Lecture 1. Approach to the coughing and dyspnoeic dog and cat 1 (including laboratory techniques)

Coughing and dyspnoea in the dog can be due to cardiac or respiratory disease, but in the cat coughing is never (or rarely) associated with cardiac disease. When presented with a dyspnoeic cat the first thing to consider is severe pleural effusion, whereas for dogs consider upper airway obstruction (rarely a foreign body) or pulmonary oedema due to heart failure first.

*It is important to remember that coughing never killed anyone but dyspnoea is life threatening. With the dyspnoeic animal the best thing to do is not panic; the dog or cat is panicking enough as it is.*

Some immediate differential considerations (not exhaustive):

“**Common things are common**”

“**There are not that many possible cardiac and respiratory diseases to choose from**”

- Has there been exposure to infectious agents? - kennel cough highly likely
- Is there profound brachycephalic airway syndrome? - that is why there is dyspnoea
- Is it a toy breed dog? – must presume has tracheal collapse until proven otherwise
- Is it a West Highland white terrier (or any terrier breed)? - Idiopathic pulmonary fibrosis and chronic bronchitis are major considerations.
- Is it an elderly Labrador (or other large breed)? - laryngeal paralysis as a cause of dyspnoea must be considered.
- Has the cat suddenly become dyspnoeic? – pleural effusion needs to be considered first.
- Is it a breed of dog predispose to heart disease that can result in left sided-congestive heart failure? – Dobermans and DCM, CKCS and endocardiosis.

1. Signalement:
Breed and age are very useful in narrowing down the likely differential list, particularly with cardiac diseases (see above).

- Older animals tend to get chronic diseases with a chronic presentation; chronic bronchitis, IPF, primary pulmonary neoplasia; laryngeal paralysis.
- Toy and brachycephalic breed have clear tendency for respiratory developmental disorders, which might have an old-age onset appearance and chronic course; tracheal collapse, extended soft palate, laryngeal collapse etc.
- Younger dogs and cats are more likely to be affected by infectious diseases or if developmental to have severe disease; tracheal collapse again, severe brachycephalic airway syndrome.
- Pedigree oriental breed might be more predisposed to asthma, but that might reflect their tendency to be kept indoors.
Gender has no link with respiratory disease, but males might be more predisposed to developing congestive heart failure.

2. History:
The signalment of the case can be extremely value in itself in diagnosis, while general history may be of less value. Chronicity or slowness of progression can be typical of some diseases, but severity of clinical signs can be more important in the immediate term as that will determine initial treatment. Severe respiratory dyspnoea needs emergency treatment and at that stage the actual cause is irrelevant, or the best information on cause can be gleaned form physical examination and thoracic radiography.

Having said that, there are historical points that can be diagnostically very useful. Some examples are as follows;

- Having spent time in a kennel or with other coughing dogs suggests kennel cough is likely.
- Goose-honking cough is typical of tracheal collapse.
- WHWTs with IPF, despite obvious clinical signs which can be severe, are often otherwise normal.
- Old dogs with chronic cough alone as a clinical sign could well have primary lung neoplasia.
- Old dogs with stridor and change in tone of their bark are likely to have laryngeal paralysis.
- A history of surgery for a malignant tumour (e.g., osteosarcoma) would make pulmonary metastatic neoplasia suspicious.
- A history of hunting and eating snails and slugs would raise suspicion about respiratory parasites. The geographical location might also be significant (Angiostrongylus).
- Trauma or exposure to poisons might have cause thoracic damage or airway and lung pathology.

3. Physical examination:
Full evaluation of the cardiac and respiratory system is necessary, with particular attention being paid to the cardiac system. The aim of the physical examination is to confirm if at all possible that cardiac disease is NOT the cause of cough and dyspnoea (see lecture 2). The examination of the respiratory system is more to determine the severity of the disease presentation as this has clear bearing on how the case should be managed in the immediate term.

Check to see if coughing can be elicited on tracheal compression. This is very useful in cats to confirm the cat is actually coughing. Percuss the chest to see if there is a distinct ventral line suggestive of pleural effusion. In the same manner if percussion of only one side of the chest elicits cough this is likely to be the site of disease, and this can often be confirmed on a V/D thoracic radiograph. Auscultate the thorax for respiratory sounds. The presence of wheezing implies narrowed airways and is typically seen in cats with asthma, but they may be intermittent and localised. Crackles are always abnormal and usually seen with pulmonary fibrosis, chronic bronchitis and also with severe pulmonary oedema. Rhonchi are harsh low pitched
sounds that can be simply associated with rapid breathing post exercise or with excitement and panting. If associated with disease they simply reflect poor ventilatory ability and/or capacity. In any case two or more of these sounds can be heard at the same time and this is referred to as mixed respiratory sounds. Normal breath sounds are just that and often called bronchovesicular, but this term is being used less.

Counting respiratory rate and appreciating effort can be problematic not least because of panting in dogs and stress in cats. So care has to be exercised in deciding there is true tachypnoea and dyspnoea. A patient clearly adopting a position to ease breathing (orthopnoea) is clearly abnormal and also of major concern.

Checking for nasal patency is worthwhile in brachycephalic dogs and cases with nasal discharge or bleeding is present, but oral examination is rarely of value and the oropharynx and larynx can only be clearly examined under light anaesthesia. There are exceptions to this but they are rare.

Hydration status, poor demeanour and presence of pyrexia can be supportive of respiratory infection, but might be caused by disease elsewhere and those cases may have elevated respiratory simply as a response to pyrexia.

4. Diagnostic Tests:

4.1. Thoracic Imaging (see lecture 3).
The right lateral thoracic radiograph is still one of the most powerful diagnostic tools available in veterinary practice. Its value can be as much in what cannot be seen as what can be seen.

4.2. Routine Haematology and Biochemistry:
Biochemistry profiles have limited use in the diagnosis of respiratory disease, but can give information on the patients overall health status. Haematology is most useful in the diagnosis of respiratory infection (leucocytosis and neutrophilia with a left shift; typically severe bacterial bronchopneumonia) and parasitism and hypersensitivity (eosinophilia, and rarely basophilia). The confirmation of these cells types in airway washes is doubly supportive of a tentative. However, in most respiratory diseases there are no changes on blood smears. The possible use of C-reactive protein as a measure of inflammation is a consideration but the test is not readily available yet.

4.3. Cardiac Biomarkers:
The use of cardiac biomarkers to allow differentiation between cardiac and respiratory disease are advocated by some, and while there may be some evidence of such value in cats, their overall value is questionable. Their use in determining the degree of cardiac impairment in a patient clearly showing evidence of cardiac disease, prediction of response to therapy and prognosis for survival is probably where their real value will lie in the future.

4.4. Cytology & Diagnostic Pathology:
Airway samples, obtained blindly using a catheter or with bronchoscopy guidance and trans-thoracic samples (pleural fluid and lung biopsy tissue) are very useful in
diagnosis. Without pathology definitive diagnosis is not possible, but sampling, along with the rest of the clinical features, can greatly improve the chances of getting close.

Normal airway cytology samples typically include epithelial cells and macrophages, with small numbers of polymorph nuclear leucocytes (rarely eosinophils). The presence of neoplastic cells, while not a common finding, is diagnostic. Increased numbers of neutrophils and activated foamy macrophages over an above what would be expected in a normal sample, is indicative of non-specific inflammation. The presence of intra-cellular bacteria supports a diagnosis of infection (typically bronchopneumonia), but other non-cellular organisms might simply be part of the normal flora. Increased numbers of eosinophils, or any eosinophils for that matter in a clinically affected dog, would suggest hypersensitivity (“allergy”) or parasitism. In the cat eosinophils are regarded by some as part of the normal airway cytology, but there is some disagreement on this point. If found in a clinically affected cat airway eosinophils should be presumed to be part of the ongoing pathology (asthma typically).

Pleural effusion samples are of immense diagnostic value and can be assessed in general practice for specific gravity using a hand held refractometer, and cellularity and protein content using a standard dip stick kit. Also direct smear and in-house staining can give useful information (see lecture 6).

Lung biopsy sampling (fine needle or Tru-Cut) has variable utility. It is best reserved for solid mass lesions (suspect primary neoplasm) that are close to the chest wall. Radiographic localisation and/or ultrasound guidance can improve the amount of diagnostic material obtained. Sampling diffuse lung changes is of little value. Open lung biopsy is only undertaken as a last resort, and even in referral practice is rarely use.

4.5. Bronchoscopy:
Predominantly a referral centre technique but more widely used in general practice. Probably the one of the best ways to confirm many respiratory diseases, and to improve the quality of sample collection. This topic will not be covered in detail here and the interested reader should consult specific paper and textbooks on the subject.
Lecture 2. Approach to the coughing and dyspnoeic dog and cat 2; how to differentiate between cardiac and respiratory causes

The most common shared clinical signs of cardiac and respiratory disease are coughing and dyspnoea for the dog and dyspnoea only for the cat (see lecture 1). Coughing in the cat is invariably due to respiratory disease. Cyanosis is more likely to be due to respiratory disease and syncope due to cardiac disease. Exercise intolerance and pre-syncope (in-coordination without loosing consciousness) can be associated with diseases affecting either system, but if respiratory cyanosis can often be seen.

There are several common scenarios where differentiating cardiac from respiratory disease is necessary.

• Clinical presentation alone including one or more of the following: cough, dyspnoea, exercise intolerance, syncope.
• Evidence of cardiac disease; the presence of a murmur without altered heart rate and normal rhythm, and no change in peripheral indicators of cardiac function.
• The co-existence of evidence of heart failure and respiratory disease; the typical shared clinical signs, supported by the presence of changes in cardiac parameters.

The rational approach to differentiating between cardiac and respiratory causes of shared clinical signs can be best illustrated by a clinical example.

Clinical Example:

History: An 8 yr old male CKCS spaniel presents with a 4 week history of cough, but is otherwise normal. The presence of a murmur has been noted for several years and has increased in grade in recent years and is now graded 4/6. The dog had been in kennel in the week prior to developing the cough.

Question: Is the cough (mitral valve disease) cardiac or respiratory chronic persistent kennel cough)? Does the dog also have tracheal collapse or other respiratory cause of coughing?

Physical examination: normal heart rate with some irregularity depending on rate (sinus arrythmia probably) loud pansystolic 4/6 left heart apical (mitral murmur), MM colour and CRT OK, good strong femoral pulse with no pulse deficits, no obvious change in respiratory rate, effort or wounds.

Conclusion: there is no evidence this dog has developed congestive heart failure and that the coughing is therefore, more likely to be respiratory. The presence of a murmur indicates the dog (considering the history and breed) has mitral valve endocardiosis. The history of being kennelled makes it even more likely the dog had kennel cough which has become persistent.

Attempt at confirmation; thoracic radiographs do not show any evidence of Left Atrial enlargement, indicating the coughing is not cardiac in origin.

Alternative Radiographic Findings; there is some evidence of LA enlargement, but no evidence of congestive heart failure (congestion (engorgement) of the pulmonary veins) or pulmonary oedema. There is also some evidence of tracheal collapse. The conclusion is less equivocal. The cough might be due to a combination of factors;
• Compression of the left mainstem bronchus by the enlarged left atrium
• An increased tendency of the bronchi to collapse because the dog has subclinical tracheal collapse
• An increased sensitivity of the airways due to persistent kennel cough that facilitates coughing caused by the two previous points.

**Useful points in assisting differentiation:** “is there ANY evidence of heart failure?”

• Peripheral indicators of cardiac function.
  o MM colour, CRT, HR and rhythm, strength of peripheral pulses, pulse deficit.
• Auscultatory findings.
  o HR and rhythm, murmur, respiratory sounds, upper airway, referred sound to thorax or isolated to the thorax (wheezes, crackles and rhonchi).
• Diagnostic tools.
  o Thoracic radiography, heart chamber enlargement, pulmonary vascular congestion, pulmonary oedema, any evidence of obvious respiratory disease (eg neoplasia).
  o ECG; to determine if rhythm is normal or abnormal
  o Cardiac biomarkers; cardiac troponins, BNP (sensitivity and specificity are an issue).

**Response to therapy:**

In the event that there is no clear answer to the question is it cardiac or not, then trial treatment with furosemide or pimobendan is worth considering. A clear response would suggest a cardiac explanation (but might not always be the case) and then continual cardiac therapy is required.
Lecture 3. Thoracic imaging

Thoracic radiography is an essential diagnostic aid in cardiac and respiratory medicine however interpretation is dependent on the quality of the images obtained. Ultrasonography can be an adjunct to routine radiography when investigating respiratory disease, but its important use is in echocardiography. Computed tomography is an emerging modality of immense value, but MRI has no role in investigation of respiratory disease.

Thoracic radiography
Sufficiently powered x-ray unit, good quality films and screens, automatic processing, selection of restraining and positioning devices, good centring and coning (minimise scatter, improve contrast), avoidance of grids with low-output machines and sedation all contribute to the production of good quality diagnostic radiography. Digital radiography gives definite advantages over film radiography for obtaining diagnostic films in a practice setting. The most common thoracic radiographic problems in veterinary practice are poor processing (primarily under developing because chemicals are not changed regularly), recumbency atelectasis, inappropriate exposure, inadequate positioning (rotated views, forelegs not pulled forward), under aerated lungs (expiratory films) and inadequate collimation or centring. Digital imaging has greatly improved the diagnostic quality of thoracic radiography in practice (solves bad habits)

Assessment of the Respiratory System Radiograph
The lung pattern changes in response to both respiratory and cardiac diseases, but from the assessment of the cardiac silhouette the primary source of the problem should be identified (exclude a cardiac explanation for the clinical signs). The normal lung pattern consists primarily of the pulmonary vasculature. Vessels are mostly seen adjacent to bronchi, with the arteries dorsal (on the lateral view) and lateral (on the VD/DV view) to the adjacent bronchus. Veins are ventral and medial to the bronchi respectively. The bronchi are seen because they are delineated by the adjacent blood vessels and the air within the bronchi. The vascular pattern is more prominent in the cat. The rest of the normal lung pattern is presumed to represent the lung parenchyma. This pattern is linear, but whereas the pulmonary vasculature, particularly in the cat, spreads out towards the lung periphery, the interstitial pattern is more haphazard giving a reticulated appearance to the lung field.

Vascular Pattern; this is the predominant density in normal lung; indistinct vascular pattern suggests lung changes (presuming the radiographs are of sufficient quality). Congested vessels imply cardiac disease (congestive heart failure)
Bronchial Pattern; bronchial walls are seen on radiographs as parallel lines ('tramlines'). Thickened bronchial walls seen from an end-on view will appear as rings ('doughnuts'). An end-on bronchus may occasionally be seen with one associated vessel ('signet ring'). In chronic airway disease the bronchi often become dilated (tubular or saccular bronchiectasis).
Alveolar Pattern; alveoli and bronchioles are not normally visible. When the alveoli fill with fluid (eg. oedema, blood, exudate), cellular infiltrate or collapse, they form soft tissue densities, outlining the air filled bronchioles (air bronchograms). There is an associated loss of the vascular walls and bronchial walls.
Interstitial Pattern; the normal interstitium (alveolar walls and supporting tissue) gives the background hazy/grey appearance to the lung. When disease affects the interstitium it becomes thickened and therefore more visible as a fine linear or reticular mesh-like pattern. It differs from the vascular pattern in not following any particular direction. The pattern it creates is sometimes described as 'lace-like' or
'honeycomb'. An interstitial pattern sometime obscures the vessels towards their periphery, and is often identified by excluding all other explanation so of increased density.

**Cavitatory Lesions (air filled or solid):** these are lesions that are occupying lung space, some of which are very rare, and may be solid or air-filled. They include cysts, bullae, blebs (congenital or acquired), abscess, trauma, granulomas, neoplasia (primary), bronchial obstruction - pneumatocele

**Pleural (Mediastinal) Changes:** the pleural can contain fluid (pleural effusion) or free air (pneumothorax, pneumomediastinum). With mild effusions the radiographs should be inspected for subtle lobe-fissure lines, particularly on the ventro-dorsal views. With severe effusions the cardiac silhouette is obscured and the lung lobe edges are pushed away from the thoracic cage and visible. The position and width of the mediastinum are best noted on the VD or DV view. Free air in the mediastinum will cause the structures within it to be highlighted (arteries, veins, oesophagus).

The thoracic cage should also be assessed for evidence of changes. Major considerations are fractured ribs, rib-cage deformities and diaphragm integrity. The cardiac silhouette must also be assessed since cardiac disease can give similar clinical signs to respiratory disease (see lecture 2). From a thorough examination of good quality radiographs it should be possible to determine the degree of cardiac involvement in the lung changes seen (vascular congestion and pulmonary oedema), if the changes are primarily due to respiratory disease and to classify the predominant lung and airway pattern. It is also important to be aware of change in the cardiac silhouette and how LA enlargement can be an important cause of coughing in dogs.

**Computed Tomography (CT)**
Lung CT is becoming a more widely used technique for evaluation of the respiratory system and information on CT features of respiratory disease is emerging all the time. However, there are few experts in veterinary lung CT and since such facilities are mainly the reserve of specialist centres, lung CT will remain a referral option in many cases. However, CT allows evaluation of lung changes at a level that cannot be achieved with radiography and enables more accurate diagnosis of many conditions. CT findings often equate accurately with pathological changes and moreover it allows more accurate localisation of pathological changes, such as seen with pneumonia and neoplasia.
Lecture 4. Review of upper airway diseases; nose to carina

1. Rhinitis
Rhinitis is an all-encompassing term describing a condition where there is an active inflammatory reaction in the nasal passages causing sneezing, nasal discharge and nasal discomfort. Typically it involves secondary bacterial infections, and this can be so deep-seated as to involve the adjacent boney structures. Where the condition results in chronic hyperplastic changes in the nasal mucosa, chronic rhinitis exists. This is often associated with lymphocyte and plasma cell infiltration. Rhinitis has a multiplicity of possible causes and each cause will have subtle differences regarding clinical signs, progression and treatment. Eosinophilic infiltration is presumed to reflect an allergic reaction and can be acute or chronic.

Causes include viral (feline rhinotracheitis, feline calici and reo virus), rickettsial (chlamydia psittaci var felis), bacterial infections (Bordetella bronchiseptica, Staphylococcus and non-haemolytic Streptococcus spp and Mycoplasma spp), fungal (Aspergillus fumigatus (dogs), Cryptococcus neoformans), allergic, foreign bodies, neoplasia and consequence of poor anatomy. Consider FeLV and FIV, environment and exposure situations (catteries, kennels etc).

Clinical signs can include nasal discharge (unilateral/bilateral, clear (serous) mucoid, mucopurulent or blood tinged), sneezing, epistaxis occasionally (neoplasia, foreign body), stertor and facial deformity and facial pain. Secondary signs of epiphora and conjunctivitis might be seen.

Diagnosis
Definitive diagnosis can be difficult, time-consuming and expensive. Agent isolation from nasal and ocular material and serological testing can be attempted. Radiography and computed tomography (probably more informative) are useful in chronic cases and rhinoscopy is necessary in many chronic cases as it allows identification of fungal plaques, visible masses, turbinate atrophy and mucopurulent material. It also greatly assists sampling but make sure to check clotting profiles beforehand. Nasal sampling can included biopsy and washes and very useful in chronic rhinitis and neoplasia. Nasal swabs then to be of limited value.

Therapy
This is obviously dependent on the underlying cause.

1. Rhinarial tumours; excision, cryosurgery and radiotherapy
2. Nasal cavity tumours; rhinotomy, tumour excision, nasal curettage (palliative), radiotherapy, chemotherapy.
3. Chlamydia infection; doxycycline.
4. Viral infections preventative control with vaccination and good husbandry practice in catteries, and breeding colonies, good nursing care, nasal decongestants, antibiotics, anti-viral agents (trifluridine) for corneal ulcers, recombinant feline interferon, assisted feeding.
5. Fungal infection Surgical (topical application); installation of fungicidal agents, one hour infusion of clotrimazole under general anaesthesia. 70% success after 1 treatment; 90% success after 2, enilaconazole at 10mg/kg q12hr for 14 days via indwelling catheters; medical oral ketoconazole or fluconazole (50-65% success), oral itraconazole (70% success).
2. Nasal Neoplasia

Typically malignant, occurring in older, medium to large size dogs, are locally aggressive and destructive and show limited metastatic tendency. The most common tumours are carcinoma, including adenocarcinoma, and sarcoma (fibrosarcoma, chondrosarcoma and osteosarcoma). Nasal tumours show clinical signs typical of nasal disease with nasal discharge which is usually unilateral, but can become bilateral. The discharge can be serous, mucoid, muco-purulent or blood tinged. Overt epistaxis might occur, and the presence of blood is highly suspicious of neoplasia. Stertorous breathing, nasal deformity and nasal pain can also be present. Local pressure and extension can result in epiphora, exophthalmous and neurological signs.

Diagnosis

Usually this is achieved by using a combination of clinical history presentation, imaging and histological evaluation. The latter is required for definitive diagnosis. CT is more accurate than plain radiography, but there are cost constraints. Tissue sampling, using radiographic images as a guide, can be obtained by fine needle aspiration of biopsy, but surgical biopsy via a rhinotomy approach may be needed.

Therapy:

Palliative therapy can be obtained with glucocorticosteroids, NSAID and antibiotics. Therapy beyond palliation depends on tumour staging. Most nasal tumours when identified have already caused local destruction, and the extent of that destruction will affect the response to therapy. The greater the destruction the more likely therapy will be only palliative. Lymph node involve is a poor sign as it suggest metastatic spread, and visible metastases in the lung is the worst outcome. However, detection of distant metastasis is rare, indicating that therapy is always warranted in nasal neoplasia.

Radiotherapy is now accepted as the definitive treatment for nasal neoplasia, but its use is restricted by access to such equipment and the expense. Median survival can be up to 19 months and greater than 36 months if followed with surgery. Radiotherapy can also be used when palliation is the only option, and tends to give survival times of 3 to 9 months. Chemotherapy can give resolution for up to 9 months and a recommended protocol is; alternating carboplatin and doxorubicin i.v. q 3 weeks and daily piroxicam p.o. All these treatments have potential side effects, with the side-effects of radiation therapy often due to damage to local adjacent tissue and structures; oral mucositis, conjunctivitis, rhinitis, keratoconjunctivitis sicca, progressive vision loss in eye close to the radiotherapy zone.

3. Brachycephalic Airway Syndrome

A complex group of anatomical deformities affecting several (brachycephalic) breeds which result in varying degrees of upper airway obstruction, and includes the following:

- Congenital anatomical deformities (singly or in combination)
- Stenotic nares
- Extended/thickened soft palate
- Laryngeal deformities
- Laryngeal collapse
- Everted saccules
- Hypoplastic trachea

The clinical features are typical of what could be expected with upper airway obstruction, but the condition can result in involvement of the lower airways and lung resulting in more complicated clinical presentations. Typical clinical signs include dyspnoea, inspiratory stridor, cyanosis, collapsing and exercise intolerance, and often
worsen on excitement, exercise and in a warm environment. Secondary complications can be the result of aspiration pneumonia, non-cardiogenic pulmonary oedema, chronic bronchitis, chronic pulmonary interstitial disease (lung fibrosis?) and aerophagia and gastric dilation. Sleep apnoea can be seen in bulldogs and many are likely to have some degree of pulmonary hypertension.

**Diagnosis**
Diagnosis is based on the presentation of a typical brachycephalic breed with pronounced inspiratory stridor. On radiography thickened/extended soft palate, cor pulmonale, right-sided heart enlargement, hepatomegaly, hypoplastic trachea are often seen. Confirmation is by laryngoscopy and bronchoscopy to identify the anatomical deformity. P-pulmonale (tall P waves) and exaggerated respiratory sinus arrhythmia might be present on ECG.

**Therapy**
Surgical correction of operable anatomical abnormalities is the best option and can include correction of stenotic nares, extended soft palate, everted laryngeal saccules, emergency/permanent tracheostomy. Oxygen supplementation is needed during crises with glucocorticosteroids to control laryngeal oedema, and cage rest and exercise restriction. Avoidance or care when there are inciting causes, such as exercise, excitement or hot weather is advisable. Prognosis is fair if not too adversely affected, but poor to grave if seriously affected and not operatively correctable.

4. **Laryngeal Paralysis**
Laryngeal paralysis is a failure to abduct the arytenoid cartilages during inspiration and is very common in geriatric dogs, particularly Labrador retrievers (at least in Scotland). The cause is unknown in the majority of cases, but polyneuropathies and myopathies, neuromuscular disease and congenital forms and trauma/damage to the recurrent laryngeal nerve need to be considered.

Clinical signs can vary and may not be apparent in milder cases until respiratory work increases. Hyperthermia, exercise, stress and excitement often exacerbate dyspnoea, which is typically inspiratory (stridor). There is progressive appearance over months or years which eventually results in severe respiratory distress and exercise intolerance, and in severe cases cyanosis and collapse. Dysphonia (change in tone of bark) can be found as well as coughing, gagging, choking, and dysphagia. Muscle atrophy and neurological signs may be apparent in some cases. The laryngeal obstruction can cause secondary non-cardiogenic pulmonary oedema.

The clinical signs alone can be sufficient to make a diagnosis, but confirmation requires visualisation of the failure of the arytenoid cartilages to abduct during inspiration.

**Therapy**
Sedation if distressed and oxygen supplementation with cage rest and cooling can overcome the initial emergency. Glucocorticosteroids can relieve laryngeal swelling, but in many case laryngoplasty is needed. This is successful in about 90% of dogs, but surgery may eventually fail and may predispose to aspiration pneumonia. It is not worth undertaking this procedure in dogs that have concurrent dysphagia or chronic bronchitis or evidence of previous aspiration pneumonia.

5. **Tracheal Collapse**
In the majority of cases dorso-ventral flattening of the trachea and flaccidity of the dorsal membrane are the major problems and the trachea may only develop a partial
collapse. In other cases, the collapse is so complete as to result in life-threatening respiratory distress. The cause is unknown but may be a congenital mal-development of the tracheal cartilages. Clinical signs tend to develop with age and this might reflect age-related degeneration of the tracheal cartilage. Obesity and other respiratory diseases can compromise tracheal mechanics in dogs where the trachea lacks structural rigidity and the dorsal membrane is flaccid and wide, and so precipitate clinical signs.

Tracheal collapse is mainly a problem of middle-aged toy breeds (e.g., Yorkshire terrier) and clinical signs are related to the severity of the collapse. If the condition occurs in younger dogs, the clinical signs tend to be more severe. Often the trachea can be easily compressed on manipulation. Coughing is found in most cases and can have a goose-honk, seal-bark sound. Signs are often aggravated by excitement, lead-pulling and airway inflammation. Inspiratory dyspnoea (stridor) is evidence of severe disease, while expiratory dyspnoea with a clear end-expiratory grunt can be heard in many cases.

**Diagnosis**
The typical breed with a chronic cough is highly suggestive of the disease. Plain radiographs can detect the collapse in about 60% of cases, and the dynamic narrowing can be seen on fluoroscopy, but not in all cases. Ultrasound has been advocated as a minimally invasive way of diagnosis and tracheal collapse can be readily seen on CT. A preferred method of diagnosis is bronchoscopy which allows visualisation of the entire trachea and importantly the carina and mainstem bronchi. If these structures are collapsing, that has implications for treatment.

**Therapy**
Conservative management should be attempted first, and includes obesity control, use of a harness, controlled exercise, glucocorticosteroids to control airway inflammation, bronchodilators (minimal value in most cases) and selective use of anti-tussives. In situations where the collapse is life-threatening or the persistence of the clinical signs intolerable then surgical and interventional procedures can be considered, including extra luminal support rings and intra luminal stents. These are specialist procedures and are not without problems. Concurrent management of other conditions such as congestive heart failure also needs to be considered.

A good response to therapy (medical or surgical) suggests a favourable prognosis, but progressive disease resulting in eventual respiratory failure or intractable coughing often occurs. Most dogs will tolerate a level of coughing that does not affect quality of life, but many owners find this hard to deal with. Educating the owner to the management of the condition is, therefore, important.
Lecture 5. Review of lower airway diseases; bronchi to alveoli

1. Infectious Diseases (for Cat Flu, see Lecture 4)

1.1. Acute Tracheobronchitis (kennel cough)
The single most common cause of coughing in the dog and it is presumed to involve infection with *Bordetella bronchiseptica* or canine parainfluenza virus (CPiV). Other viruses (CAV-2, CDV) and mycoplasma may be implicated, and in complicated cases secondary bacterial proliferation can result in bronchopneumonia. Infection is probably by inhalation of infected aerosolised sputum, but close physical contact with oro-nasal secretions and fomites might also be a route of transmissions. The history of the dog being in a suitably infective environment is highly suggestive, but not always a requirement for diagnosis. Clinical signs typically include acute onset coughing that can be mild to severe, paroxysmal and is often described as harsh or hacking. There may be mild systemic signs of pyrexia, inappetance and lethargy. Signs typically appear 3-10 days after exposure.

Diagnosis
Typical history and clinical presentation with spontaneous resolution or predictable response to antibacterial therapy are diagnostically useful. Diagnostic techniques rarely applied to these cases.

Therapy
Likely to be self-limiting in most cases (up to three weeks duration) but antibacterial agents speed resolution. Potentiated-sulphonamides, fluoroquinolones, doxycycline are usually effective. Antitussives can be used to control excessive coughing. Antibiotics (and maybe Mucolytics) will be necessary if there is significant secondary bacterial infection (usually signs of pneumonia) and reasonable attempts should be made to keep separate from other susceptible dogs. It is probably worthwhile to avoid excessive exercise and dry, dusty and cold environments in case this might result in continual airway damage. Prophylactic vaccination does reduce chances of infection in high-risk environments and is worth considering for dogs entering a boarding kennel.

Usually there is spontaneous resolution of clinical signs but this can take up to three weeks in some dogs. Bronchopneumonia may develop in some dogs, but is rare and development of a chronic non-responsive cough can occur in some cases. Usually such dogs are said to have chronic tracheobronchial syndrome) rather than being diagnosed with chronic bronchitis (see below).

1.2. Canine Influenza

The recent reports of transmission of equine influenza virus to kennelled dogs and the possibility that transmission has also occurred between dogs (in the USA outbreaks, but not the Newmarket outbreak) is a worrying development and may indicate the emergence of a new canine infectious disease. While there is no clear evidence that this virus has entered the pet population in the UK, the presence of respiratory infection with clinical signs varying from mild (kennel cough-like) to severe (pneumonia) might raise suspicion of canine influenza infection. However in the cases seen so far the potential key involvement of *Streptococcus spp* in the generation of severe disease needs to be considered, in particular in the context of a kennelled population.
2. Chronic Bronchitis
Chronic bronchitis is defined as chronic bronchial inflammation associated with mucus hypersecretion. On histopathology, there should be evidence of airway wall thickening, an increase in goblet cell numbers and mucous gland size, widespread loss of ciliated epithelium. The primary cause is usually unknown but excessive production of mucus itself causes plugging of smaller airways and further damage by providing a suitable environment for secondary bacterial infections. Secondary to respiratory infections are common and CB can be secondary to other chronic respiratory diseases. Airway damage by inhaled irritants and allergens and defective mucociliary clearance mechanism such as that caused by immotile cilia syndrome (ciliary dyskinesia) can contribute.

The clinical signs show marked variability and the condition is progressive and the airway changes irreversible. Coughing should have been present for at least two months and Tachypnoea, dyspnœa and exercise intolerance is noted in advanced disease. Pyrexic, anorexic or inappetant and lethargic can occur and are presumed to represent concurrent bronchopneumonia. Debility and cachexia are found with advanced disease. Increased respiratory sounds are often, but not always, found on auscultation and typically include wheezes and crackles. Cor pulmonale with pulmonary hypertension and signs of right sided congestive failure can develop in chronic cases.

Diagnosis
The clinical features of the disease coupled with radiographic and bronchoscopic evidence of usually used to make a definitive diagnosis. Look for increased bronchial markings, bronchiectasis, and evidence of long standing respiratory disease (cor pulmonale, right-sided cardiac enlargement and hepatomegaly, interstitial fibrosis) on thoracic radiographs. Bronchoscopy can show any or all of the following; roughened bronchial walls, blanched mucosa or mucosal inflammation with hyperaemia, excess airway mucus visible and bronchiectasis. Without histological proof bronchoscopy is the best way to determine there are chronic airway changes. Bronchial and bronchoalveolar lavage samples can be variable depending on the stage of disease and whether or not there is concurrent bacterial infection. Findings include large amounts of mucus and variable numbers of polymorphonuclear leucocytes (neutrophils and/or eosinophils), macrophages and plasma cells. Curschmanns spirals may be present as well as variable bacterial populations (mainly gram negative aerobes). The presence of large numbers of eosinophils supports a diagnosis of allergic chronic bronchitis (see PIE).

Therapy
Treat the underlying cause where possible and advise weight control in obese animals. Trial the dog on a variety of medications selecting those to give the best response, and antibacterial therapy is necessary if concurrent bacterial bronchopneumonia present. Glucocorticosteroids (prednisolone) are the drug of first choice and may be required long-term. If feasible they should be administered by inhalation (fluticasone) once initial control has been achieved with oral administration. Bronchodilators can be added but are of questionable value (β-agonists and methylxanthines). Mucolytics are worth trying with or without inhaled steam or nebulised hypertonic saline, chest percussion and physiotherapy, but so-called expectorant agents are of questionable value. Anti-tussives are contra-indicated or at least should be reserved for control of excessive coughing. As the disease progresses rest and exercise control will be needed and avoidance of dusty, smoky and very cold environments.
Typically there is good response to steroids, but response will decline over time. Recurrent exacerbations prove harder to control and eventually deterioration and respiratory failure (months to years) occurs. Severe bacterial infections are of major concern and should be dealt with quickly.

3. Bronchiectasis (See Chronic Bronchitis)
Usually a sequel to other severe and chronic respiratory diseases such as chronic bronchitis, ciliary dyskinesia and eosinophilic bronchitis

**Diagnosis**
Cylindrical or saccular dilatation lobar bronchi visible may be visible on radiography, but are often more convincing on computed tomography and best confirmed on bronchoscopy where the airways can be seen to be cavernous and often with roughened mucosa and accumulation of purulent exudates.

**Therapy**
Management of the underlying cause if at all possible and control of airway hygiene including reduced exposure to cold air, dust, smoke, physiotherapy and steam inhalation and appropriate use of antibacterial agents. Anti-tussives should be avoided.

The prognosis is poor as it typically reflects ongoing chronic lung pathology and eventually proves refractory to treatment.

4. Airway Foreign Bodies
Inhalation of small objects is relatively uncommon, but inhalation of food material, or worse, gastric contents is more common and more hazardous (see Pneumonia). Discrete objects include grass seed heads, small twigs and small stones, inhaled during playing, exercising etc. Hair, food, fluids and medications can also be a problem. Usually clinical signs are sudden onset and can be associated with severe distress and panic. With discrete objects, once they do not cause airway obstruction, coughing is typical and is often pronounced, harsh and hacking and can end with retching. Coughing can subside after 3 to 4 day becoming soft and paroxysmal and then persist for months if the foreign body is not removed. Respiratory distress, depends on the size of the object, its location (rostral to carina if severe dyspnoea, but rare event) and if secondary bronchopneumonia develop. Marked halitosis can become obvious if the foreign body is present for weeks to months. Surprisingly many dogs and be otherwise normal.

**Diagnosis**
History of coughing after playing with an object or running through undergrowth is highly suspicious of inhalation and pneumonia coinciding with a period of vomiting, regurgitation or dysphagia would also be suspicious. Radiodense metal or stone objects, increased density in the hilar region, pleural effusion or lung consolidation with air bronchograms can be seen on radiography, but often inhaled vegetative matter is not seen or does not cause significant radiographic changes. Bronchoscopy gives the best chance of visualising and identifying a foreign body and of course is the preferred method of retrieval.

**Therapy**
Remove as soon as possible by bronchoscopic retrieval and this is usually successful when carried out by an experienced operator. However, small foreign bodies can remain in the airways for several months without causing significant harm.
Thoracotomy may be needed for the removal of large objects occluding the trachea, removal of consolidated lung lobe where a foreign body is embedded and to drain, debride and examine the pleural space if the foreign body has migrated.

Even in uncomplicated cases antibacterial therapy should be used and can often be beneficial prior to attempting bronchoscopic retrieval. In cases where there is bronchopneumonia, lung lobe consolidation, pyothorax targeted antibacterial is needed. The prognosis for discrete foreign body inhalation is very good once it can be retrieved, but becomes more guarded if there is secondary lung parenchymal and pleural involvement. If the foreign body is large enough of course asphyxia and death can occur. Inhalation of food and stomach contents is of major concern as it tends to result in extensive bronchopneumonia, with such repeated events the prognosis goes from guarded to grave.

5. Feline Asthma Syndrome
Asthma can be defined as a reversible form of bronchoconstriction that results in wheezing and dyspnoea, but which also involves a significant inflammatory component. Possibly involves a Type I or Type III hypersensitivity reaction to inhaled allergens such as house dust mites, air pollution, smoke, carpet cleaners, air fresheners and deodorants/sprays, seasonal pollens. A role for respiratory infections must be considered.

Clinical signs are variable but can include paroxysmal appearance, coughing, wheezing, crackles, dyspnoea, Tachypnoea and orthopnoea. In severe cases rib fractures and pneumothorax can develop.

Diagnosis
History and clinical signs are very suggestive particularly in young to middle aged cats and possibly Siamese. Presence of eosinophils in airway samples would suggest an allergic reaction (if not proved to parasitic), but are not always found with neutrophils being common in those cases. Radiography often shows a bronchial pattern, but it can be mixed or interstitial. Hyperinflation (air-trapping), hyperlucency of the lung field, with flattening of the diaphragm and collapsed middle lung lobe is not uncommon. A circulating eosinophilia may be found. Assessing for allergen exposure by intra-dermal testing or serum allergen specific IgE is of little value with many false positive tests.

Therapy
A rapid response to dexamethasone, bronchodilators and oxygen is highly suggestive of a diagnosis of asthma in cats. Treatment depends on the severity and the persistence of clinical signs and exclusion from the owner's bedroom (human dander and house dust mite) may help. Removal other potential triggers such as household aerosol products, dusty cat litter and consider treating for parasitism. Bronchodilators may be of some benefit with terbutaline (0.625-1.25mg per cat q8-12h PO) being the most commonly used or salbutamol or albuterol by inhalation (Aerocat spacer device). Glucocorticosteroids, however are the primary method of control as this is an inflammatory disease. Oral prednisolone at 1-2mg/kg q12h for 7-10 days then slowly reducing to 0.2mg/kg q48h is used first and then inhalation of fluticasone propionate at 125mg q12 hr or beclometasone propionate 100 mg q12 can be trialled. Combined steroid bronchodilators can also be used, but the B-agonists can sometimes cause unwanted side-effects such as tachycardia. Other treatments, usually in conjunction with glucocorticosteroids or in an attempt to reduce steroid dose include cyproheptadine (serotonin antagonist) (1-4 mg per cat q12h PO), cyclosporine, leukotriene receptor antagonists but all have doubtful or unproven efficacy. A
treatment worth considering is doxycycline as there is some evidence that asthma cats can have concurrent *Mycoplasma* infection complicating the clinical picture.

Most cats respond favourably to oral prednisolone and can be controlled on an alternate day, low dose regime and many will tolerate inhalation therapy. Untreated cases may develop irreversible chronic bronchitis and irreversible lung changes.

6. Inflammation (pneumonia):
Lung inflammatory disease is more properly known as “pneumonia” and if the predominant cell type is the eosinophil it is often referred to in the dog as pulmonary infiltration with eosinophilia (PIE), eosinophilic pneumonia or eosinophilic bronchopneumopathy (see later).

In many cases the underlying cause of pneumonia cannot be determined, but the effect is the same with neutrophil infiltration of the lung and airways and secondary proliferation of bacteria, most of which are part of the normal local flora (typically gram-negative anaerobes). A major cause of pneumonia in the dog is aspiration, but in general bacterial bronchopneumonia is relatively rare, and even rarer in cats. Bacteria that can be regarded as not part of the normal flora include pseudomonas and microaerophilic saprophytic organisms such as bacteroides, nocardia and actinomyces. In certain geographical areas mycotic pneumonia is important.

**Diagnosis**
A diagnosis of pneumonia is suspected in a dog presenting with respiratory signs, a soft cough, pyrexia and inappetance or anorexia. However, if pathology is limited to a single lobe the dog may appear relatively normal apart from coughing. Radiographic evidence of lung consolidation and in particular if there are distinct air-bronchograms is also highly suggestive of pneumonia. A leucocytosis with a neutrophilia and left shift is also highly supportive of a diagnosis but is not always present.

**Therapy**
Should be focussed on resolving the bacterial infection and if there is severe respiratory compromise appropriate support needs to be given. This can include cage rest, good nursing support, physiotherapy, fluid therapy and oxygen supplementation. Delivering oxygen using nasal prongs is highly effective and required little equipment or technical expertise. Antibacterial therapy should be parenteral (preferably intravenous) in the first instance and continued for several weeks. Resolution of pyrexia within 24hrs of starting antibacterial therapy is good evidence that the appropriate drugs have been selected. Control of pyrexia using NSAIDs might be worth considering. Lung lobectomy is an effective way of resolving lobar pneumonia where complete resolution with antibacterial therapy has failed. Typically such cases have recurrence of full clinical sign once antibacterial therapy is stopped. Recurrent bronchopneumonia is of serious concern and indicates there is an intractable underlying problem. Often this is due to other chronic respiratory diseases or diseases that are resulting in aspiration of food or stomach contents. Unless these problems can be resolved or controlled prognosis is grave in such cases.

7. Pulmonary Fibrosis:
Pulmonary fibrosis is best regarded as an interstitial lung disease and the most convincing fibrotic disease in the dog and cat is Idiopathic Pulmonary Fibrosis (IPF). Chronic interstitial lung changes are also identified on thoracic radiography that can be attributed to systemic illnesses such as metastatic mineralization with
hyperadrenalocorticalism, or may even be a consequence of natural ageing changes, and it is presume that these also reflect a degree of fibrosis.

Dogs and cats affected with IPF will show the typical signs of respiratory disease, and the timing and severity will be dependent on the extent of the disease and its rate of progression. Coughing, tachypnoea and dyspnoea are common findings, coupled with varying degrees of exercise intolerance, cyanosis and syncope. Right sided heart failure is a rare outcome but many have pulmonary hypertension. In dogs the condition is seen mainly in middle to old-aged West Highland white terriers, but has also been reported in other terrier breeds.

**Diagnosis**
Thoracic auscultation typically demonstrates increased respiratory rate, noise and effort, with distinct inspiratory pulmonary crackles (not so obvious in cats) being the best indication of fibrosis. Pulmonary crackles, however, are also a consistent sign with severe pulmonary oedema and chronic bronchitis. Pulmonary fibrosis is often suspected because of radiographic changes that are best described as “interstitial”. However, the issue of radiographic quality and interpretation is a major confounding factor in identifying interstitial lung patterns and fibrosis in particular. High resolution computed tomography (HRCT) greatly improves the quality of thoracic imaging and the identification of genuine interstitial lung patterns, but its use is constrained by availability, cost and expertise for interpretation. HRCT findings include ground glass opacity, sub-pleural bands, parenchymal bands, subpleural and peribronchovascular interstitial thickening and traction bronchiectasis, and these changes appear to correlate well with the severity of disease. HRCT is probably the best tool we have at present in making a reasonably accurate diagnosis, but needs to be interpreted in the light of bronchoscopic findings. Bronchoscopic evaluation of the respiratory system is invaluable in the investigation of the suspect canine IPF case, because it excludes chronic bronchitis as a diagnosis. In practice, IPF is usually diagnosed on the basis of historical and clinical features supported by radiographic, bronchoscopic and airway cytology results. For example, in the case of IPF, it is the clinical features of dyspnoea with extensive pulmonary crackles in a predisposed breed of middle to old age (eg West Highland white terrier, Cairn terrier) that gives the highest index of suspicion as to the diagnosis. Pathological diagnosis is rarely (if ever) achieved in the live patient.

**Therapy**
Is of little benefit in IPF, but they do tend to be trialled on prednisolone and may show a response if chronic bronchitis or active inflammation is implicated, but not if the presentation is exclusively caused by fibrosis. Because many of these dogs have pulmonary hypertension, sildenafil (Viagra) is being trialled in many of these patients and some show a response. Combination therapy of sildenafil with pimobendan is being trialled in human patients in Japan and some reports suggest it is of clinical benefit.

8. **Pulmonary neoplasia:**
Lung parenchymal tumours can be either primary or metastatic, with the latter more common since the lung is the main site of metastases for malignant tumours. Primary lung tumours can also metastasise locally to other lung sites. Single primary lung tumours that are detected incidentally, for example thoracic radiography carried out for other reasons, have the best prognosis, while metastatic lung disease has a very grave prognosis and apart form palliative therapy, is untreatable.

Lung neoplasia is typically found in middle to old-aged dogs and results in clinical signs typical of respiratory disease. Coughing is common with primary neoplasia as it
is invariably due to bronchial compression. Dyspnoea, exercise intolerance and paraneoplastic signs such as cachexia and hypertrophic pulmonary osteopathy (Mairie’s disease), are poor prognostic signs as they tend to be associated with advanced disease. The progression of primary tumour growth and spread is not known, but is probably quite slow in the early stage of disease and becomes more rapid in the later stages. This suggests that early detection of disease, particularly solitary masses, and immediate surgical intervention, would greatly improve outcome.

The most common primary tumours are carcinomas, with adenocarcinoma making up 95%. Examples of common secondary tumours are osteosarcoma, mammary carcinoma, melanoma, lymphoma, hemangiosarcoma and anal sac adenocarcinoma.

**Diagnosis**

Diagnosis is based on identification of classic radiographic changes in the right age of dog. Typically, primary tumours are single lung lobe masses and so are very radiodense and well delineated. They can involve multiple lobes (more advanced disease), and in rare instance adenocarcinomas can present as a diffuse nodular-interstitial lung pattern. Metastatic lung neoplasia typically gives well delineated multiple nodular densities (cannonball lung), less well defined multiple masses, or diffuse nodular-interstitial density. The staging of disease also involves radiographic assessment of lymph node involvement, which if present gives a poor to grave prognosis. Often the extent of lymph node involvement is not determined until thoracotomy. Disease extent, and therefore, prognosis is greatly improved with use of CT. Definitive diagnosis depends on histological confirmation, but failure to do so should not prevent an attempt at surgical removal of well delineated, localised mass lesions. Samples can be obtained by direct fine needle aspirate of the lesion, and in some cases neoplastic cells can be found in broncho-alveolar lavage samples (probably when the disease is more advanced). Bronchoscopy often demonstrates bronchial collapse at end-expiration with exuding of blood tinged mucus from the collapsed airway.

**Therapy**

Resection of the affected lung lobe is the preferred treatment for primary lung neoplasia and prognosis is greatly improved if there is no lymph node involvement (often only confirmed at surgery). However, there is concern that metastatic spread has already occurred at the time of surgery, even though it might not be visible. Survival can be up to 24 months, but there is no data on how long survival might be for asymptomatic incidental primary tumours, and therefore whether or not surgery improves survival in such cases. In clinically affected dogs survival without treatment tends to be weeks rather than months. In those dogs that have negative prognostic indicators (e.g. involvement of several lobes and/or lymph node, pleural effusion, hilar localisation) surgical resection might only result in a maximum of 6-8 month survival.

Chemotherapy has limited value in pulmonary neoplasia, but can be considered for palliative treatment of extensive primary lung tumours where resection has not been complete, and for metastatic neoplasia. Reported protocols include; cisplatin, carboplatin and vinorelbine for primary carcinomas, the CHOP protocol for lymphoma and cisplatin/carboplatin for osteosarcoma.

**9. Eosinophilic Lung Disease**

Although eosinophils are associated with parasitism and allergy there are instances when no known cause for tissue Eosinophilia can be found. This is the case for nearly all cases of eosinophilic bronchitis and pneumonia in the dogs, although in the cat, as
part of the asthma complex, an allergic reaction is presumed to be the underlying problem.

Eosinophils in bronchoalveolar lavage are the usual way in identifying airway/lung Eosinophilia, but cells can be found on FNA of lung tissue. Nevertheless, BAL sampling is usually sufficient, and if no cells are found, and the technique was carried out properly, that can be presumed to be the case at that point in time. However, it is possible that the degree of BAL eosinophilia is related to the stage of disease and may be different between two disease time points. This can result in false negative results and should be interpreted with caution. Normal cats are also reported to have up to 25% of their BAL samples being eosinophils, but this finding is questioned by some cytopathologists, one criticism being that the volume of instilled fluid used in the study to determine this finding, was quite large.

**Clinical Conditions:**

**Respiratory parasitism**
Parasitism in dogs and cats can be a contributory factor to the eosinophilic airway and lung diseases. Foxes often act as a reservoir of infection for canines. The type of parasites involved will depend on geographical location but can include Filaroides spp (Oslerus osleri, Filaroides hirhti), Crenosma vulpis, Aelurostrongylus abstrusus, Capillaria aerophilia, and the heartworms Angiostrongylus vasorum, and Dirofilaria immitis. These parasites result in eosinophilic pneumonitis and/or eosinophilic bronchitis. In the case of *D. immitis*, pulmonary eosinophilic granulomatosis can develop. Eosinophilic pneumonia secondary to ascarid migration through the lung is suspected to occur in some young dogs.

*Angiostrongylus vasorum* parasitizes the pulmonary artery and its branches, but is also found in the right ventricle. First stage larvae enter the airways and are coughed up, swallowed and passed in the faeces. The pre-patent period is approximately 50 to 60 days. Dogs tend to be between four months and four and half years of age and often reared outdoors in runs. Variable clinical signs are partly depending upon the level of infection and many cases are subclinical. Coughing is the most common clinical presentation. Additional clinical signs include weakness, subcutaneous swelling (haematoma), lameness, anaemia, pulmonary crepitation, right sided heart failure, collapse, dyspnoea and respiratory distress, emaciation, stunting and poor performance. Lumbar pain, hind leg paresis and intracranial haemorrhage have been reported with associated neurological signs. Many infected dogs are likely to be subclinical or mildly affected and the published descriptions might best describe the more severe forms seen at referral centres.

The prognosis for subclinical and mildly affected cases is good, with a good response to treatment. More severely affected cases may develop respiratory problems. Pulmonary thromboembolism may lead to death

*Crenosoma vulpis* predominantly parasitises the airways with snails or slugs acting as intermediate hosts and pathology is similar to Angiostrongylis. Dogs of any age can be affected, and re-infected over time, and show variable clinical signs (usually mild) while many cases are sub-clinical. Coughing is the most common clinical presentation and dyspnoea may occur occasionally. A mixed pattern, with a patchy alveolar density and a diffuse interstitial pattern might be seen on radiographs.
Diagnosis
The clinical signs of lung parasitism can vary widely from mild cough, to severe dyspnoea and heart failure and are dependent on the parasite involved. Diagnosis is usually by demonstrating evidence of the parasites presence; heartworm antigen test, faecal analysis, BAL samples, but in some instances indirect evidence is all that is needed to at least consider treating for parasitism; e.g. opportunity for exposure to Crenosoma vulpis where there is a high density of urban foxes.

Therapy
Treatment of parasitism is dependent on the parasite involved, but typically involves the use of a benzimidazole or avermectin based-anthelmentics. Glucocorticosteroids, usually prednisolone, can be used to suppress the hypersensitivity reaction. Eosinophils are particularly sensitive to the effects of glucocorticosteroids, which are potent inducers of apoptosis.

Eosinophilic bronchitis/asthma (PIE) (see Asthma in cats above)
Dogs with airway Eosinophilia without obvious involvement of the lung parenchyma are suspected to have eosinophilic bronchitis. However, it is likely they have some degree of interstitial lung involvement that might not be detectable radiographically. In those cases where a distinct interstitial lung pattern is evident these dogs are usually referred to have Pulmonary Infiltration with Eosinophilia (PIE), or Eosinophilic Bronchopneumopathy (EBP). In this description the “Eosinophilia” refers to the lung parenchyma and not the circulation. However, many of these dogs will have a circulating eosinophilia, typically less than 5x10^9/l, but is some instances as high as 70x10^9/l. High circulating eosinophil counts are likely to correlate with the severity of clinical signs, and the possible involvement of migrating ascarid larvae should be considered.

The clinical signs of PIE can vary in severity, but typically involve coughing. Even in severely affected dogs there is rarely evidence of pyrexia and the dogs may appear relatively bright and alert. This is useful in differentiating from bacterial bronchopneumonia.

Eosinophilic pneumonia
Where the eosinophilic reaction in the lung is so extensive as to cause lung consolidation and air bronchograms to be visible on radiographs, a diagnosis of Eosinophilic Pneumonia can be made. Where lung consolidation is due to granuloma formation (typically confirmed on post mortem) then a diagnosis of Pulmonary Eosinophilic Granulomatosis (PEG) can be made, but this is only suspected to occur in D. immitis infection. Eosinophilic pneumonia is part of the PIE spectrum of diseases and is also treated with glucocorticosteroids in the first instance. For both PIE and Eosinophilic Pneumonia, rapid initial response to prednisolone is a good sign and treatment can often be tapered and removed after 6-8 weeks, but some may need continuous or intermittent therapy for life. For cases unresponsive to prednisolone, indefinite treatment with prednisolone plus azathioprine/cyclophosphamide is more likely. Surgical removal of single consolidated lung lobes might also be appropriate, but treatment for PEG seems to be unsuccessful.

For all dogs with eosinophilic airway and lung disease trial treatment with an anthelmentic is advisable. This less likely to be applicable to the cat where clinical infection with lungworm seems to be rare.
10. Non-Cardiogenic Pulmonary Oedema (and pulmonary haemorrhage)

Pulmonary oedema is typically a consequence of left-sided congestive heart failure and is the main differential consideration for respiratory diseases causing moderate to severe clinical signs (dyspnoea and exercise intolerance) (see Lecture 2). Pulmonary oedema can be also caused by non-cardiac diseases, although this is much rarer, and may also be a hidden contributor to the pathology seen with other diseases such as pneumonia and pulmonary fibrosis. The fundamental difference between cardiogenic and non-cardiogenic pulmonary oedema is the manner in which the oedema forms and the treatment.

Bleeding into the pulmonary parenchyma can give clinical and radiographic features similar to all other lung parenchymal diseases and can be caused by a variety of conditions and events, but overall is relatively rare. Trivial pulmonary haemorrhage is likely to occur in many diseases but remain hidden from diagnosis.

Clinical conditions

Non-cardiogenic pulmonary oedema (NCPO)

As name implies NCPO is lung oedema that is not of cardiac cause. It is much less common cause of oedema and is believed to be a consequence of fluid movement across a leaky vascular endothelium. This can be caused by pathological damage of the endothelium, functional alterations in the mechanisms that control endothelial fluid movement and rapid fluctuations in trans-pulmonary pressure. Examples of causes include severe systemic illnesses such as necrotising pancreatitis and renal failure (uremic syndrome), seizures, electric shock and other severe CNS conditions (neurogenic PO) and any condition causing asphyxia, such a strangulation and laryngeal paralysis. Raised pulmonary venous pressures do not contribute to the development of NCPO.

Diagnosis

With the large array of possible causes it can be difficult to identify NCPO in any one case. However, in any case with a possible diagnosis listed above that also is showing physical evidence of respiratory distress or radiographic evidence of an interstitial and/or alveolar pattern on radiography should be suspected on NCPO. In contrast with cardiogenic PO, which tends to localise to the hilar region, non cardiogenic PO can be present in any area of the lung.

Therapy

Because non-cardiogenic pulmonary oedema does not involve raised left atrial pressures treating to reduce pre-load or after load as with treatment of non-cardiogenic pulmonary oedema is not advocate. If the initial cause has been corrected then treatment is conservative and based on cage rest and oxygen supplementation with the expectation of clear improvement within the following 24hrs. However, since the clinical presentation can be alarming many clinicians will elect to use some frusemide in case it will be of more immediate benefit. There is no evidence such an approach has any benefit and theoretically could be detrimental. Failure to control the underlying disease might result in persist NCPO, but in many cases the appearance of NCPO is sporadic and self-limiting.

Pulmonary haemorrhage

Pulmonary haemorrhage results in a radiographic pattern that is often indistinguishable from bronchopneumonia, but is relatively rare and should only be considered as a possible diagnosis if there is clear supportive evidence. Since the lung parenchyma cannot be sampled easily confirmation of haemorrhage can be difficult.
**Diagnosis**
Respiratory sighs and radiographic changes reminiscent of bronchopneumonia, where there is no fever or other evidence of infection might suggest haemorrhage. Clear evidence of a coagulopathy such as warfarin poisoning would make a diagnosis nearly complete. The presence of blood either on expectoration or on BALF sampling does not in itself support a diagnosis as this type of bleeding can be due to other causes. Evidence of trauma would also be highly supportive of a diagnosis.

**Therapy**
The underlying cause of the haemorrhage should be treated, but this is usually limited to coagulation disorders. In most other situations haemorrhage will resolve spontaneously although this could take some time. Continual on-going haemorrhage carries a poor prognosis and the use of blood transfusion may need to be considered in the early phases of manage.
Lecture 6. Review of pleural and mediastinal diseases

Diseases of the pleural space typically result in varying degrees of pleural effusion and this is the most important consideration regarding pleural disease in cats and dogs.

Pleural Effusions

A small quantity of serous fluid is normally present in the pleural space but is not detectable on radiography so the identification of even minimal increases in pleural fluid quantity is abnormal. However, the importance of pleural effusion is often related to the volume and its effect on respiratory function.

Effusion Types

1. **True transudates**; translucent colourless, serous, low protein, cellularity and specific gravity.
2. **Modified transudates**; opaque, coloured yellow to pink, moderate protein, cellularity and specific gravity. Most true transudates become “modified” after a short period.
3. **Exudates**; opaque, coloured yellow to brown, high protein, cellularity and specific gravity. May contain organisms (pyothorax).
4. **Chyle**; opaque, milky-white to blood-tinged, moderate protein, high cellularity, high lipid content (triglycerides), high specific gravity, large numbers of lymphocytes.
5. **Blood** (haemothorax)
6. **Air** (Pneumothorax)

Pleural and ascitic fluid should routinely be tapped to determine the type of effusion and it’s classification. Once this has been performed, then the diagnostic pathway can be decided. Whilst this table classifies effusion by a number of categories, simply determining its character (colour and transparency) and the SG is often sufficient to classify it - this can therefore usually be performed in-house.

<table>
<thead>
<tr>
<th>Effusion Type</th>
<th>Transparency</th>
<th>Colour</th>
<th>Specific Gravity</th>
<th>Protein Content (g/l)</th>
<th>Cell Count per µl</th>
<th>Predominant Cell Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>True Transudate</td>
<td>Translucent clear</td>
<td>Yellow or colourless</td>
<td>&lt; 1.018</td>
<td>&lt; 25</td>
<td>&lt; 1500 (&lt;)</td>
<td>-</td>
</tr>
<tr>
<td>Modified Transudate</td>
<td>Partially opaque Turbid</td>
<td>yellow to pink</td>
<td>&gt; 1.018</td>
<td>&gt; 30</td>
<td>1500 to 5000 (+)</td>
<td>Variable Cell Type Note: A few red cells are not uncommon (PCV &lt; 5%)</td>
</tr>
<tr>
<td>Exudate</td>
<td>Opaque Turbid</td>
<td>yellow to brown</td>
<td>&gt; 1.035</td>
<td>&gt; 30</td>
<td>&gt; 5000 (+++)</td>
<td>Neutrophil</td>
</tr>
<tr>
<td>Chyle</td>
<td>Opaque Turbid</td>
<td>white or pink</td>
<td>&gt; 1.030</td>
<td>&gt; 25</td>
<td>1500 to 10000 (++)</td>
<td>Lymphocyte TGs are very high compared to serum</td>
</tr>
</tbody>
</table>

Many diseases can result in different types of effusion and it is probably easiest to consider the cause on the basis of the effusion type, bearing in mind several diseases can cause different effusion types. The following lists are reasonably exhaustive, but it is interesting to note that in 30% of pleural effusion cases and underlying cause is not found. Furthermore the single most common cause of pleural effusion in the cat is congestive heart failure.
1. **True and Modified Transudates.**
   1. **Hyoproteininaea.**
      a. Protein-loosing enteropathies, malabsorption and maldigestion.
      b. Hepatic failure (reduced albumin production).
      c. Starvation.
      d. Severe intestinal parasitism.
      e. Protein-loosing nephropathy.
      f. Amyloidosis.
   2. **Right-sided congestive heart failure in the dog (more typically causes ascites).**
   3. **Left-sided congestive heart failure in the cat.**
   4. **Systemic illness.**
   5. **Immune-mediated diseases (very rare cause of pleural effusion).**
   6. **Lung lobe torsion.**
   7. **Allergic or anaphylactic reactions.**
   8. **Neoplasia.**
   9. **Diaphragmatic hernia.**

**Exudates.**

1. Many of the conditions that cause transudates.
2. **Active inflammatory processes.**
3. **Bacterial Infections.**
   a. Bacteria from bite wounds.
   b. Migrating foreign bodies.
   c. Inhaled and migrating foreign bodies.
   d. Penetrating wounds of the chest wall.
   e. *Nocardia* and *Actinomyces* sps, mycobacteria.
4. **Feline infectious peritonitis virus infection (wet form; pyogranulomatous pleuritis).**
5. **Neoplasia.**
6. **Thoracic trauma.**
7. ** Mediastinal disease.**

**Chyle.**

1. **Idiopathic in the majority of cases.**
2. **Thoracic duct rupture (rare, probably unlikely cause).**
3. **Inflammatory processes.**
4. **Lung lobe torsion.**
5. **Neoplasia.**
6. **Mediastinal disease.**
7. **Mediastinal lymphosarcoma.**
8. **Congestive heart failure (cats).**
9. **Cardiomyopathy (cats), very common cause of chylothorax.**
10. **Pericardial disease.**
11. **Heartworm disease.**

**Haemothorax.**

1. **Coagulopathies.**
2. **Trauma.**
3. **Blood vessel erosion.**
4. **Infections, abscessation, neoplasia.**
5. **Inflammatory processes.**
6. **Pneumothorax.**
7. **Trauma to the chest wall (open pneumothorax).**
8. **Damage to the airways and lung tissue.**
10. Idiopathic.
11. Iatrogenic.

Tension pneumothorax is where the air is trapped during expiration in the pleural space, causing lung collapse. Pneumomediastinum can be caused by the same mechanisms and can be spontaneous and self-limiting.

Irrespective of the cause most cases of pleural effusion share the same clinical features simply because fluid or air accumulation compromises lung expansion. So it can be expected there will be varying degrees of respiratory embarrassment varying from tachypnoea to dyspnoea and in severe cases orthopnoea (remains standing (reluctant to lie down (dogs) or sternal recumbency with abducted elbows and neck extended (cats, but also dogs). Exercise intolerance is commonly reported in dogs with some showing cyanosis at rest or after minimal exertion. Collapse and sudden death may occur but are relatively rare events. Secondary effects, often associated with chronicity, include weight loss, inappetance and anorexia. Pyrexia would suggest infection and there may be additional signs of congestive heart failure if that is the underlying cause.

On physical examination there may be muffled heart and airway sounds and altered thoracic resonance on chest percussion. Increase in chest resonance will be noted with pneumothorax. Abdominal changes may include distension if there is concurrent ascites and emptiness if large abdominal contents have herniated into the thorax.

**Diagnosis**

While cases should be handled with care, thoracic radiography will identify significant effusions in all case, but rarely will give a definitive diagnosis. Changes typically can be described as homogenous ground glass appearance, pleural fluid lines, lung lobe compression, pleural fissure lines, and visible lung lobe borders. There may be widening of the mediastinum. Ultrasonography can further confirm the presence of pleural fluid, the extent of mediastinal involvement and assist guided sampling and also assess hepatic veins and the presence of ascites. Echocardiography will clarify the degree of cardiac involvement and is required in many cat pleural effusion cases. Thoracocentesis is diagnostically important, but also the first therapeutic intervention useful and fluid can be easily assessed in a practice laboratory. Lastly surgical exploration may be needed for both diagnostic and therapeutic reasons. While a major undertaking, involving both hazard and expense, it is necessary in undiagnosed and/or un-resolvable pleural effusion cases.

**Therapy (see table below)**

Thoracocentesis is needed for the immediate relief of life-threatening respiratory distress and will give a rapid improvement in respiratory function. It is easiest to drain form the right side 6-7 rib space just above the level of the costrochondral junction and since dogs and cats have an incomplete mediastinum it may be possible to drain enough from the right side alone. Repeated drainage (continuous or intermittent) drainage requires pleural catheter placement under general anaesthesia and this also facilitates pleural lavage which is particularly useful in pyothorax. Catheters can be left in place for 10 to 14 days, but after that a clinical decision on continued treatment must be made and the catheters themselves begin to cause problems.

Surgery may be required to attempt to make a diagnosis, break down adhesions, open pockets of effusion, allow accurate pleural catheter placement, obtain diagnostic
samples, remove neoplasms, consolidated or torse lobes, repair diaphragmatic hernias and treat unresolving or recurrent pneumothorax.

If an underlying case is identified then therapy should be directed at that with a view to effecting a cure or controlling the clinical signs. Examples include managing causes of hypoproteinaemia, congestive heart failure, treatment of pyothorax, surgical techniques to control chylothorax, management of bleeding disorders.

Prognosis depends on the nature of the effusion and the cause. Pleural effusion is a serious condition and may require radical and often long-term therapy. In many situations the condition will not be resolved. Prognosis is grave with neoplastic causes, while pyothorax is usually curable with the proper intervention. Unresolvable chylous effusions will result in debility and cachexia in the long-term, while most cases of pneumothorax resolve spontaneously.

<table>
<thead>
<tr>
<th>Hypoproteinaemia</th>
<th>Congestive heart failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Treat the gastrointestinal, renal or hepatic causes.</td>
<td>• Diuretic</td>
</tr>
<tr>
<td>• Protein diet of high biological value and high bioavailability.</td>
<td>• ACE inhibitors</td>
</tr>
<tr>
<td>• Anti-inflammatory agents, immunosuppressive and cytotoxic agents as indicated.</td>
<td>• Pimobendan</td>
</tr>
<tr>
<td>• Hepatic support.</td>
<td>• Mange heart rate</td>
</tr>
<tr>
<td>• Improve glomerular function</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Haemothorax</th>
<th>Pyothorax</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Thoracocentesis to alleviate dyspnoea.</td>
<td>• Treat vigorously with thoracocentesis, until 50ml/day/dog sterile serous fluid are obtained</td>
</tr>
<tr>
<td>• Whole blood transfusions.</td>
<td>• Pleural lavage 2 to 4 times daily (20ml/kg body weight).</td>
</tr>
<tr>
<td>• Vitamin K1 supplementation (rodenticide poisoning).</td>
<td>• Antibacterial agents, based on culture and sensitivity testing, but also by empirical selection for at least 6 weeks (4 months for Nocardia).</td>
</tr>
<tr>
<td>• Immunosuppressive agents as indicated.</td>
<td></td>
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<table>
<thead>
<tr>
<th>Chylothorax</th>
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</thead>
<tbody>
<tr>
<td>• Initial thoracocentesis.</td>
</tr>
<tr>
<td>• Monitor for hyponatraemia and hypokalaemia.</td>
</tr>
<tr>
<td>• Treatment of congestive heart failure (mainly cats).</td>
</tr>
<tr>
<td>• Dietary control.</td>
</tr>
<tr>
<td>o Restrict dietary fat intake (commercial products preferred).</td>
</tr>
<tr>
<td>o Feed a high protein, high carbohydrate diet with vitamin supplementation.</td>
</tr>
<tr>
<td>o Medium-chain triglyceride dietary fats.</td>
</tr>
<tr>
<td>• Surgical ligation of thoracic duct +/- pericardiectomy</td>
</tr>
<tr>
<td>o If dietary management is unsuccessful.</td>
</tr>
<tr>
<td>o There is a chronic build up of chyle in the thorax.</td>
</tr>
<tr>
<td>• Diuresis to minimise volume of fluid</td>
</tr>
<tr>
<td>• Rutin supplementation of questionable value.</td>
</tr>
</tbody>
</table>
**Diseases of the Mediastinum**

Although not that common conditions affecting the mediastinal space can have characteristic features. Typically these diseases result in mediastinal widening, but mediastinal narrowing can also occur and the clinical signs can be explained when considering the structures within the cranial mediastinum.

Causes of mediastinal changes include mediastinitis caused by foreign body penetration of the oesophagus with subsequent abscess and granuloma formation, oedema, haemorrhage caused by trauma, coagulopathies and neoplasia, mediastinal neoplasia itself including lymphomas and chemodectomas, lymphadenopathy due to inflammation, neoplasia and infection, physical widening by congenital pericardiodiaphragmatic hernia (caudal mediastinum), gastro-oesophageal reflux of the stomach through a hiatal hernia, and megaoesophagus.

The clinical signs of mediastinal disease are invariably due to compression of structures such as the trachea (dyspnoea, cough, stridor), oesophagus (dysphagia, regurgitation, retching), vago-sympathetic trunk (Horners syndrome), major vessels (head and forelimb oedema, vena cava syndrome and rarely the recurrent laryngeal nerve (laryngeal paralysis).

**Diagnosis**

This can be suggested by the clinical signs, but significant widening is best appreciated on V/D or D/V thoracic radiographs and can include caudal displacement of the cranial lobe borders, cardiomegaly and megaoesophagus. Ultrasonography can allow some discrimination of tissue structures contributing to the widening and allow guided sampling (not always possible). Surgical exploration may be needed to assist diagnosis or treatment.