Practical Approach to Cardiac Evaluation in the Field

Joseph J. Bertone, DVM, MS, Dip. ACVIM

A detailed examination of the cardiac system is essential to a complete physical examination of horses. An understanding of the peculiarities of cardiac auscultation in horses is important in this evaluation. These peculiarities are associated with the large gauge of the equine central cardiac system and high vagal tone. Author’s address: Idaho Equine Hospital, 16080 Equine Dr, Nampa, Idaho 83687. © 1999 AAEP.

1. Introduction
A detailed examination of the cardiac system is essential to the purchase examination, evaluating poor athletic performance and diagnosing other systemic and cardiovascular disorders in horses. A good understanding of the peculiarities of cardiac auscultation in horses is important to this examination. Most often, these peculiarities are related to the large size of the central cardiovascular system and high vagal tone, which slows the cardiac cycle to the point where these sounds become distinct. Many sounds that are considered normal in horses are abnormal in other species.

A. Environment, Artifacts, The Stethoscope
The examination should be completed in a quiet room. Common auscultable artifacts include respiratory sounds, shivering, subtle hair rubbing, and gastrointestinal sounds. In general, the diaphragm portion of the stethoscope is adequate for a complete examination, but the bell portion may be useful on occasion. Both sides of the chest and all the valve areas should be identified and auscultated carefully.

B. Valve Areas
The valve areas are the approximate anatomic locations of the valves and the areas of maximum intensity of sounds commonly heard in association with the particular valve (Fig. 1).

The mitral valve area (M) is at the left fifth rib and intercostal space just above the halfway point between shoulder and elbow. The aortic valve area (A) is at the left fourth intercostal space just below the point of the shoulder and just forward of the border of the triceps muscle. The pulmonic valve area is at the left third intercostal space just below the point of the shoulder and deep to the triceps muscle. The tricuspid valve area is at the left third intercostal space just above the halfway point between shoulder and sternum and deep to the triceps muscle. On the right side, the tricuspid valve area is in the third to fourth intercostal spaces in the ventral third of the thorax.1

C. Heart Sounds
Central cardiovascular sounds are associated with vibrations of the myocardium, large vessels, and blood. The vibrations result from sudden accelera-
tion and deceleration of blood against the surrounding anatomic structures. Four heart sounds are frequently audible in horses and are associated with normal hemodynamic events. The number of heart sounds heard varies from 2 to 4 between and within horses. Physiologic circumstances that alter heart rate alter the number of sounds heard. In general, the faster the rate, the less distinct and the fewer sounds heard.

The point of maximal intensity of the first heart sound (S1) is just dorsal to the left cardiac apex. This sound is heard best over the mitral and tricuspid valve areas. The first heart sound occurs concomitantly with the palpable apex beat and is immediately followed by the arterial pulse. The intensity of S1 may be increased with tachycardia or with decreased PR intervals. In this situation, pre-systolic AV valve closure does not occur, and the S4 is superimposed over S1. Varying intensity of S1 occurs with varying ventricular filling, associated with premature ventricular contractions, atrial fibrillation, and ventricular tachycardia. The first heart sound is louder, and has a greater duration and lower pitch than the second heart sound (S2). The major component of S1 is associated with the initial movement of the ventricle and rapid deceleration of blood against the AV valves, and the initial ejection of blood into the pulmonic and aortic vessels. Splitting of S1 occurs in horses. Asymmetric ventricular activation with ventricular extrasystoles can result in abnormal splitting of S1. True splitting of S1 can be differentiated from the more common atrial sound (S4) closely followed by S1.2

The second heart sound (S2) is best heard over the aortic and pulmonic valve areas, and is associated with rapid rebound deceleration of blood against the aortic and pulmonic valves. Increased intensity of S2 may be heard with pulmonary and peripheral hypertension. Splitting of S2 varies with respiration and is commonly heard. Pulmonic valve closure can both precede and follow aortic valve closure in normal horses. Inspiratory-associated splitting of S2 occurs with increased venous return to the right heart and increased right ventricular stroke volume leading to delayed pulmonic valve closure. More extreme splitting of S2 is most commonly associated with severe chronic respiratory disease (heaves).2

The third heart sound (S3) is best heard over the cardiac apex. This sound usually occurs very shortly (0.14–0.17 s) after the onset of S2. S3 is associated with the end of the rapid filling phase and deceleration of the ventricle as it reaches the limits of distention. S3 may vary in intensity or disappear with changes in heart rate.2

The fourth heart sound (S4) is heard best at the heart base. The primary component of this sound is associated with atrial contraction. The late portion of S4 is associated with transient closure of the AV valves and sudden checking of ventricular distension and may be heard when the PR interval is greater than 0.28 seconds. Isolated S4 can be heard in second- and third-degree AV block and differentiates second-degree AV block from sinoatrial block.2

Gallop rhythms may occur with tachycardia. Atrial contraction can occur during the previous period of rapid ventricular filling, resulting in a summation of the S4 and S3 sounds.2

D. Murmurs

Murmurs are prolonged audible vibrations that occur during a normal silent period of the cardiac cycle. Murmurs result from turbulent flow, disruption of laminar flow, and vortex shedding.3 The likelihood that laminar flow will be converted to turbulent flow is represented by the Reynold’s number:

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\text{Reynold’s number (Re)} = \frac{\text{diameter (cm)} \times \text{velocity (m/s)}}{\text{density of fluid (g/cm}^3\text{)} \times \text{Viscosity (g/cm × s}}^3\text{)}
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Hence, the larger the vessel, the more likely the occurrence of turbulent flow. The large-gauge equine vessels predispose horses to murmurs (e.g., the soft blowing decrescendo and crescendo–decrescendo murmurs of normal large central blood vessel blood flow). Murmurs may be associated with increased velocity of blood flow (e.g., aortic
stenosis) or decreased blood viscosity (e.g., anemia), and may not indicate organic heart disease. Murmurs may also be associated with flow through a constricted area or valve, because although the diameter is reduced, the velocity is greatly magnified. Therefore, regurgitant flow through an incompetent valve, or flow through an intracardiac shunt, or through a stenotic aorta may be associated with murmurs. Murmurs may be classified according to timing, intensity, radiation, and shape.

Murmurs associated with AV valve insufficiency often radiate down to the apex and dorsal to the valve area. Sudden rebound deceleration of the associated blood column against the pulmonic and aortic valves generates sounds (S2) heard best above the valves at the beginning of diastole. Murmurs associated with aortic and pulmonic valve insufficiency are best heard below the valve areas toward the ventricles.

Pan-systolic and pan-diastolic murmurs encompass S1 and S2, or S2 and S1, respectively. Holosystolic and holo-diastolic murmurs occur between S1 and S2, or S2 and S1, respectively. Proto- (early), meso- (mid), and tele- (late) systolic and diastolic murmurs can be heard as well. A continuous murmur spans systole and diastole. The author uses the Grade I to VI scale to grade cardiac murmurs:

- **Grade I**: The softest audible murmur heard after careful auscultation in a localized area of the thorax. Grade I murmurs are auscultable in a quiet enclosed area.
- **Grade II**: A faint murmur audible after a few seconds of auscultation, but localized to a specific anatomic site.
- **Grade III**: A murmur that is immediately heard, but localized to a specific anatomic site. There is no palpable thrill (chest vibration).
- **Grade IV**: A murmur that is immediately audible and heard over a wide area. There is no palpable thrill.
- **Grade V**: A murmur that is immediately audible and heard over a wide area. A palpable thrill is evident. The murmur cannot be heard when the stethoscope is removed from the thoracic wall.
- **Grade VI**: A loud murmur that is immediately audible and heard over a wide area. A palpable thrill is evident. The murmur can be heard when the stethoscope is removed from the thoracic wall.

In many cases, the greater the intensity of the murmur, the more likely it is associated with pathology. However, small defects may be associated with loud murmurs, and have little athletic significance.

The location, magnitude, and radiation can be used to categorize murmurs. Radiation indicates the direction at which a loud murmur decreases in intensity. For example, typically with ventricular septal defects, murmurs radiate from the right (point of maximal intensity) to the left side of the chest in an area approximate to the ventricular chambers. In other words, the murmur is loudest on the right, and can be heard on the left side at a reduced intensity. The location of the point of maximal intensity of the murmur can be used to locate the underlying lesion. The point of maximal intensity of a palpable precordial thrill may also be useful.

The shape of a murmur is exemplified by the frequency, intensity, as evident during phonocardiography, or Doppler cardiography. Murmurs can be plateau (sudden rise to flat and then sudden decreased intensity), decrescendo (acute rise with a downward slope, crescendo (upward slope to a sudden decrease), crescendo–decrescendo (diamond-shaped), or continuous.

Functional murmurs are those occurring in the absence of cardiac disease. These murmurs can occur in systole or diastole. Innocent systolic murmurs tend to be decrescendo or crescendo–decrescendo, low-intensity (Grade III or less), early systolic murmurs that end considerably before S2. These functional ejection murmurs are associated with normal rapid blood flow in early ventricular systole and appear to be influenced by an increased stroke volume. These murmurs may become more or less intense with exercise. Functional systolic ejection murmurs are associated with fever and severe anemia as well. Functional diastolic murmurs are presystolic or early diastolic. Presystolic murmurs are associated with atrial vibrations between S4 and S1 and are usually low-pitched, rumbling murmurs. The early diastolic murmurs that closely following S3 are probably associated with rapid ventricular filling. A squeak is an early-diastolic, short, musical murmur usually best heard in the mitral valve and/or aortic areas. This murmur is associated with rapid atrioventricular blood flow and has not been associated with any cardiac disease.

**E. Other Cardiac Sounds**

Systolic clicks are high-frequency sounds that occur between S1 and S2 and are of unknown origin or significance. Systolic clicks can be heard in normal animals. Pericardial friction rubs are short, scratchy sounds associated with S1. They are attributed to the rubbing of inflamed pericardial and epicardial surfaces. Pericardial sounds can become splashy if both gas and fluid are present within the pericardium.

**F. Cardiac Rhythm**

Relative to other domestic species, many rhythms are considered normal in resting horses. Horses experience large variations in cardiac rhythm associated with normal changes in parasympathetic tone. A sinus rhythm is commonly auscultated with heart rates of 32 to 40 beats per minute. Sinus bradycardia is a sinus rate of less than 26 beats per minute and sinus tachycardia is a rate greater than 50 beats per minute. Sinus bradycardia is most
often the result of high parasympathetic tone and often occurs with sinus arrhythmia and a wandering atrial pacemaker. In the normal horse with sinus bradycardia, an increase in heart rate should be seen with excitement and exercise. Sinus tachycardia is frequently seen in the excitable horse but may also accompany underlying disease processes such as heart failure, electrolyte disturbances, colitis, anemia, and shock. Sinus arrhythmia is commonly auscultated as a waxing and waning of the heart rate that may be respiratory or nonrespiratory in origin. Increases in heart rate occur with inspiration in respiratory sinus arrhythmia. Nonrespiratory sinus arrhythmia is often associated with second-degree AV block.

Sinoatrial block is associated with elevated parasympathetic tone. This arrhythmia occurs when the SA node depolarization is blocked to the point that it does not leave the SA node. On auscultation, the S4 heart sound is not heard, but there is a diastolic pause twice as long as the preceding and following S2–S1 interval. This rhythm is much less common than second-degree AV block and should also disappear with a reduction of vagal tone.

Atrioventricular block can be incomplete or complete. Complete heart block is always a sign of cardiac disease. Incomplete AV block is often found in normal horses and is usually considered benign if the AV block disappears after exercise or excitement. First- and second-degree AV blocks result from increased parasympathetic tone. First-degree AV block results in a prolongation of the S4–S1 interval and can be suspected on auscultation. Second-degree AV block results in an occasional S4 not followed by S1 or S2 diastolic pause. Mobitz type I (Wenkebach) AV block is characterized by variations in the interval between S4 and S1. However, the dropped ventricular contractions should occur with some rhythm. Some horses will occasionally drop 2 beats in succession without any other evidence of underlying cardiac disease.

G. Exercise or Excitement

Exercising or sudden excitement will often reduce many of the cardiac sounds and arrhythmias to the more typical sounds heard in people and small animals. Under many circumstances, resolution of abnormal sounds with an increased heart rate is an indication that the sounds auscultated are within normal limits.

H. Electrocardiography

The electrocardiogram is a valuable tool for the determination of rate, rhythm, and conduction times in the horse. Electronic miniaturization has allowed for palm-sized, patient-side instrumentation to be developed (Fig. 2). These units can be used patient side (Fig. 3) and can be used to send data for consultation (Fig. 4).
References


