Internal Medicine Diagnostics—Thoracic Cavity

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The most valuable tools of the trained veterinarian are the ability to perform a complete physical examination, interpret the findings, make some logical conclusions based on these findings, and design a course of therapy to return the patient to normal function. The successful diagnostician may perfect his clinical exam by perfecting his ability to interpret what he finds or by employing more sensitive diagnostic tools in order to gain more specificity in defining and treating the problems he sees. Diagnosis of problems in the thoracic cavity are often overlooked. More often than not the problem stems from the failure to perform a good examination of the chest. Avoidance of the thoracic cavity, however, is the result of confusion over interpretation of what is seen and heard. The purpose of this paper is to review some of the diagnostic methods used in physical examination of the thoracic cavity. The focus will be on auscultation since this is the most useful diagnostic procedure every veterinarian can perform.

Physical examination of the thorax begins with inspection of the animal. At this time a decision can oftentimes be made whether the problem is thoracic or abdominal. Hallmarks of disease in the chest are: labored breathing (prolonged inspiration or expiration), marked thoracic or abdominal excursions with each breath, flared nostrils, or open mouth breathing. Cardiovascular disease may be heralded by distended jugular veins, abnormal jugular pulsations or edema. Palpation of the thoracic cage may reveal thrills (in the cardiac dullness area), friction rubs, fractured ribs, or subcutaneous emphysema.

Auscultation is the most important tool used in the diagnosis of diseases of the chest. The majority of clinical conditions involving the chest can be diagnosed by careful auscultation alone. Under the best circumstances other dianostic procedures (ECG, radiograph, ultrasound, endoscopy) can be implemented for confirmation of the diagnosis but the bovine practitioner must rely on the stethoscope alone. Besides being the most useful diagnostic procedure available, auscultation takes a small amount of time, it yields a great amount of information, and it is cost effective. The drawbacks are few. Skill is required for interpretation of information gained by using the stethoscope and communication is often difficult because of confusing terminology, which is especially true of lung sounds.

The requirements for productive auscultation are a good quality, comfortable stethoscope. The accuracy of diagnostic evaluation is based in part on the acoustic accuracy of the stethoscope. However, the acoustics of any stethoscope will reflect the acoustics of the human ear when it is worn.[1] The diaphragm of the stethoscope amplifies high frequency sounds while attenuating low frequencies.[2] Poor quality or cracked diaphragms will attenuate all frequencies. The bell is used to amplify low frequency sounds. The shallow, bowl-shaped bells have no useful high frequency response at all. The tubing of the currently available stethoscopes are either single or double. Although the single tube is more compact and subject to less extraneous noise, it is subject to irregular distortion patterns and suffers from considerable loss of output at high frequencies. The double tube stethoscopes amplify high frequency sounds but they are often more cumbersome to use. The stethoscope with fused double tubes has the same acoustical advantage of the double tubes while being more compact. With tubes of increasing length both high and low frequency sounds will become progressively more damped. The earpieces should be tight fitting to avoid air leaks and admission of extraneous noise. Only when one auscults the thoracic cavity in relative quiet can the trained ear distinguish sounds generated in the chest from extraneous noise.

The acoustic system is made up of: (1) the source producing vibrations within the body which are transmitted through tissue to the wall of the chest; (2) the stethoscope, which receives vibrations at the surface of the skin and transmits them to the ear; and (3) the ear, itself, which permits one to hear vibrations as sounds.

By auscultating the cardiac area of either the left or right side, one should always hear 2 distinct sounds for each cardiac cycle. The normal range for the heart rate of the cow is between 60 and 80 beats per minute. The first heart sound (S_1) occurs at the onset of ventricular contraction (systole) and is produced basically by the closure of the tricuspid and mitral (AV) valves and partially by the opening of the pulmonic and aortic (semilunar) valves.[3]

The second heart sound (S_2) follows S_1 and marks the end of systole. It is generated mainly by closure of the semilunar valves but the opening of the A-V valves may also contribute to genesis of the sound. This sound may be variably split with respiration in the normal animal. Consistent splitting of the S_2 with every cardiac cycle may be suggestive of pulmonary hypertension, the most common cause of the latter in cattle being hypoxia (high altitude or brisket disease).

The first heart sound is louder, longer, and lower pitched than S_2 and is heard best at the apex of the heart. The second heart sound is heard best at the base of the heart, the location of which is reached by forcing the stethoscope between the elbow and thorax and moving dorsally up under the triceps. The intensity of both sounds depends on the vigor of ventricular contraction, valve structure, chest conformation, and type of disease process (if any) present.

In addition to S_1 and S_2, the astute practitioner may hear S_4, which precedes S_1, or S_3, which follows S_2. The fourth heart sound is a low frequency sound generated by atrial contraction, and heard best at the heart base. It may be timed very closely to S_1, giving a sound which is difficult to distinguish from a split S_1. The third heart sound is also a low frequency sound, which is heard best at the apex of the heart, and is generated by ventricular filling. Auscultation of 3 distinct cardiac sounds is termed a gallop rhythm. A presystolic gallop (S_4-S_1-S_2) is normal in cattle. The significance of a protodiastolic gallop (S_1-S_2-S_3) is questionable if no other signs of heart disease are present.

Interpretation of cardiac murmurs is relatively easy if the practitioner is familiar with the origin of heart sounds, can locate the position (apex vs. base) and side (left vs. right) where the murmur is loudest, and knows the age and medical history of the animal. Congenital murmurs, the most common of which is the ventricular septal defect (VSD) in cattle, are heard in young animals, whereas acquired murmurs occur most commonly in adults. Acquired murmurs are commonly caused by vegetative endocarditis, usually involve the tricuspid valve, and occur in cows with intermittent fever, and other signs of a persistent infection.

Cardiac murmurs which occur between S_1 and S_2 are systolic murmurs. In cattle early systolic low intensity murmurs at the left heart base are not uncommon and are considered "functional" or ejection sounds. The functional murmur is often associated with fever, excitement, or anemia. The defects of pulmonic stenosis (PS) and aortic stenosis (AS) may produce a similar murmur at the left heart base but are rare in cattle unless they are caused by valvular endocarditis. A "relative" pulmonic stenosis murmur may accompany a harsh right sided murmur in young calves and is very suggestive of a VSD.

The systolic murmur heard best at the left apex of the heart is usually mitral valve regurgitation. This lesion is uncommon in cattle compared to horses and dogs and, when it occurs, is generally a sign of severe myocardial disease and dilation of the ventricle, such as with Vitamin E-Se deficiency.

A right-sided systolic murmur in cattle is generally found with either a VSD or tricuspid valve insufficiency. Tricuspid insufficiency (TI) will occur most often in older animals with chronic infection who have acquired vegetative valvular endocarditis. The murmur of TI is heard best at the right base. The murmur produced by a VSD occurs most often at the right sternal border and is accompanied by a left basilar murmur of relative PS. Diastolic murmurs (occur after S_2) are rare in cattle but may be associated with valvular endocarditis. In cases such as the latter, the diastolic murmur is also accompanied by a systolic murmur ("to and fro murmur"). In the young calf a continuous (systolic and diastolic) murmur is the sign of a patent ductus arteriosus.

The murmurs or sounds which occur with pericarditis (traumatic) are distinctive in cattle. The "washing machine" or splashing sounds can be heard at the left base and at the apex during systole and diastole. Distinct cardiac sounds are often muffled by the pericardial effusion.

Cardiac arrhythmias in cattle are rarely primary signs of cardiac disease. They usually occur with gastrointestinal disease (atrial fibrillation, bradycardia) electrolyte disorders (atrial or ventricular premature beats), excitement, viral infection (myocarditis), or other disorders characterized by severe metabolic derangement (hypocalcemia, hypercalcemia). The arrhythmias usually resolve with correction of the primary condition and therefore require no specific therapy. The atrial arrhythmias which are present in adult lymphosarcoma usually indicate specific involvement of the heart.

Auscultation of the lungs can also be rewarding in the information that it yields. However, interpretation of lung sounds and the confusing terminology used to describe lung sounds often leads to a reluctance to complete this part of the physical exam. The bovine practitioner must cultivate his ability to auscultate since radiography and the other more sophisticated diagnostic tools of the small animal veterinarian are not always practical. The practitioner begins his examination of the lungs by distinguishing normal breath sounds from the added (adventitious) sounds generated by pathologic processes. Evaluation of lung sounds is best during deep respiratory efforts, especially when optimal quiet is not possible. Deep breathing can be transiently produced by holding off the nostrils for a minute and then ausculting the chest immediately after release. Sustained deep respiratory efforts can be produced by putting a plastic bag loosely over the muzzle of the cow, thereby forcing the cow to rebreathe her expired air. Variations in lung sounds will occur with differences in age, respiratory pattern, chest thickness, area of the chest being auscultated, and the amount of disease present.[4]

Normal lung sounds can be divided into bronchial (tracheal), vesicular, and bronchovesicular sounds.[4] Bronchial breath sounds are those heard with the stethoscope over the trachia. The sounds are characterized by having clearly audible inspiratory and expiratory sounds. They have been likened to harsh, tubular sounds.[4] Vesicular sounds are also normal breath sounds heard over the lungs. These soft, "sipping" sounds are thought to be generated by the lobar and segmental bronchi normally. Smaller airways may contribute to sound production in disease conditions. Under conditions of quiet respiration, vesicular sounds may become inaudible in late expiration. The term "bronchovesicular" is applied to sounds with characteristics which are intermediate between bronchial and vesicular sounds.[4,5]

Bronchovesicular sounds may be heard when the patient is breathing deeply. It is not uncommon to hear the description of harsh or rough lung sounds used. This term usually refers to an increased intensity of normal breath sounds, particularly those of low frequency. The clinical significance of harsh sounds is questionable. The animal breathing rapidly from heat or excitement will have harsh lung sounds. The cow with IBR may also have harsh or rough breathing sounds.

Adventitious or added lung sounds are sounds produced by pathologic processes which can be further classified into discontinuous and continuous sounds. Discontinuous sounds, known also as crackles, were formerly called râles. The confusion over interpretation of such things as dry râles for interstitial pulmonary edema has led to the recent change in nomenclature. Crackles are intermittent, non-musical sounds which have been described as clicking, popping, and bubbling.[4] The sounds may be generated by a number of mechanisms such as bubbling of secretions in airway (in severe pulmonary edema or bronchopneumonia or by the sudden opening of a diseased airway late in inspiration in lungs that inflate asynchronously such as in fibrinous pneumonia, fibrosis, or interstitial pulmonary edema. Crackles can be further subdivided into coarse and fine crackles, a distinction formerly used for dry and moist rales, respectively. Coarse crackles are louder than fine crackles and have been described as gurgling or bubbling. These sounds are heard in bronchopneumonia and late pulmonary edema.[4,5] Fine crackles are likened to the cracking of cellophane and may be heard with interstitial edema, interstitial pneumonia, or chronic fibrosis.

Adventitious sounds of the continuous type are known as wheezes or formerly as rhonchi. They are produced when a narrowed airway oscillates between being opened and nearly closed as air passes through it.[4,5] The pitch of the sound produced is related to the velocity of the air moving through it rather than the size of the airway. Wheezes can be high pitched (sibilant) or low pitched (sonorous). Most wheezes occur during expiration, though severe upper respiratory obstruction (occlusive tracheal mass) can produce an inspiratory wheeze also known as stridor. Wheezes are heard in disease conditions such as bronchospasm (allergic), mucosal inflammation, mucous plugging, or through external compression of airways by tumors, abscesses, or lymphademopathy.[4,5] The wheeze produced by secretions in the airway will change after a deep cough. The pleural friction rub is a distinctive loud, coarse rubbing sound which often is more localized than pulmonary crackles. Interpretation of the silent lung, on the other hand, is more difficult. Fluid and air are 2 media through which loss of sound energy is great. Therefore, pleural effusion and pneumothorax are causes of a silent lung. Other reasons for silent lung may be diaphragmatic hernia or other space occupying lesions, extreme obesity, pulmonary emphysema, severe small airway disease and neuromuscular weakness. The truly silent lung must be distinguished from the case in which extraneous sounds (hair and skin sounds, heart sounds, gastrointestinal sounds) render the normal breath sounds inaudible.

When auscultation of the chest has been completed, most practitioners will have completed the thoracic cavity exam. Following will be a brief review of some other diagnostic aids which may be useful for examination of the thoracic cavity and the indication for their use.

Percussion of the chest is a useful diagnostic tool when it is performed frequently. The tools for percussion (percussion hammer and spoon) are inexpensive and easy to transport. The percussion border of the cow is very steep compared to other species. At the fifth intercostal (IC) space, the border is at the costochondral junction. From this space it moves dorsally in a straight line to the level of the scapulo-humoral joint at the seventh IC space, mid thoracic level at the ninth IC space, and parallel with the ileum at the eleventh IC space. Percussion is useful when pleural fluid, pulmonary consolidation, or emphysema is suspected. The normal resonance will be replaced by dull, solid sounds in the case of fluid or consolidation. The line between dullness and normal resonance may be uniform in the case of pleural fluid. On the other hand, emphysema is accompanied by an increased or drum-like resonance and extension of the percussion border beyond normal limits.

Radiography of the chest for most bovine practitioners is relatively impractical except for calves. In calves, a chest radiograph is an extremely useful prognostic tool. It is not only helpful to clarify the meaning of sounds which are difficult to interpret but to define distribution and severity of pulmonary disease. It can be utilized to evaluate progress with therapy in the valuable calf.

Electrocardiography is used almost exclusively for the determination of aberrant cardiac rhythms since limb lead criteria for cardiac enlargment patterns are not well defined in the cow. Three attachment sites only are used for the base-apex lead.[6] Electrocardiography is used when one wishes to be more specific about the diagnosis of a cardiac arrhythmia, such as following calcium therapy. An important indication for use is to distinguish supraventricular from ventricular rhythms. The latter have a much more guarded prognosis and may require therapy. A further use for electrocardiography is in monitoring patients being treated for atrial fibrillation.[6] The use of quinidine intravenously in this group can predispose to a number of rhythm disturbances which warrant an effective monitoring system for the detection. Electrocardiographic monitoring in these patients will also allow early detection of the return to normal sinus rhythm so that therapy can be discontinued.

Aspiration and biopsy are probably the most underused diagnostic aids available to the bovine practitioner. Relatively simple techniques with inexpensive tools can yield a great amount of information about disease. The transtracheal wash, for example, in a herd outbreak of pulmonary disease or in an individual who has not responded to routine therapy can give new insight into etiology, severity and

microbial sensitivity. Pericardial centesis at the left 5th IC space below the elbow can make a diagnosis between infectious effusion (traumatic), benign effusion (heart failure), or neoplasia (lymphosarcoma). Pleural centesis can be similarly rewarding in distinguishing the cause of silent lung, i.e. between fluid, emphysema, or solid lung. All of these techniques, though relatively simple, require surgical preparation of the site and laboratory assistance in cytologic evaluation, culture, etc. The most common complication is local infection at the site of puncture which can be avoided by improved technique and local infusion of antibiotics as the needle is withdrawn.

Endoscopy is not used frequently by the bovine practitioner because of infrequent use of costly equipment. When the equipment is available, it is indicated for use in the case of upper airway obstruction. Skillful manipulation of the flexible endoscopes can also aid in obtaining tracheal fluid aspirates for bacterial culture when pneumonia is diagnosed.

The use of ultrasound in echocardiography will probably never become a tool of the general practitioner but it has yielded invaluable information about the detection of cardiac disease for the academician. Detection of abnormal valves (vegetative endocarditis), dilated or hypertrophied cardiac chambers and effusions (pleural or pericardial) by non-invasive techniques are definite advantages over other methods. However the cost of the equipment and technical skills required to perform and interpret the exam will limit its applicability to private practice.

In conclusion, a number of diagnostic tools are available for use in evaluation of diseases of the thoracic cavity. The most important of these tools is the art of auscultation. Knowledge of the origin and mechanism of production of cardiac and lung sounds will allow the practitioner to accurately diagnose the majority of the diseases he sees in the field. A number of other diagnostic procedures such as radiography, aspiration, and percussion are then used to further define or confirm the tentative diagnosis made by auscultation.

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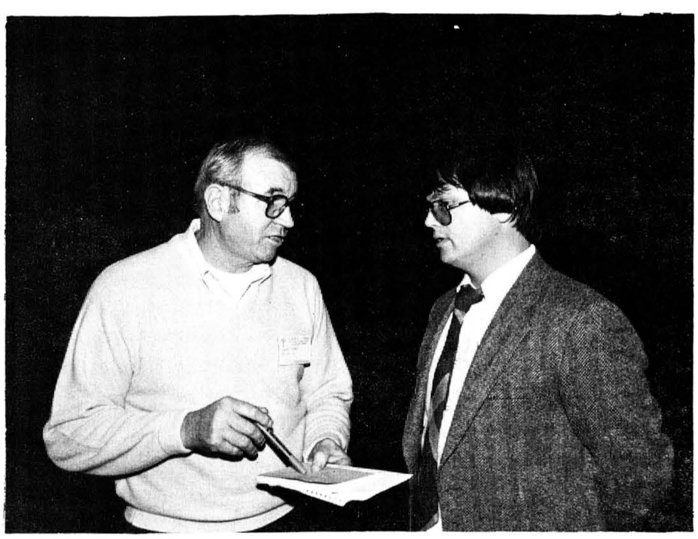

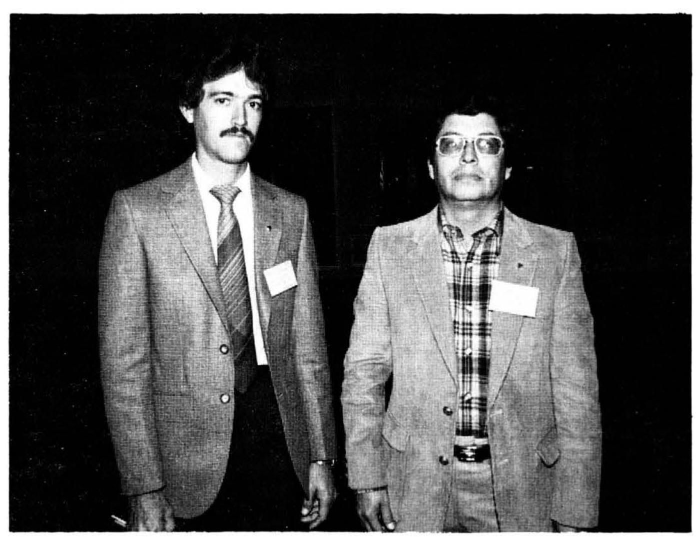

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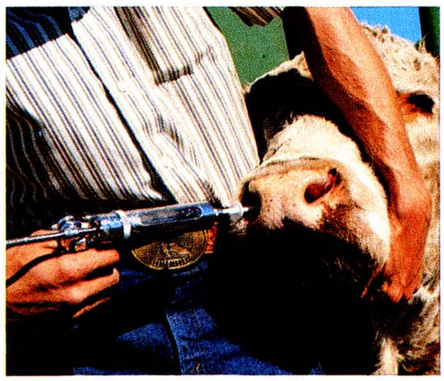

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