Respiratory System
Module 2
The Nasal Cavity, Paranasal Sinuses, Guttural Pouches, Larynx, Trachea and Bronchi

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## Rhinitis and Tracheitis According to the Type of Exudate

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<td>Reactive sub mucosal glands</td>
<td>Mild irritation</td>
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<td>Catarrhal</td>
<td>Goblet cell hyperplasia and mucosal gland hypersecretion</td>
<td>Chronic, irritation, moderate injury</td>
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<td>Fibrinous</td>
<td>Fibrinogen leakage from nasal blood vessels</td>
<td>Severe tissue injury</td>
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<td>Purulent</td>
<td>Exudation and accumulation and of neutrophils (pus)</td>
<td>Pyogenic organisms</td>
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<td>Granulomatous</td>
<td>Accumulation of macrophages, lymphocytes, plasma cells and connective tissue</td>
<td>Chronic inflammation, pathogens resistant to phagocytosis</td>
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Two types of exudates can be seen at the same time with names such as mucopurulent (mucus and pus); fibrinopurulent (fibrin and pus); fibrinonecrotic (fibrin and necrosis); fibrinohemorrhagic (fibrin and blood), etc
Canine Infectious Respiratory Disease (CIRD) previously referred to as “Kennel Cough” comprises a number of acute vial infections caused by canine distemper virus (Morbillivirus), canine adenovirus (CAV-2), canine parainfluenza virus (CPI-1), and canine influenza (CIV H3N8).

CIRD usually produces acute transient viral rhinitis, but sometimes becomes complicated with bacteria (*Bordetella bronchiseptica*, *E. coli*, *Streptococci*, *Staphylococci*) and turn into a chronic bacterial rhinitis and sinusitis.

In canine distemper, non-suppurative encephalitis and enteritis have more clinical significance.
Chronic Rhinitis

Note lymphocytes and plasma cell diffusely infiltrating the nasal submucosa (arrows) and goblet cell hyperplasia with mucus hypersecretion (star).

Note mucopurulent discharge in nostrils
**Chronic Mucopurulent Rhinitis in a Dog**

- This dog was euthanized because of poorly response to treatment.
- The palate was removed to visualize the exudate in the nasal cavity (arrows).
- Note copious mucopurulent exudate in the nasal cavity (asterisk).
- Chronic inflammation results in goblet (mucus) cell hyperplasia and excessive mucus production.
5-yr-old Great Dane with a 9-month history of nasal discharge. Nasal biopsy confirmed mycotic rhinosinusitis (see link below for more information).

A nasal biopsy is showing lymphocytes and plasma cells infiltrating the nasal mucosa (arrow) and a large mass of non-septate fungal hyphae (star).

http://www.vet.ohio-state.edu/assets/courses/vcs753/case3/case3.html
Examples of Rhinitis in Cats

Note mucopurulent exudate in nostrils

Exudates (arrow) and turbinate necrosis (star)
Rhinitis with conjunctivitis is common in cats.

The most frequent etiologies:

**Viral:**
- Feline Calicivirus
- Feline Infectious Rhinotracheitis

**Bacterial:**
- *Bordetella bronchiseptica*
- *Escherichia coli*
- *Streptococcus*
- *Staphylococcus*
- *Chlamydiaphila psittaci*

**Mycotic:**
- *Cryptococcus neoformans*

Etiological diagnosis requires laboratory tests like bacteriology, virology or immunohistochemistry.
Chronic Rhinitis Causes Bone Loss

Neutrophils cause bone lysis and promote osteoclastic resorption (loss) of bone.

Chronic Rhinitis

Unilateral loss of conchal bone

Bone loss
Cryptococcus neoformans / Cryptococcus gatti

- Important mycotic disease of the nasal cavity and sinuses of cats
- Not all cats that get in contact with Cryptococcus get the disease.
- Immunosuppression is a major risk factor.

Thick copious mucopurulent discharge also covering the left orbital skin.

Multiple yeasts surrounded by a thick capsule (hallo) H&E. PAS and Mucicarmine stains reveal that the capsule is composed of polysaccharide (arrows)
Necrosis of the nasopharynx

Purulent exudate (**star**) and hyperemia (arrows).

Purulent exudate on dorsal and ventral conchae and in meatuses.

Example of Purulent Rhinitis in Cattle

Neutrophils admixed with fibrin.

Purulent exudate (**star**) and hyperemia (arrows).
Example of Fibrinous Rhinitis in Cattle

Thick layer of fibrin on the nasal mucosa (star). Fibrinous exudation implies severe tissue where blood fibrinogen leaks and subsequently is polymerized into fibrin.

- This is an example of a viral rhinitis (IBR -BovHV-1) complicated with a superimposed bacterial infection.

- Bacteria that cause this type of secondary infection can be inhabitants of the normal flora.
Granulomatous rhinitis is typically caused by organisms that survive phagocytosis such as *Mycobacterium spp*, fungal organisms such as *Cryptococcus* and *Blastomyces* among others. Allergic rhinitis has also been reported in cattle with nasal granulomas.
Example of Purulent Rhinitis in a Pig

Gross: Thick layer of fibrinopurulent exudate on the nasal mucosa (star).

Histo: Large aggregate of neutrophils on the mucosa surface

Remember, bacteria like *Bordetella bornchispetica* and *Pasteurella multocida* that cause this type of lesion are inhabitants of the normal flora.
Inclusion Body Rhinitis

- Inclusion Body Rhinitis is caused by a Herpes virus (Cytomegalovirus) in piglets less than two weeks old.
- The infection often goes unnoticed causing only transient rhinitis
- Epiphora (overflow of tears) results from the obstruction of lachrymal ducts. Tears mix with dust and dirt producing localized skin irritation around the eyes (white arrow).
- There is no mortality except in immune-suppressed piglets that develop a disseminated fatal infection.
- Grossly, there is only nasal hyperemia.
- Histologically, the mucosa shows gigantic (cytomegalic) cells (black arrows) containing large basophilic intranuclear inclusion bodies, hence the term "Cytomegalovirus."
Atrophic Rhinitis of Pigs

- Atrophic Rhinitis is a widely distributed disease of pigs, and the etiology has been controversial.
- Current literature suggests a co-infection with toxigenic Pasteurella multocida and Bordetella bronchiseptica.
- To check for atrophic rhinitis, the snout is typically cut transversally between the 1 and 2nd premolars.
Four sections of snouts that illustrate moderate to severe atrophy of conchae. Pigs with atrophic rhinitis may have a higher incidence of pneumonia. The effect on weight gain is still controversial.
Strangles (*Streptococcus equi*) is an important equine disease that may occur as an outbreak with high morbidity (90%) but low mortality (5% > foals). It causes purulent (suppurative) rhinitis and lymphadenitis with the formation of abscesses.

Some horses can develop a fatal immune-mediated vasculitis known as *purpura hemorrhagica*.

Bacterial metastasis to the internal organs is referred to as "bastard strangles."

Involvement of retropharyngeal lymph nodes can compress laryngeal nerves and cause secondary laryngeal hemiplegia.

For an excellent 6-minute podcast of Strangles click on the YouTube
Purulent Rhinitis in a Horse / Strangles Postmortem

Note plaque of exudate in the nasopharynx (arrow) and mucosal hyperemia (asterisk).

Aggregates of neutrophils in nasal epithelium (star).
1. Sinusitis
2. Guttural pouch empyema
3. Lymphadenitis and abscesses
4. Meningitis
Examples of Granulomatous Rhinitis in Horses

Note polypoid nodule in the nasal cavity. Although it looked tumoral, histopathology revealed a multilobulated granuloma containing round bodies with a thick capsule (arrows).

Organisms were identified as *Rhinospndium seeberi*, a human and animal pathogen classified as a protist and not as a true fungus.
Guttural Pouches

Note how thin is the membrane that forms the guttural pouch.

Forceps showing the nasopharyngeal opening into the guttural pouch (star).

- Guttural pouches are ventral dilations of auditory tubes (Eustachian tubes) in horses.
- Eustachian tubes connect the middle ear with the pharynx in all species.
- The function of the guttural pouches is uncertain, but it is believed that cool down the blood going to the brain.
Mucus from the guttural pouches moves into the pharynx and swallowed. Flow obstruction results in accumulation of mucus known as "guttural pouch mucocele."

Alterations in the defense mechanisms can lead to secondary bacterial or fungal infection of the guttural pouches.

Pyogenic bacteria can cause accumulation of pus known as "guttural pouch empyema."

Guttural pouch tympany is an abnormal accumulation of air.

Fungal infections are known as guttural pouch mycosis.
Guttural Pouch Tympani

- Guttural pouches overdistended with trapped air.

- Typically occurs from the first few days of life to 1-year-old foals

- Clinically characterized by large swelling of guttural pouches.

- Minimal distress (non-painful), stridor.

- The pathogenesis refers to the unidirectional air flow caused by the valve action of an abnormal nasopharyngeal orifice.

Note swelling of the guttural pouch (arrows).
Empyema of guttural pouches can be uni- or bilateral.

It is often a sequel of upper respiratory infection with *S. equi* (Strangles) or other pyogenic bacteria.

Clinical signs include intermittent nasal discharge, enlargement of retro pharyngeal lymph nodes, and parotid swelling.

In severe cases, guttural pouch empyema can interfere with swallowing (dysphagia).

Note mucopurulent discharge from the nostrils (blue arrow).
Guttural Pouch Empyema

Endoscopy

- Note thick purulent exudate in the right guttural pouch (arrow).

- Endoscopy is useful for the clinical diagnosis of guttural pouch empyema.

Postmortem

- Note thick purulent exudate in the left guttural pouch.
- Right pouch distended with exudate.

- Etiological diagnosis always requires bacterial culture.
Multifocal, round, raised plaques of fibrinonecrotic exudate on the surface of the pouch mucosa (arrows).

Large, solid mass of fibrinonecrotic exudate firmly attached to the guttural pouch mucosa (asterisk).

Microscopic view of fungal hyphae in mycotic plaque (black arrows). HE

C = occipital condyles.
Guttural pouches are immediately adjacent to the internal carotid artery and several cranial nerves.

Erosion of the carotid artery is an important sequel to guttural pouch mycosis. It causes epistaxis that is in some cases fatal.

Thrombosis of a carotid artery leading to brain thromboembolism is another sequel to guttural pouch mycosis.

Injury to cranial nerves is another important sequel.
The incidence of nasal tumors in domestic animals is low and are most commonly seen in dogs and cats, and to a lesser extent, horses.

The old notion that long-nose breeds dogs are most frequently affected is now uncertain.

Retrovirus-induced nasal carcinoma in ruminants is common in some geographical areas.

Nasal tumors often bleed or become infected causing a nasal discharge often mistaken for a bacterial or mycotic rhinitis.

Nasal tumors cause damage to nerves and brain and a variety of neurological signs.
Nasal Tumors

Nasal tumors of stromal origin:
- Fibrosarcoma
- Chondrosarcoma
- Other

Nasal tumors of epithelial origin:
- Adenomas (rare).
- Carcinomas (more common).

Clinical Diagnosis:
- Radiographs / CT / MRI
- Rhinoscopy
- Cytology
- Biopsy

Cytology or biopsy
(algorithm)
Inflammation vs Neoplasia
Note growth of a large tumoral mass in the nasal cavity (asterisks).
Cat had progressive swelling of facial bones and loose teeth.

Cytological examination demonstrated malignant epithelial cells. A biopsy confirmed the histopathological diagnosis of a nasal carcinoma.

Because of the poor prognosis, the cat was euthanized and sent to postmortem examination.

Nasal Carcinoma / Cat

Tumor arising from the nasal epithelium. This tumor was locally invasive, but there was no evidence of metastasis.

Note sheaths of neoplastic epithelial cells with abundant cytoplasm and large nuclei. HE.
Large tumoral mass occupying the entire left nasal cavity. Histopathology confirmed the diagnosis of Fibrosarcoma.
Nasal Carcinoma with Metastasis to the Brain

Brain hemorrhage and necrosis caused by a metastatic nasal carcinoma (arrow)

Nasal tumor eroding the cribiform plate (arrows)

Tomography: Brain metastasis (arrow)
• Retroviral-induced neoplasia of sheep and goats.

• In some endemic regions the incidence is high.

• Clinical signs are nonspecific and include severe respiratory distress, nasal hemorrhage, weight loss (cachexia).

• Tumor typically arises from the ethmoidal conchae and expands into the nasal cavity destroying the nasal conchae. Craniofacial deformities are rarely seen.
Nasal Lymphoma / Horse

1-year-old Stallion with history of maxillary swelling
Postmortem: 10-cm mass in the right maxilla

Dr. Shannon Martinson

Monomorphous population of neoplastic lymphocytes
**Necrotic Laryngitis (Calf Diphtheria)**

Calf Diphtheria is a secondary infection caused by *Fusobacterium necrophorum* in animals in which the integrity of the normal laryngeal mucosa has been compromised such as in viral infections (i.e. IBR), trauma, excessive vocalization (separation anxiety).

Pieces of exudate can be aspirated into the lung and cause necrosuprative bronchopneumonia.

Plaques of fibrinonecrotic diphtheritic exudate (asterisk) in the larynx.
Tracheitis Based on type of Inflammation

- Purulent
- Fibrinous
- Granulomatous
Pure viral tracheitis is rarely seen at necropsy since it is not fatal unless complicated with bacteria. This kind of inflammation occurs in viral tracheitis superimposed with bacteria.
This cow was accidentally given a disinfectant (ammonium chloride) which was subsequently aspirated.

Necrotic mucosa detaching from the trachea (diphtheritic membranes).

Fibrinonecrotic exudate on tracheal mucosa (diphtheritic membranes).

Fibrinonecrotic Tracheitis
Canine trachea and lungs with parasitic bronchitis caused by *Oslerus* (*Filaroides*) *osleri*. This metastrongyle nematode affects young dogs worldwide.

Clinical signs in severe parasitic infections include a cough, inspiratory wheezing, exercise intolerance, etc.

The parasitic nodules are at the tracheobronchial bifurcation but occasionally extend deeper into the distal bronchi.

Microscopic appearance of nodules in the bronchial lumen (BL) lined by ciliated epithelium (arrows) and containing coiled parasites (asterisks).
Lungworms are nematodes that parasitize the bronchi and bronchioles causing chronic bronchitis and bronchiolitis.

These parasitic infections are referred to as verminous pneumonia or verminous bronchitis.

The most common lungworms are:

- *Dictyocaulus viviparus* (Bovines)
- *Dictyocaulus filariae* (Ovine)
- *Metastrongylus apri* (Porcine)
- *Cronosoma vulpis* (Foxes, dogs)
Animals with severe parasitic bronchitis develop obstructive pulmonary disease caused by bronchial plugs of mucus mixed with parasites.

The bronchial obstruction could also lead to atelectasis (to be discussed in next tutorial module).

Diagnosis in the life animal is made by finding parasitic larvae in feces by the Baernann technique.
According to the exudate, rhinitis is classified in serous, catarrhal, purulent, mucopurulent, fibrinous and granulomatous. Fibrinous rhinitis typically implies severe mucosal injury with leakage of fibrinogen from blood vessels.

Feline Calicivirus, Feline Infectious Rhinotracheitis, *Chlamydophila* spp and the fungus *Cryptococcus neoformans* are primary causes of rhinitis in cats. *Bordetella bronchiseptica*, *E. coli* and Streptococcus spp are common secondary bacteria in feline rhinitis.

IBR, EVR, PI-3 virus, Adenovirus, Canine Distemper, Canine Adenovirus (CAV-2) and Canine PI-1 virus are also important pathogens of the nasal cavity.

Rhinitis can have nasty sequels such as sinusitis, meningitis, lymphadenitis in all species, and guttural pouch empyema in horses.

Inclusion Body Rhinitis is a transient infection of young piglets caused by herpes-cytomegalovirus. The infection induces cell enlargement and large intranuclear inclusions. In rare cases, disseminated fatal infection can occur.

Atrophic rhinitis is a common disease characterized by inflammation and atrophy of the nasal turbinates. The proposed etiology is a dual infection with toxigenic strains of *Pasteurella multocida* and *Bordetella bronchiseptica*. 
**Streptococcus equi** is the causative agent of Strangles in horses that causes severe rhinitis, sinusitis, lymphadenitis and in some cases guttural pouch empyema.

Accumulation of mucus in sinuses is known as sinus mucocele and accumulation of purulent exudate is known as sinus empyema.

Guttural pouches are ventral dilations of the auditory (Eustachian) tubes in horses.

The most common guttural pouch problems are empyema, mucocele, tympany, mycosis, and hemorrhage.

Because of the close association of guttural pouches with blood vessels epistaxis and neurological signs are common complications.

Nasal tumors often produce nasal discharge mimicking rhinitis or can induce exophthalmia or craniofacial deformation. The final diagnosis requires lab work, a nasal biopsy.

In small ruminants, nasal carcinomas are often caused by a retrovirus.

Nasal tumors are usually invasive and can metastasize to the brain.
Necrotic laryngitis, also known as Calf Diphtheria, is caused by *Fusobacterium necrophorum*. Lesions consist of fibrinonecrotic plaques in laryngeal mucosa causing airway obstruction and possible aspiration of exudate into the lungs or disseminated fusobacteremia.

Tracheitis, the inflammation of the tracheal mucosa, can be caused by a virus, bacteria, fungus, tracheal aspiration or irritant gases.

Viral tracheitis, such as bovine Herpsevirus-1 (IBR), is often complicated by a secondary bacterial infection.

*Oslerus osleri* is a parasitic disease of dogs and other carnivores characterized by the presence of large nodules in the tracheobronchial bifurcation. It only has clinical significance very severe infections.

Some nematodes known as lungworms parasitize the bronchi and bronchioles causing chronic bronchitis and bronchiolitis (Verminous Pneumonia).

The best-known lungworms are *Dictyocaulus viviparus* in cattle, *Dictyocaulus filariae* in sheep, Metastrongylus apri in pigs, and *Cronosoma vulpis* in foxes, dogs, and other wild mammals.
I hope that you enjoyed this module, but most important, that you learned something about respiratory pathology

If you have any critiques or found mistakes, please let me know at lopez@upei.ca

For a quick Quiz, please go to the next slide
Click or “copy and paste” the link into your browser

Some images were acquired from veterinary colleges of Canada, United States, and Mexico and the names of pathologists who contributed with some slides are known. Their valuable contribution is sincerely acknowledged.

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