

# Veterinary Bioscience: Cardiovascular System



## LECTURE 10 CLINICAL EXAMINATION OF THE CARDIOVASCULAR SYSTEM

### INTENDED LEARNING OUTCOMES

At the end of this lecture, you should be able to:

- identify key aspects of a general clinical examination pertinent to assessing function of the cardiovascular system;
- describe what dynamic changes during the heart cycle create each of the normal heart sounds (S1, S2, S3, S4);
- know where anatomically to clinically auscultate the major heart valves;
- know what changes to the normal heart sounds may be detectable on cardiac auscultation;
- be able to identify the key factors used to characterise murmurs;
- appreciate the respiratory signs and pulmonary auscultation findings that may be associated with cardiac failure.

### KEYWORDS

Clinical examination; auscultation, pulse, capillary refill time, heart sounds, murmur.

### NOTES

#### Physical examination

- Appraisal of body condition
- Assessment of respiratory rate and effort (at rest)
- Mucus membrane colour and capillary refill time
- Jugular vein examination for abnormal distension or pulsations
- Precordial palpation for the cardiac apex beat and thrills (vibratory sensations)
- Arterial pulse evaluation for strength, regularity and character
- Cardiac auscultation
- Pulmonary auscultation ± percussion
- Abdominal palpation for hepatomegaly or ascites

#### General condition

Animals with advanced congestive heart failure may be in poor body condition with muscle wastage. Note any **non-thoracic abnormalities**, which might indicate other systemic disease.

## Respiratory rate

The respiratory rate is a useful indicator of congestive heart failure; usually the respiratory rate will rise with pulmonary oedema or pleural effusion. Respiratory rate may be elevated during veterinary evaluation due to stress or environmental stimulation. Normal sleeping respiratory rate  $\leq 30$  breaths/min for dogs and cats. Resting respiratory rate for horses is 8-16 breaths/min.

## Mucous membranes

- *Normal* – “Healthy pink” colour.
- *Pallor* – Consistent with anaemia or peripheral vasoconstriction caused by poor cardiac output.
- *Cyanosis* – Generally cyanosis indicates severe respiratory compromise. In cardiac disease this usually indicates severe pulmonary oedema or pleural effusion. Congenital right-to-left shunts may also cause cyanosis, usually with concurrent polycythaemia so that the mucous membranes are dark purplish-maroon.
- *Capillary refill time* – Blanching of the mucous membranes should persist for no longer than 2 seconds following digital pressure. Prolonged times indicate poor peripheral perfusion.

## Pulse

Pulse quality varies according to stroke volume. The femoral arteries are palpated in dogs and cats – always check BOTH femoral arterial pulses (in case of thromboembolism). The facial arteries are palpated in horses for convenience and safety. The pulse rate can be taken to measure heart rate, although a discrepancy will exist with some dysrhythmias (pulse deficit).

The pulse "strength" detected by palpation is a function of the difference between the systolic and diastolic arterial pressures (pulse pressure) and the ability of the examiner to place the correct amount of pressure over the artery. A blood pressure of 220/180 cannot be differentiated from a pressure of 120/80 by palpation alone.

*Bounding pulses* are associated with a rapid and exaggerated increase and decay of arterial pressure. The most common clinical correlates are patent ductus arteriosus (left to right shunt) and aortic valve insufficiency.

*Weak pulses* may be associated with poor cardiac output or conditions that impede ejection of blood from the left ventricle. Clinical correlates include shock (hypovolaemia, others), pericardial tamponade and aortic stenosis.

## Jugular veins

The jugular veins may become distended with right-sided cardiac failure, as the raised right atrial pressures are transmitted to the jugular veins. Jugular pulsation may be especially marked with tricuspid regurgitation. Pericardial tamponade should also be considered when jugular distension or pulsation is detected.

*Hepatojugular reflux*: Pressure on the liver and cranial abdomen will increase venous return to the right atrium and may induce jugular distension if the pressure is already critically raised in the right atrium.

## Abdomen

Right-sided heart failure may cause hepatomegaly or ascites.

## Precordium

Palpation of the precordium (area of thorax overlying the heart) is an underestimated part of the physical examination. Information can be obtained about: heart rate, heart rhythm, cardiac size, strength of the apical impulse, thrills associated with loud murmurs, large pleural effusions (“barrel-shaped chest”), and chest compressibility.

## Auscultation

Auscultation is a vital part of the clinical examination. When auscultating the heart, attention must be paid to each of the valve areas.

It is important to find a quiet area when auscultating, as background noise can affect your ability to hear heart or lung sounds. The patient should be in a natural standing position with the nose parallel to the floor/table/ground. Animals that are sitting or lying down will have displacement of the heart within the thoracic cavity, which will affect your ability to localise the sound or lesion. Panting dogs should be restrained from panting by the owner or nurse. Cats can be refrained from purring by distracting them with running water in a nearby sink. If all fails on a first attempt at auscultation, always be willing to repeat your exam after the animal has had time to acclimatise to the environment.

## Heart sounds

In general, heart sounds are created by vibrations of the wall, valves and vessels (normal sounds, gallop sounds) and by turbulent blood flow (high velocity flow, incompetent valves, shunts). Auscultate over a wide area to ensure all areas of the heart are evaluated and no subtle abnormalities are missed.

Sound	Aetiology	Pathologic condition (dogs and cats)
<b>S1</b> “ <b>lub</b> dub”	The first heart sound is a normal sound caused by closure of the atrioventricular valves and vibrations of the cardiac walls with abrupt deceleration of blood flow. S1 is typically longer and lower pitched than the second heart sound. It is heard best at the left apex.	
<b>S2</b> “lub <b>dub</b> ”	The second heart sound is produced by closure of the semilunar (aortic and pulmonic) valves. It is heard loudest at the heart base. It is a shorter and higher pitched sound than S1.	
<b>S3</b> “lub dub- <b>da</b> ”	The third heart sound is due to vibrations in the heart walls associated with rapid early ventricular filling.	In dogs an S3 is usually associated with myocardial failure (i.e. dilated cardiomyopathy or severe mitral regurgitation) and is referred to as an S3 gallop.
<b>S4</b> “ <b>ba</b> -lub dub”	The fourth heart sound is caused by atrial contraction acutely forcing blood to quickly move into the ventricular cavity (at the very end of diastole).	An S4 can be auscultated in dogs and cats when the atria dilate in response to ventricular stiffness (high filling pressures) such as in hypertrophic cardiomyopathy (S4 gallop).
<b>Systolic click</b>	A transient click can sometimes be heard in mid to late systole over the mitral valve. This is usually the result of delayed closure or prolapsing of a portion of the valve.	Systolic clicks are typically related to mitral valve abnormalities (i.e. early endocardiosis). They can occasionally be found over the tricuspid valve.

**Note:** *In large animals (i.e. horses), S3 and S4 sounds can be detected in normal animals* (large heart size and relatively slow rate). Many horses will have an audible S4 (especially if a 2<sup>nd</sup> degree AV block is present) and some horses will have an audible S3. Systolic clicks can also be heard in some normal horses and are of unknown significance.

## Cardiac murmurs

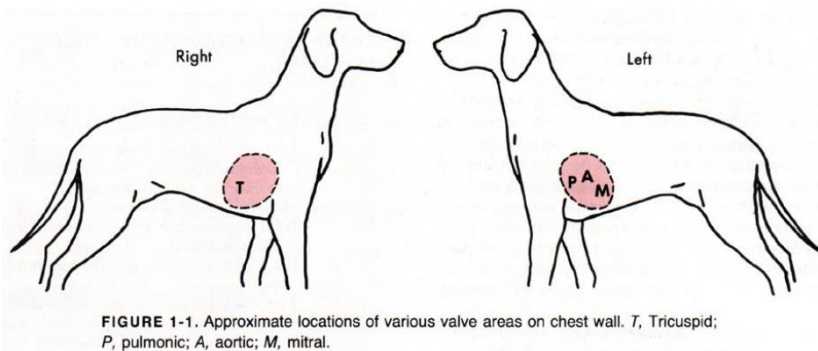
Cardiac murmurs are longer sounds occurring during normally quiet periods, i.e. between S1 and S2, or between S2 and S1. Cardiac murmurs are described based on:

**Timing:** **Systolic** murmurs occur between S1 and S2. **Holosystolic** murmurs occur throughout systole but with both S1 and S2 still audible. **Pansystolic** murmurs occur throughout systole but S1 and S2 are not discernible. **Diastolic** murmurs occur between S2 and S1. **Continuous** murmurs occur throughout systole and diastole. **To and fro** murmurs occur when there are separate systolic and diastolic components.

**Intensity:** The intensity of a murmur is graded on a scale of I to VI. This system is used to characterise the murmur, it is not used to assess severity of disease.

- **Grade I:** A very soft, focal murmur detected after several minutes listening.
- **Grade II:** A soft murmur, readily localised, but quieter than the S1 and S2 heart sounds.
- **Grade III:** A moderate intensity murmur, similar audibility to S1 and S2 heart sounds.
- **Grade IV:** A loud murmur, louder than S1 and S2 heart sounds, no palpable thrill.
- **Grade V:** A very loud murmur, radiates well, accompanied by palpable precordial thrill.
- **Grade VI:** Grade V plus audible when the stethoscope is removed from the chest wall.

**Point of Maximal Intensity (PMI):** The PMI is usually described by the hemithorax, valve area or base/apex location where the murmur is the loudest. For example, left apical region or left hemithorax over the 4th intercostal space at the costochondral junction is a typical PMI description for mitral regurgitation. [Refer to anatomy notes]



From: Nelson and Couto

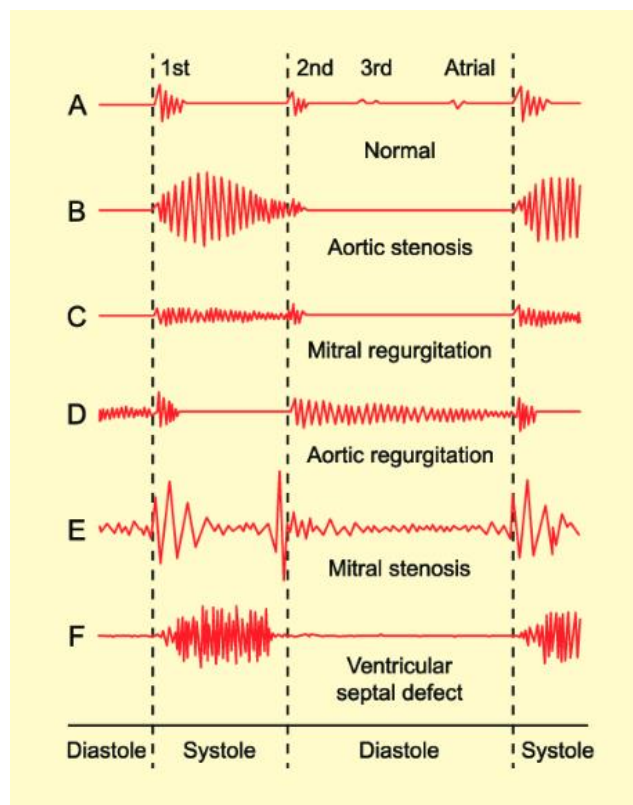
**Radiation over the chest wall:** A murmur may radiate from the PMI to other cardiac regions and even non-cardiac regions such as the thoracic inlet and calvarium (i.e., sub-aortic stenosis). Radiation is taken into consideration when assessing the murmur intensity.

**Quality or character:** Murmurs can also be described according to their quality, frequency and characteristic shape (change in intensity throughout the cycle) recorded by a phonocardiogram. High frequency sounds may be described as musical, whereas mixed frequency sounds are often described as harsh. The terms flat or plateau, ejection, and blowing are commonly used terms to describe the quality of murmurs. For example, systolic flat or plateau murmurs begin and end abruptly, but do not change in frequency or tones throughout systole. These murmurs are most consistent with mitral or tricuspid valvular regurgitation. Systolic ejection murmurs may begin and end abruptly but classically the frequency changes during the cycle. The frequency may increase (crescendo) or decrease (decrescendo) or do both during the cycle.

PMI	Character	Differentials
Left apex	Systolic ejection	Early mitral regurgitation may sometimes manifest a harsher sound; subaortic stenosis (SAS) is sometimes best heard over the costochondral junction which reflects the lesion location (SUB-aortic).
	Systolic plateau	Mitral regurgitation, classic character and location; Consider endocardiosis if small breed; Consider endocarditis if larger breed with 'new' murmur or fever; Consider dilated cardiomyopathy (DCM) in large/giant breeds with softer murmurs.
Left base	Continuous	Patent ductus arteriosus (PDA), typically heard very high at the left base; Small breeds of dogs and herding breeds are typical signalment.
	Systolic ejection	SAS or pulmonic stenosis (PS) or possibly physiologic murmur (softer); Check location > PS typically more cranial than SAS; Check signalment > PS: small breeds, brachycephalics, terriers, SAS: larger breeds.

	Diastolic, blowing	Aortic regurgitation, typically heard best over aortic valve area, sometimes heard with murmur of SAS or VSD; rarely may hear high velocity pulmonic regurgitation.
Right apex	Systolic ejection	Ventricular septal defect (VSD), heard best at the right sternal border (most common congenital heart defect in the cat, horse and cow); occasionally high velocity tricuspid regurgitation may have an ejection quality, but PMI should be higher at the right apex.
	Systolic plateau	Tricuspid regurgitation, classic character and location; Consider endocardiosis, or TR secondary to pressure overload i.e., pulmonary hypertension or PS, or congenital valve dysplasia (Labradors, Great Dane, Boxer, other large breeds).

**Note: In large animals (i.e. horses),** ‘physiological’ or ‘functional’ murmurs can occur in the absence of pathology. These murmurs represent normal rapid turbulent blood flow within large diameter vessels of young (2-3 years), athletic breed horses (Thoroughbred, Standardbred); typically grade II – III or less. Stenotic lesions of the heart in horses are exceedingly rare.



Phonocardiogram of normal and abnormal heart sounds.

### Audibility of the heart

It should be noted that to some extent, the audibility of the heart will depend on thoracic conformation.

- *Increased audibility:* cardiac enlargement, hyperdynamic heart
- *Decreased audibility:* pericardial effusion, pleural effusion, thoracic mass, severe myocardial failure

### Lung sounds

Respiratory sounds are divided into normal sounds and abnormal sounds.

- **Normal sounds:** These are the bronchovesicular sounds which comprise normal breath sounds.

- **Abnormal sounds:**

- *Crackles* – Usually end-inspiratory, may be fine (sound like scrunching tissue paper) or coarse (sound like Velcro). May indicate small airways opening with alveolar oedema or pulmonary fibrosis.
- *Wheezes* – Associated with airway obstruction, e.g. feline asthma or bronchial disease.
- *Rhonchi* – Low frequency sounds.

## **Percussion**

Percussion of the chest may be affected by tapping the chest wall directly or using the middle finger as a pleximeter. The resulting sound will be dull when overlying fluid or soft tissue, or resonant when overlying air or air-filled lung. It is particularly useful when pleural effusions are suspected.