Respiratory System Pathology

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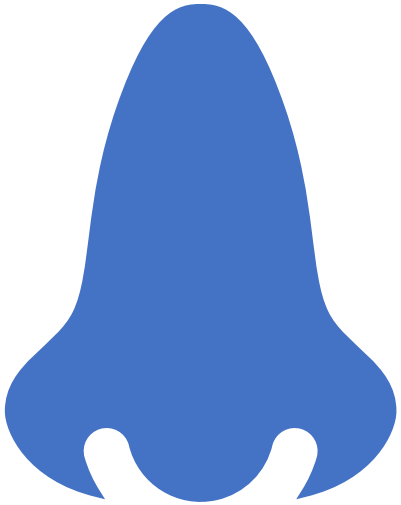

Specific Diseases of the Nasal Cavity and Sinuses

Equine Diseases with Rhinitis

- Glanders
- Pseudoglanders
- Strangles
- Streptococcal infections
- Equine viral rhinopneumonitis
- Equine influenza
- Infectious bovine rhinotracheitis (IBR)
- CGB
- Inclusion body rhinitis, etc.

RUAM (*Malleus, glanders*)

Etiology:

Burkholderia mallei (formerly *Pseudomonas mallei*, *Malleomyces mallei*, *Leofflerella mallei*), a Gram-negative, aerobic bacillus.

Susceptible animal species:

A disease of equids.

Occasionally occurs in humans (zoonosis) and in carnivores (lion, tiger, dog, cat) consuming horse meat.

Goats and sheep are susceptible to contact infection, whereas cattle and pigs are resistant.

Glanders (*Malleus*, *Ruam*)

- Glanders is among the oldest recorded infectious diseases, historically prevalent in military animals.
- Owing to its high lethality, it constituted one of the earliest biological agents employed in warfare.

Glanders (*Malleus, Ruam*)

- Following the increase in motorized transportation and the implementation of serological diagnostic methods, eradication programs led to a rapid decline of the disease worldwide.
- However, it still persists in some countries of Eastern Europe and Asia.
- In Turkey, although it was endemic until the 1970s, conscious eradication programs have nearly eliminated the disease since then.

Glanders (*Malleus*, *Ruam*)

Characteristics of the Agent and Transmission:

- The agent is sensitive to environmental conditions.
- Infection spreads through **direct or indirect** contact with the **excretions and discharges** of infected animals.
- Transmission likely occurs via the **oral route**, and experimental oral infections have successfully produced a **typical chronic respiratory disease**.

Pathogenesis of Infection:

- Intranasal and intratracheal inoculations result in the acute form of the disease.
- Aerogenic infection has also been reported.
- Entry of the agent through nasal mucosa or skin wounds is of minor significance.

The disease usually follows a chronic course.

The agent is commonly detected in skin lesions, nasal mucosal lesions, and discharges.

In horses developing the acute disease, and more commonly in donkeys, the agent spreads to multiple tissues.

It is excreted via feces, urine, saliva, and lacrimal secretions.

Pathogenesis:

- Current knowledge is *insufficient to fully explain* the pathogenesis.
- The agent **typically reaches** the nasal cavity and lungs **through secondary routes.**
- **Nasal glanders usually develops secondarily (hematogenous spread),** whether the agent is ingested or inhaled.
- Entry through nasal mucosal wounds is of minor importance.
- Cutaneous glanders occurs via skin wounds but develops secondarily from the respiratory system.
- From these sites, the agent may disseminate to other organs.

Pathogenesis :

- It is assumed that the agent, **taken orally**, passes through the *pharyngeal and possibly intestinal mucosa* and **localizes in lymph nodes**.
- In this focus, the agent either multiplies or is eliminated.
- From the lymph nodes**, it spreads to the lungs via lymphatic and blood circulation**.
- In the lungs, it causes localized *cellular infiltrations*.
- *Sometimes* the disease **remains at this stage** and may even **resolve** (primary glanders).
- In most cases, however, it disseminates to other organs, particularly to the nasal mucosa, producing **rhinitis malleosa.**

In horses, chronic glanders syndrome presents **in three forms of lesions.**

Pulmonary glanders----- Exudative / Nodular lesions

Nasal glanders------- Ulcerative / Nodular lesions

Cutaneus glanders------- Ulcerative / Nodular lesions

- During the course of the disease, *progression from one form to another may occur*, and cases have been observed in which an animal exhibits **all three forms** simultaneously.

- In the acute form of the disease in donkeys, as well as during exacerbations of the chronic form in horses, all three forms may occur simultaneously.

Clinical findings

- Clinical symptoms appear depending on the severity and distribution of pathological lesions.
- Acute nasal glanders begins with fever and chills.
- **Usually a unilateral nasal discharge is present.**
- **The discharge** is initially *serous*, later becoming sticky, mucopurulent, and finally *purulent*.
- It is green-yellow in color, often containing blood and exfoliated epithelial cells forming floccular structures.
- Inflammation is frequently bilateral and also involves the pharynx and larynx.
- When lesions are localized in the larynx, stenosis develops; regional lymph nodes are enlarged, and the glottis is edematous.
- Affected animals may exhibit dysphagia and respiratory distress.

- **Characteristics of the Chronic Form**
- Occurs mainly in the lungs.
- **Clinical Findings:**
  - Irregular and recurrent fever
  - Chronic bronchitis
  - Dry, harsh, and sometimes mild cough
  - Varying degrees of dyspnea (shortness of breath)
  - Signs of bronchopneumonia and pleuritis
- **General Condition:**
  - Activity decreases, and cachexia develops in affected animals.

- **Epistaxis and pulmonary hemorrhage** may occur during this stage.
- Some cases may recover, while debilitated animals may *die within 2–3 weeks*.
- In the latent form, clinical signs are absent.
- Certain cases resolve spontaneously.
- In cutaneous glanders, besides pathological lesions, **phlegmon** in the legs may lead to **elephantiasis.**

Nasal glanders *(Rhinitis malleosa)*

Nasal glanders *(Rhinitis malleosa)*

Macroscopic Findings:

- Nasal cavity lesions begin as **pyogranulomatous changes** in the submucosa.
- Typical nasal lesions appear as multiple **small nodules** in the submucosa, surrounded by a hyperemic zone.
- Nodules may occur as single or widespread lesions.

- The centers of the nodules undergo suppuration and necrosis of the overlying mucosa, resulting **in primary glanders ulcers (lenticular ulcers)** with straight edges and flat bases, resembling punch-hole defects.
- These ulcers may coalesce, forming **secondary ulcers (“chewed ulcers”)** characterized by raised margins and bases composed of granulation tissue.
- Subsequently, new generations of nodules and ulcers may develop.

- Sticky exudate rich in infectious agents is discharged from the ulcers.
- In mild cases, granulation tissue develops at the site of the ulcers.
- Subsequently, contraction of collagen fibers leads to the formation of stellate fibrous scars (glanders scars, **scatrix**).
- Nodules, ulcers, and scars may be observed simultaneously in the nasal mucosa.
- The number of lesions varies from case to case.

- In mild cases, a few nodules appear in the posterior part of the nasal cavity (especially on the nasal septum), while the anterior part shows only hyperemia and catarrh.
- In severe cases, lesions are present throughout the nasal cavity.
- **Perforation** of the nasal septum may also occur.

- **Microscopic Findings:**
- Since the agent reaches the nasal mucosa secondarily, the first microscopic finding is *vascular hyperemia* and *inflammatory thrombosis* (forming the hyperemic ring around the nodule).
- In the perivascular tissue, there is dense infiltration of neutrophilic leukocytes along with hemorrhages.
- Many neutrophils undergo nuclear fragmentation (***karyorrhexis***), producing an appearance similar to scattered coal dust.
- ***Karyorrhexis*** is considered **a characteristic finding** for the diagnosis of glanders.

- **At the stage of ulcer formation**, tissue loss extends from the epithelial layer into the submucosa.
- As the lesion progresses, histiocytes increase in addition to neutrophils.
- Epithelioid cells and, in part, multinucleated giant cells develop from histiocytes.
- Lymphocytes are located more peripherally, while fibrocytes and fibroblasts form the outermost layer.
- Over time, granulation tissue increases, becomes rich in collagen fibers, and eventually forms fibrous scar tissue.
- In nasal glanders, submaxillary and retropharyngeal lymph nodes consistently show lymphangitis: nodules appear in acute cases, whereas scars are found in chronic cases.

- **Laryngeal Lesions in Glanders:**
- Lesions resemble those in the nasal cavity.
- They may extend to the cartilage and cause focal necrosis.
- Edema of the glottis leads to dysphagia and respiratory distress.

- **Tracheal Lesions in Glanders:**
- Tracheal lesions are usually of the ulcerative type, and less frequently appear as pyogranulomatous nodules.
- They generally develop as a result of pulmonary glanders lesions opening into the bronchi and bronchioles.
- These lesions are characterized by granulation tissue composed of epithelioid and giant cells.
- A marked presence of plasma cells is also observed.

Pulmonary glanders *(Pneumonia malleosa)*

Pulmonary Lesions in Glanders:

- Depending on the virulence of the agent and the host response, pulmonary lesions may be **acute or chronic**, and morphologically present as either **exudative or productive (granulomatous) inflammation**.
- When the agent reaches the lungs **via the lympho-hematogenous route**, it spreads mainly by lymphogenous and, less commonly, by bronchogenous pathways.
- In lymphogenous spread, a glanders nodule forms at the site of arrival, which is later resorbed through lymphatic pathways (*resorptive glanders nodule*).
- In bronchogenous spread, expanding glanders lesions open into the bronchi; during this process, glanders lesions also develop in the bronchi, trachea, and larynx.

Pulmonary Lesions in Glanders:

- Typically appear as characteristic **malleus nodules**.
- These nodules are distributed throughout the lungs as **miliary (very small) or larger nodules (2–10 mm)**.
- Lesions may be confined to *one lung or disseminated in both lungs.*
- They are especially prominent **beneath the pleura.**
- Morphologically, the foci may be **exudative or productive** (associated with tissue proliferation).
- In some acute cases, **diffuse pneumonia or suppurative bronchopneumonia** develops as lobular glanders (***pneumonia malleosa***).
- In this form, part of a lobe or the entire lobe may be affected.
- Lesions again may be either exudative or productive.

Exudative Pulmonary Glander

- **Exudative glanders** lesions are usually located beneath the pleura or visible on lung sections.
- They initially appear as small, localized hemorrhagic foci.
- Over time, these foci enlarge and develop into **pea- to hazelnut-sized exudative nodules.**
- Each nodule typically contains a small, yellow, dry purulent core in the center.
- *Surrounding this core is a dark-red, hyperemic ring.*

Exudative Pulmonary Glander

Microscopically:
Lesions appear in three concentric zones:

- **Central zone:**
  - Rich in neutrophils covering small groups of alveoli.
  - Nuclear fragmentation of neutrophils (karyorrhexis) produces a typical appearance for glanders.
- **Intermediate zone:**
  - Hyperemia (vascular engorgement).
  - Inflammatory edema rich in neutrophils and fibrin.
- **Peripheral zone:**
  - Marked vascular hyperemia in the surrounding lung tissue.

Exudative Pulmonary Glander

Calcification (Appearance of Mineralization):

- Over time, incomplete calcification may develop in the center of lesions, giving the foci a cloudy appearance.

Macroscopic features:

- Lesions cannot be scraped off with a knife.
- They appear translucent, grayish-white.
- Consistency resembles pork fat (different from parasitic calcification).

Microscopic findings:

- Calcium salts are deposited in the center of the lesion, leading to partial calcification.
- Surrounding areas contain neutrophils undergoing karyorrhexis.

These calcified lesions are not encapsulated by fibrous tissue as in productive glanders.

Productive Pulmonary Glander

- **These lesions are more common in endemic regions.**
- **Onset:** Begins with a hemorrhagic focus.
- **Progression:** Followed by grayish nodules ranging from miliary size to lentil–hazelnut size.
- Small nodules → usually multiple.
- Larger nodules → may appear singly.
- Suppuration does not occur in this type of nodule.
- In older nodules, calcification and necrosis may develop in the center.

Productive Pulmonary Glander

- In the center of the nodule, neutrophils undergoing karyorrhexis are present → **this finding is considered characteristic of the disease.**

Productive Pulmonary Glander

- **In the center of the nodule**, histiocytes, epithelioid histiocytes, and giant cells are present.
- The lesion is surrounded by a fibrous capsule.
- In older lesions, central calcification increases.
- The surrounding alveoli often appear empty.
- Overall, the lesion exhibits the appearance of **granulomatous inflammation**.

Cutaneous glanders
(*Dermatitis malleosa*)

Cutaneous glanders
(Dermatitis malleosa)

- Cutaneous glanders, also referred to as *farcy*, usually develops as a result of lymphatic–hematogenous metastatic spread of nasal or pulmonary glanders.
- Primary cutaneous glanders arising from external injuries is rare.
- The lesions are predominantly localized along the **lymphatic vessels of the skin**, especially on the lateral thoracic wall, ventral abdomen, and more frequently on the hind limbs.
- This form occurs not only in equids but also in carnivores.

Macroscopically:

- Cutaneous lesions in horses are characterized by thickened, **cord-like subcutaneous lymphatic vessels**.
  - Along these vessels, *nodules appear either singly or in bead-like arrangement of nodules.*
  - The centers of the nodules undergo necrosis and suppuration.
  - When they rupture to the skin surface, ulcers develop with raised edges and a base of granulation tissue, often exhibiting a "**lardaceous" (pork-fat–like) appearance**.
  - Granulation tissue proliferates around these lesions.

- A discharge with the appearance and consistency of olive oil flows from the lesions → this exudate is referred to as *huile de farcin*.
  - In the surrounding subcutaneous connective tissue, phlegmon develops (***malleus phlegmon***).
  - In the advanced stage, connective tissue proliferation occurs, and the leg acquires the appearance of an "**elephant leg**" → ***elephantiasis malleosa***.
  - The regional lymph nodes are enlarged.
  - In the latent form, no obvious external clinical signs are observed.

- **Microscopically**

  In the center, neutrophils undergoing karyorrhexis are observed.

  Around them, histiocytes, epithelioid histiocytes, and occasionally giant cells are present.

  At the periphery, a connective tissue capsule is seen → the typical appearance of a malleus nodule.

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  - Suppurative thrombi in lymphatic vessels
  - *Thrombotic-purulent lymphangitis malleosa*
  - Surrounding edema, phlegmon, and connective tissue proliferation

Pulmonary Lymph Node Lesions in Glanders

Macroscopically:

In addition to suppurative lymphangitis in the lymphatic vessels, **exudative and productive changes** related to glanders occur in the regional lymph nodes.

The lymph nodes appear yellowish in color, and **nodular structures can be distinguished.**

Microscopically:

- Local necrosis, fibrin, and leukocytic infiltration are observed.
- Subsequently, the lymph node takes on a grayish discoloration.
- In nodules of the productive type, microscopic findings resemble those seen in the lungs.

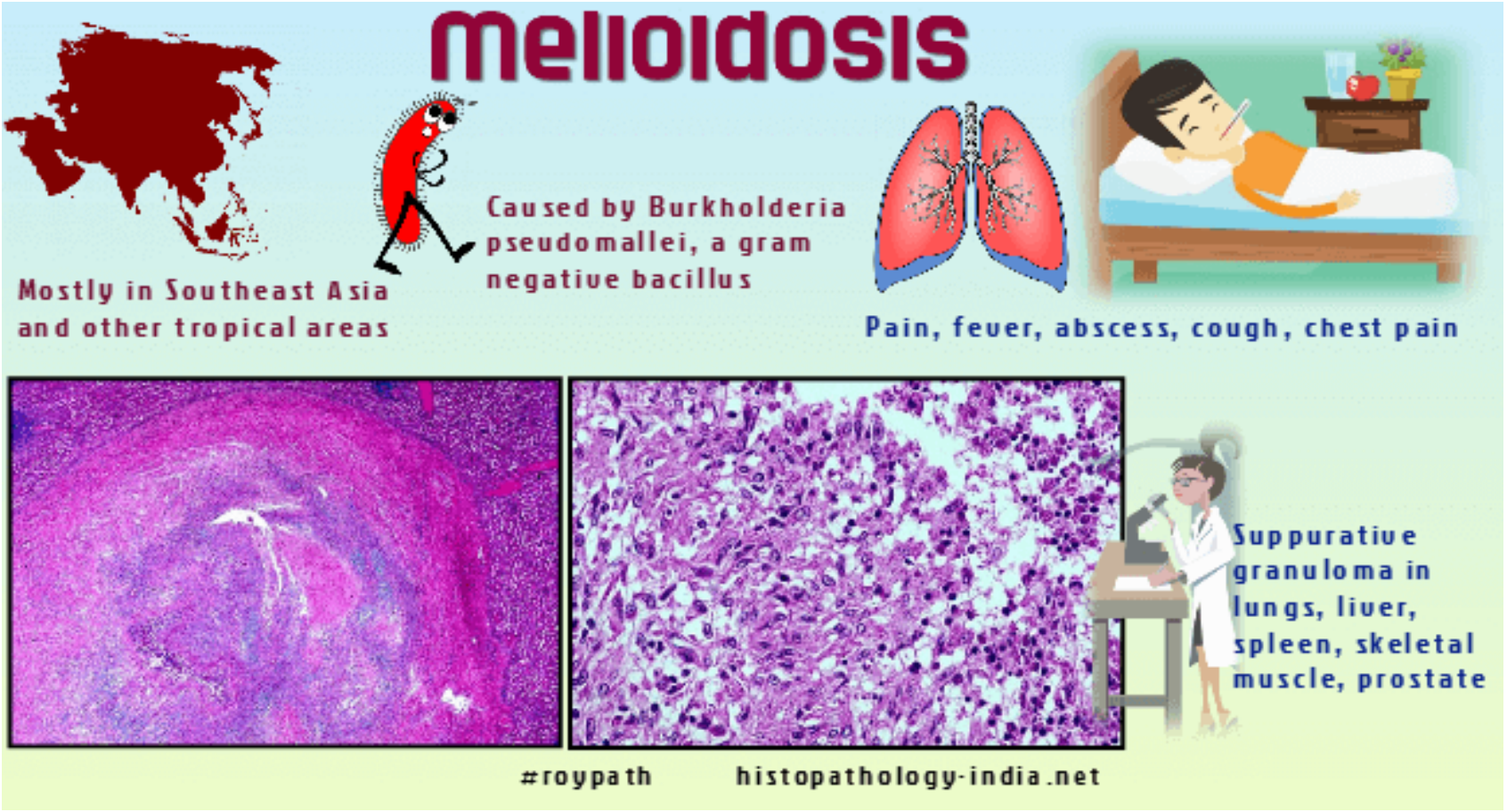
Lesions in Other Organs in Glanders

- Glanders lesions in the digestive system are rarely observed and occur experimentally when a large amount of the pathogen is administered orally.
- Hematogenous metastases are found in the spleen, and less frequently in visceral organs and muscles.
- Metastatic lesions resemble the nodules seen in the lungs.

Differential Diagnosis of Glanders

- Although characteristic findings may occur in nasal and cutaneous glanders, nasal glanders can be confused with gourme and croupous rhinitis.
- Cutaneous glanders is especially confused with epizootic lymphangitis.
- Pulmonary lesions may be mistaken for tumors and tuberculosis.
- Diagnosis, particularly in chronic cases, is confirmed by **microbiological examination and the mallein test.**

Pseudomallei *(Melioidosis)*



- **It is primarily a disease of rodents.**
  In addition to rodents such as rats, guinea pigs, and rabbits, it is also observed in domestic animals including monkeys, horses, cattle, sheep, goats, pigs, and dogs.
  Rarely, it can be fatal in humans.
  The virulence of regional strains varies.
  Breed differences play a role in the susceptibility of sheep and goats.
- The disease occurs:
  - Spontaneously in individual cases
  - In endemic regions, as small outbreaks
- It is most common in Southeast Asia and tropical regions.
  It has also been reported in some Western European countries and in Australia.

- **Melioidosis – Etiology**
  The disease is caused by *Burkholderia pseudomallei* (formerly *Pseudomonas pseudomallei*).
  The primary source of infection is rats.
  The agent spreads into the environment through nasal discharge, secretions, and excretions.
  In endemic regions, it can survive in soil and water for up to 30 months and may become pathogenic incidentally.

Transmission:

- Digestive route (most important)
- Respiratory route
- Skin wounds
- Transmission by insects

- **Pyemia →** Occurs after infection, particularly in lymph nodes, spleen, lungs, liver, joints, and nervous system, forming abscesses similar to glanders.
- **Acute form →** severe suppuration
- **Chronic form →** prolonged abscess formation
- Abscesses are usually in the form of central caseous granulomatous nodules.

In horses: The clinical presentation resembles glanders.

In dogs: In addition to organ findings, skin abscesses and epididymitis may occur.

Melioidosis in Cattle

In acute fatal infections:

- Pneumonia
- Arthritis
- Placentitis
- Endometritis
- **Reason for variations:** The virulence of the agent + the susceptibility of the animal.
  If lesions are not located in vital organs → they are usually detected incidentally during slaughter or necropsy.

Melioidosis in Sheep, Goats, and Pigs

- These species are more susceptible compared to other domestic animals.
- Both isolated cases and outbreaks may occur.

Most common findings:

- Pneumonia
- Arthritis

In pigs: Ulcers may be found in the nasal septum and tracheal mucosa.

In goats:

- Chronic infections may develop.
- In some cases, complete recovery can occur.

Lesions in Pyaemia

- The main lesions are multiple abscesses in the lungs, regional lymph nodes, and spleen.

Spleen:

- Abscesses are smaller than 1 cm.
- Appear raised from the organ surface.

Lungs:

- Numerous small abscesses (multiple abscesses).
- Larger purulent cavities filled with pus.
- Focal adhesive pleuritis may develop in these areas.

General characteristics of abscesses:

- Abscesses are not encapsulated.
- Creamy or caseous in structure.
- Contain yellow-green purulent material.

- In some cases, purulent exudate is found within the bronchi. Similar abscesses may also occur in the lymph nodes.
- These findings resemble caseous lymphadenitis in sheep and goats caused by Corynebacterium pseudotuberculosis.
- However, in pseudotuberculosis lesions there is lamellation (onion-slice appearance) and calcification.
- In experimental cases in sheep, in addition to the lesions observed in natural cases, micro-abscesses resembling glanders may also develop in the brain and nasal mucosa

Strangles (Gourme)

It is an acute, contagious disease of horses.

- Suppurative rhinitis
- Lymphadenitis (especially mandibular and retropharyngeal lymph nodes)
- Occasionally emboli in internal organs

Etiology

Streptococcus equi

- Distinct from other streptococci (e.g., *S. zooepidemicus*, *S. equisimilis*)
- Not part of the normal nasal flora

Epidemiology

Transmission and Resistance

- The pathogen within exudates is highly resistant to external conditions and can remain viable in stables for several months.

Source of Infection

- Most often carrier animals or clinically healthy individuals that harbor the pathogen.

Outbreak Formation

- Epidemics are more frequently observed among groups of young horses.

Carrier State

- Detecting carrier horses is difficult, as the pathogen is shed intermittently.

Patogenez

- The pathogenicity of the agent is related to its ability to **adhere to epithelial cells**.
- After entering the upper respiratory tract, the agent attaches to the epithelial cells, particularly in the soft palate and pharynx, and subsequently penetrates them.
- There is strong chemotaxis of neutrophils toward the mucosa and regional lymph nodes.
- The surface M protein and hyaluronic acid protect the agent from phagocytosis.
- Hemolysin secretion is not essential for pathogenic activity.
- However, each strain produces potent cytotoxins, which prevent intracellular digestion of the pathogen and lead to rapid degeneration of polymorphonuclear neutrophils.

Patogenesis

Patogenesis of *Streptococcus equi*

- **Entry and Adhesion**
  - Upper respiratory tract (soft palate, pharynx)
  - Adheres to epithelial cells
- **Invasion**
  - Penetrates epithelial cells
- **Host Response**
  - Strong neutrophil chemotaxis → mucosa + regional lymph nodes
- **Immune Evasion**
  - **M protein** and **hyaluronic acid capsule** → protect against phagocytosis
- **Tissue Damage**
  - Potent cytotoxins → inhibit intracellular digestion
  - Rapid degeneration of polymorphonuclear neutrophils

- After recovery**, about 70% of animals** do not become ill upon re-infection.
- The acquired immunity is associated with **IgA and IgG subclasses** locally formed in the nasopharynx.
- In recovered cases and in some vaccinations with **bacterin-type preparations**, **serum IgA and bacterial M protein complexes** are detected.
- These complexes are thought to be responsible for **glomerulonephritis** and **leukocytoclastic vasculitis.**

Incubation Period

- Usually **3–4 days**, but may be as short as **2 days** or as long as **15 days**.

Clinical Findings

- **Fever**, mild cough, and nasal discharge.
  - Nasal discharge: initially **serous**, then **catarrhal**, and finally becomes **purulent**.
- **Head and neck lymph nodes**: inflammatory swelling is typical.
- **Catarrhal conjunctivitis** is always present in these cases.
- **Submandibular and retropharyngeal lymph nodes** are the first and most severely inflamed organs.

- At the onset of inflammation, the lymph nodes are firm; with liquefaction and pus formation, fluctuation begins.
  The rupture of abscesses onto the skin **1–3 weeks after the onset of infection** is a typical and distinctive finding of lymphadenitis.
  Before rupture, serum oozes out, causing the hairs to stick together.
  The pus that emerges is sticky, creamy in consistency, and yellowish-white in color.
  Lymph node abscesses are the consistent hallmark of strangles (gourme); however, in rare cases, diagnosis can be made even without these abscesses.

- Nasal lesions are generally in the form of nonspecific **purulent rhinitis.**
- Large amounts of creamy, *yellow pus accumulate in the folds of the turbinates*, which can cause temporary deformation.
- The mucosa is edematous, hyperemic, and sometimes ulcerated. This typical course of strangles is quite striking. However, milder or more severe forms may also occur. In herds with mixed age groups, complications develop in approximately 20% of clinical cases.
- In older horses, the disease takes a milder course; usually **catarrhal rhinitis and pharyngitis** are seen.
- In this age group, lymph node abscesses either do not form, or if they do, the abscesses are sterile and encapsulated.

- *In severe cases*, the infection spreads to the **paranasal sinuses** and produces chronic **empyema** in these cavities.

  Severe **cellulitis** may develop in the connective tissue of the nose, pharynx, or throat.

  Retropharyngeal abscesses may rupture into the pharynx, and pus may be aspirated into the lungs (in atypical strangles).

  Occasionally, **metastatic abscesses** are observed in the liver, kidneys, synovial membranes, and brain.

- The most commonly affected internal organs are the **mediastinal** and **mesenteric lymph nodes**.

  The abscesses in these nodes are large, but rupture is very rare.

- The suppurative inflammation spreads to adjacent serous membranes, leading to **purulent pleuritis** or **peritonitis**.

  Two other important sequelae are **purpura hemorrhagica** and **cranial nerve paralysis**, which may result in **laryngeal paralysis (roaring)**, **facial nerve paralysis**, or **Horner's syndrome**.

Differential Diagnosis

- When superficial lymph nodes are affected and upper respiratory tract signs develop, the diagnosis is not difficult.

  It can also be confirmed by **endoscopic examination** of the lymph nodes around the **guttural pouch**.

  If the nasal exudate is diluted with saline and examined microscopically, **streptococci arranged in grape-like clusters** can be observed.

  However, it may be confused with other conditions such as **other streptococcal infections**, **pharyngeal injuries**, and localized **anthrax**, **glanders**, or occasionally **epizootic lymphangitis**.

Equine viral rhinopneumonitis

Equine herpesvirus (EHV):

- **EHV-1:** Causes abortion in mares.
- **EHV-4:** Causes mild respiratory tract infections in foals and racehorses.
- EHV-4 infections are particularly common in foals during the autumn months.

Patogenesis

- The infection begins with *the replication of the virus in the respiratory tract mucosa.*

  At this stage, **rhinitis and fever (pyrexia)** develop.

  As the virus invades, **pneumonia** occurs in the lungs and **endometritis** develops in the placenta.

  When the virus reaches the fetus, fetal tissue damage takes place.

  As a result of placental lesions, stillbirth may occur, or foals may be born weak and die shortly after birth.

Clinicopathological Findings:

Characterized by mild fever, serous or catarrhal rhinitis, and conjunctivitis.

Diarrhea and edema in joints are rarely observed. The respiratory form of the disease is transient.

Primary lesions caused by the virus in the nasal mucosa and lungs are rarely observed at necropsy.

However, if secondary bacterial complications are present, rhinitis, pharyngitis, and bronchopneumonia may develop.

The detection of intranuclear inclusions at necropsy is difficult.

Respiratory

Abortion

Neonatal Death

Neurological (EHM)

Ack. Dr. G. Allen (2008)

Equine influenza

- One of the most common upper respiratory tract diseases in horses.
- It usually occurs **in 2–3-year-old racehorses**.
- The causative agent **is influenza type A (A/equi-1 and A/equi-2). Type B** has no role in the infection. Similar to influenza (flu) in humans, it is **generally a mild and individual disease** in horses.
- However, in some cases, it progresses more severely, leading to **pulmonary edema and broncho-interstitial pneumonia.**
- Additionally, **secondary bacterial bronchopneumonia** may develop due to the involvement of opportunistic bacteria in the upper respiratory tract.

- **Cough**
- **High fever**
- **Difficult breathing / Dyspnea**
- **Loss of appetite**
- **Irritability**

Nasal discharge
Bronchointerstitial pneumonia
Pulmonary edema

- In horses, other viruses such as *equine rhinovirus*, *adenovirus*, and *parainfluenza virus* may also cause **mild and transient upper respiratory tract infections, unless complicated by secondary pathogens.**

- Fatal adenovirus infections that lead to severe pneumonia or enteritis are frequently seen in horses with poor immune defenses, especially in Arabian horses with hereditary immunodeficiency.