retained surgical sponge may be acute or chronic. Acute presentations generally follow a typical septic course with abscess or granuloma formation.[3] Delayed presentations may occur months or even years after the original surgical procedure and be heralded by adhesion formation and encapsulation.[3] Occasionally there may be intestinal obstruction and rarely fistulation, perforation or even extrusion.[3] The animal of this report was clinically normal within 36 hours of its exploratory laparotomy, and the dog's post surgical recovery continues to be uneventful.

AFIP Diagnosis: Omentum (per contributor): Omentitis, pyogranulomatous, sclerosing, marked, focally extensive, centered on abundant fibrillar anisotropic foreign material (surgical sponge), Cocker Spaniel, canine.

Conference Comment: Conference attendees discussed the clinical pathology findings and how these relate to the molecular basis of acute and chronic inflammation. The normocytic normochromic anemia is likely due to the chronic inflammatory condition and was probably non-regenerative (anemia of inflammatory disease, AID). AID occurs in chronic infectious, inflammatory, or neoplastic disorders and is mediated by a variety of cytokines, including tumor necrosis factor (TNF), IL-1, and interferon gamma. The resultant anemia is due to decreased bone marrow responsiveness to erythropoietin, decreased release of erythropoietin, and impaired availability of iron to the erythron. When the primary cause of AID is removed, the anemia will resolve.[4]

Other systemic affects of inflammation include fever, release of acute phase proteins, and leukocytosis. Fever is produced in response to pyrogens that act by inducing prostaglandin synthesis in the hypothalamus. Exogenous pyrogens (bacterial products) stimulate leukocytes to release IL-1 and TNF (endogenous pyrogens) that result in increases in cyclooxygenases, which then convert arachidonic acid (AA) to prostaglandins. Prostaglandins, especially PGE_2, stimulate the production of neurotransmitters that reset the temperature set-point at a higher level. Acute phase

proteins are plasma proteins that are primarily synthesized in the liver and often function as opsonins and fix complement. Three of the best-known examples include C-reactive protein (CRP), fibrinogen, and serum amyloid A protein (SAA). Cytokines such as IL-6 (for CRP and fibrinogen) and IL-1 and TNF (for SAA) induce hepatocytes to upregulate production of these acute phase proteins. A common feature of inflammatory reactions, especially those induced by bacterial infection, is a leukocytosis. Initially the increase in WBCs is due to accelerated release of cells from the bone marrow postmitotic pool, induced by IL-1 and TNF. Prolonged infection induces production of colony stimulating factors (CSFs) and results in increased bone marrow output.[5,6] The neutrophilia and monocytosis in this case is due to the inflammatory reaction and release of cytokines as a result of the foreign material in the abdomen.

Contributor: Angell Animal Medical Center, Pathology Service, 350 South Huntington Avenue, Boston, MA

References:

1. Lauwers PR, Van Hee RH: Intraperitoneal gossypibomas; the need to count sponges. World J Surg **24**(5):521-527, 2000
2. Papazoglou LG, Patsikas MN: What is your diagnosis? Retained surgical sponge. J Small Anim Pract **42**(7):325, 363, 2001
3. Zbar AP, Agrawal A, Saeed IT, Utidjian MR: Gossypiboma revisited: a case report and review of the literature. J R Coll Surg Edinb **43**(6):417-418, 1998
4. Brokus CW, Andreasen CB: Erythrocytes. *In*: Duncan and Prasse's Veterinary Laboratory Medicine Clinical Pathology, eds. Latimer KS, Mahaffey EA, Prasse KW, 4th ed., pp.38-39. Iowa State Press, IA, 2003
5. Latimer KS, Prasse KW: Leukocytes. *In*: Duncan and Prasse's Veterinary Laboratory Medicine Clinical Pathology, eds. Latimer KS, Mahaffey EA, Prasse KW, 4th ed., pp.51-52. Iowa State Press, IA, 2003
6. Kumar V, Abbas AK, Fausto N: Neoplasia. *In*: Robbins and Cotran Pathologic Basis of Disease, 7th ed., pp. 84-85. Elsevier Saunders, Philadelphia, PA, 2005

CASE IV – NIAH-1 (AFIP 2937643)

Signalment: 3-week-old, male, white leghorn, specific-pathogen-free chicken.

History: This chicken was inoculated by eye drop with 0.1ml of inoculum containing 10^7 plaque-forming units (PFU) of viscerotropic velogenic Newcastle disease virus. The chicken died three days after inoculation, and was necropsied.

Gross Pathology: There was bilateral reddening and swelling of the lower conjunctiva. The lesions on the inoculated side were more severe than on the opposite side. There were multifocal white foci on the spleen, and occasionally hemorrhages in the mucosa of the proventriculus, duodenum, and cecal tonsil in the chicken.

Laboratory Results: Newcastle disease virus was isolated from the conjunctiva using a cell culture originating from chicken kidney cells.

Contributor's Morphologic Diagnosis: Conjunctiva: Conjunctivitis, acute, severe, with fibrinoid vascular necrosis, fibrinous thrombi, hemorrhage, and edema, white-leghorn, chicken.

Contributor's Comment: Newcastle disease (ND), a serious world-wide poultry disease, is caused by ND virus (NDV), a member of the genus *Rubulavirus*, family *Paramyxoviridae*. ND is divided into five pathotypes.[1] Viscerotropic velogenic ND (VVND) (Doyle's form), is a very acute and lethal form of ND with hemorrhagic lesions of the digestive tract. Neurotropic velogenic ND (NVND) (Beach's form) has neurological and respiratory lesions. Mesogenic ND (Beaudette's form) is an acute respiratory and sometimes lethal nervous infection of young chicks. Mortality is rare in older birds. Lentogenic ND (Hitchner's form) is a mild or inapparent respiratory infection of chickens. Asymptomatic-enteric form (Ulster type) manifests chiefly as gut infections with lentogenic viruses, causing no obvious disease.

Lymphoid, vascular, respiratory, neural, and reproductive lesions are seen in the chickens as pathological features of ND.[1] It is also well known that NDV causes conjunctivitis[1-4,6] and induces conjunctivitis in humans.[5] In these human cases, an epidemic of Newcastle disease occurred in turkeys in 1965 and 1966 in the United States, and several workers in close contact with the turkeys at the processing plant developed a follicular conjunctivitis with a rise of antibodies against NDV.[5] Therefore, ND is one of a few chicken zoonotic diseases. Clinically, conjunctivitis is a significant sign of ND.

Virulent avian influenza virus infection and VVNDV infection, acute fatal diseases with systemic hemorrhages in the chickens, are very important diseases of the poultry industry. It is necessary to diagnose and differentiate them as rapidly and correctly as possible. There are few reports on conjunctivitis induced by virulent avian influenza except one report of avian-influenza-virus-induced conjunctivitis,[7] while there are many reports on macroscopical NDV-associated –conjunctivitis.[1-4,6] Detection of conjunctivitis with vascular necrosis can be important in the diagnosis of VVND infection in the chickens, although more pathological studies of chickens infected with NDV are necessary.

AFIP Diagnosis: Eye, conjunctiva: Conjunctivitis, acute, focal, moderate, with necrotizing vasculitis, white leghorn chicken, avian.

Conference Comment: The contributor provides a brief overview of the various pathotypes of Newcastle Disease (ND). Viscerotropic velogenic ND (VVND) is the most severe form of ND and is likely the most serious disease of poultry throughout the world.

VVND affects numerous species of exotic pet and exposition birds, waterfowl, and domestic poultry. Transmission between birds is via aerosolization and transmission between premises is often via fomites. In affected birds, morbidity rates approach 100 percent and mortality often reaches as high as 90 percent. Neurologic and gastrointestinal signs are most common. However, non-vaccinated birds may be found dead without prior signs of illness. Gross lesions include subcutaneous and periocular edema, hemorrhagic and catarrhal tracheitis, airsacculitis, necrohemorrhagic enteritis (often with Peyer's patch and cecal tonsil ulceration), petechial hemorrhagic proventriculitis, and yolk peritonitis.[1,8] Histologic findings include necrotizing vasculitis, thrombosis, diffuse lymphoid depletion, and nonsuppurative encephalomyelitis.[1]

ND belongs to the Paramyxoviridae virus family, and like other members of this group, has two important surface proteins, hemagglutinin/neuraminidase (HN) and fusion (F) protein. HN is important in initial attachment of the virus to the host cell receptor. F protein has a critical role in virus and cell fusion and penetration of the host cell membrane. Other viruses in the family Paramyxoviridae include the following:[9]

Subfamily Paramyxovirinae
Genus *Paramyxovirus*
- Bovine parainfluenza virus-3
- Sendai virus (mouse parainfluenza-1)
- Human parainfluenza virus-1 and –3

Genus *Rubulavirus*
- Avian paramyxovirus-1 (NCDV)
- Simian virus-5
- Mumps virus
- Human parainfluenza virus-2

Genus *Morbillivirus*
- Canine distemper virus
- Rinderpest virus
- Peste-des-petits-ruminants virus
- Dolphin Morbillivirus
- Phocine distemper virus
- Measles virus

Subfamily Pneumovirinae
Genus *Pneumovirus*
- Bovine respiratory syncytial virus
- Pneumonia virus of mice
- Turkey rhinotracheitis virus
- Human respiratory syncytial virus

Contributor: National Institute of Animal Health, Laboratory of Chronic Diseases Pathology, 3-1-5, Kannondai, Tsukuba, Ibaraki 305-0856, Japan (http://www.niah.affrc.go.jp/index-j.html)

References:

1. Alexander DJ: Newcastle disease and other avian paramyxoviridae infections. *In*: Diseases of Poultry, eds. Saif YM, Barnes HJ, Glisson JR, Fadly AM, McDougald LR, Swayne DE, 11th ed., pp.64-87. Iowa State University Press, Ames, IA, 2003
2. Brown C, King DJ, Seal BS: Pathogenesis of Newcastle disease in chickens experimentally infected with viruses of different virulence. Vet Pathol **36:**125-132, 1999

3. Cheville NF, Stone H, Riley J, Ritchie AE: Pathogenesis of virulent Newcastle disease in chickens. J Am Vet Med Assoc **161:**169-179, 1972
4. Katoh H: Pathological Studies on Newcastle disease: Laryngotracheal and conjunctival lesions caused by so-called Asian type Newcastle disease virus. Jap J Vet Sci **39:**15-26, 1977
5. Hales RH, Ostler HB: Newcastle disease conjunctivitis with subepithelial infiltrates. Brit J Ophthal **57:**694-697, 1973
6. Spalatin J, Hanson RP, Jones TD: Edema of the eyelid and face of chickens exposed to the viscerotropic type of Newcastle disease virus. Avian Dis **17:**623-628, 1973
7. Uys CJ, Becker WB: Experimental infection of chickens with influenza A/Tern/South Africa/1961 and chicken/Scotland/1959 viruses. II. Pathology. J Comp Pathol **77:** 167-173, 1967
8. Website: http://www.vet.uga.edu/vpp/gray_book/pdf/VND.htm
9. Lamb RA, Kolakofsky D: Paramyxoviridae: The viruses and their replication. *In*: Fundamental Virology, eds., Fields VN, Knipe DM, Howley PM, 3rd ed., pp. 577-588. Lippincott-Raven, Philadelphia, PA, 1996

Shelley P. Honnold, DVM
Major, Veterinary Corps, U.S. Army
Wednesday Slide Conference Coordinator
Department of Veterinary Pathology
Armed Forces Institute of Pathology
Registry of Veterinary Pathology*

*Sponsored by the American Veterinary Medical Association, the American College of Veterinary Pathologists and the C. L. Davis Foundation.