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Interpreting Cardiac Murmurs in Horses: A Review and Clinical Examples

Jonathan M Naylor DVM, PhD, Diplomate ACVIM, Diplomate ACVN

Heart murmurs occur in horses of all ages. One study detected cardiac murmurs in 81% of 846 thoroughbred racehorses.¹ Many murmurs are normal findings, others reflect cardiac pathology that is limiting, or may limit, the horse's performance and life expectancy.²⁻⁶ Veterinarians are often faced with the problem of diagnosis and prognosis. This is particularly important in pre-purchase examinations and when trying to identify the cause of exercise intolerance or weight loss. This issue of *Large Animal Veterinary Rounds* reviews some key points in the effective examination of the cardiovascular system in the horse and new information about common mistakes in interpretation. A simple scheme for the differentiation of common functional and pathological murmurs is presented to increase diagnostic accuracy and case discussions allow the practice of this skill.

Murmurs are usually low frequency sounds at the lower limit of human hearing. They can be readily masked by extraneous noise, so auscultation should be carried out in a quiet area. Background sound makes it impossible to detect all but the loudest of cardiac murmurs. Stethoscopes vary slightly in quality; a key point is to look for earpieces that fit snugly, yet comfortably, in the ear canals. Earpieces that are angled slightly forward give the best fit.

In taking a history, special attention should be given to age, level of training and fitness, problems with exercise tolerance, and increased respiratory rate or cough. An examination of the cardiovascular system includes: the color of the mucous membranes, capillary refill time, pulse rate, pulse strength, and the degree of jugular distension. The heart should be ausculted in a systematic fashion. It is easiest to start on the left side, over the mitral valve area. Sometimes this can be located from anatomic landmarks; ie, it lies in the fifth intercostal space just below the point of the shoulder. Many veterinarians prefer to identify the mitral valve area by palpating the apex beat. This is the area where the contracting ventricle produces a vibration on the chest wall. It can be identified either by placing the palm of the hand over the thorax or by feeling the vibration transmitted through the head of the stethoscope as it rests on the chest. Either way, the apex beat lies close to the mitral valve. At the apex beat, the first heart sound produced by closure of the atrioventricular valves (mitral on the left, tricuspid on the right), at the beginning of ventricular systole, is loudest (Figure 1). As the stethoscope is moved cranially, the aortic and pulmonic valves are ausculted in turn and the second heart sound, produced by closure of these valves at the end of ventricular systole, becomes relatively louder. When present, the third heart sound produced by ventricular filling should be loudest over the apex, while the fourth heart sound, produced by atrial contraction, is loudest over the base. Examination on the right side should include auscultation at the base (the tricuspid valve area), and towards the apex where murmurs from ventricular septal defects are loudest.²⁻⁷

All murmurs are caused by turbulent blood flow. This turbulence produces vibrations that are transmitted through the thoracic wall where they can be detected as sound waves or, in very severe



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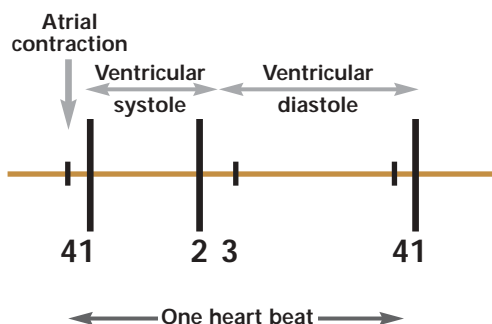
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Figure 1: Schematic representation of equine heart sounds, represented by vertical bars. The vertical axis is intensity (loudness), the horizontal axis time. Numbers correspond to the names of the individual heart sounds. S1 is produced by closure of the mitral and tricuspid valves, S2 by closure of the aortic and pulmonic valves.



cases, as a thrill. The intensity of a murmur is graded on a 6 point scale:

- grade 2 murmurs are heard as soon as the stethoscope head is placed over its point of maximal intensity
- grade 3 murmurs are easily detectable
- grade 5 or more murmurs are accompanied by a palpable thrill in the thoracic wall
- grade 6 murmurs can be heard when the stethoscope is no longer touching the body wall and they radiate all over the thorax

Sometimes murmurs are simply the result of the rapid ejection of blood into a large vessel. These are called flow murmurs and are a type of functional murmur. The primary significance of functional murmurs is that they may be confused with murmurs produced by structural changes within the heart. Only two flow murmurs are common. Systolic ejection murmurs are usually heard on the left side of the heart over the aortic outflow tract and are particularly common in foals. Diastolic filling murmurs are heard as a squeak between S2 and S3 in some fit, young-adult horses (the “2-year-old squeak”). Another type of functional murmur is the systolic murmur of tricuspid regurgitation, heard over the right side of the heart towards the base. This is common in athletic horses and is the result of minor tricuspid valve incompetence, secondary to hypertrophy of the cardiac muscle and distortion of the valve annulus. Less commonly, mitral valve regurgitation can develop in heavily trained, young horses, probably as a result of the same mechanism.⁸

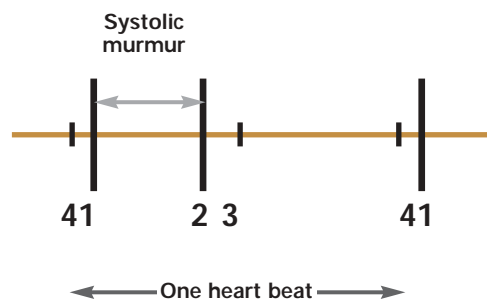
There are exceptions to every generalization in veterinary medicine, but as a group, functional murmurs are of grade 1 or grade 2 intensity, and occasionally of grade 3. The common diastolic functional murmur occurs between S2 and S3. The prime locations for systolic functional murmurs are over the aortic valve on the left and the tricuspid valve on the right. These generalizations only apply to horses that are not suffering from anemia, shock, or severe cardiovascular stress from some unknown cardiac cause. For

example, loud flow murmurs of grade 3 intensity or more can be heard in anemic or colicky horses.

Pathological murmurs are due to structural problems within the heart walls, adjacent vessels, or valves. In very young foals, the common structural murmur is produced by a patent ductus arteriosus. If the stethoscope is placed high up over the base of the heart, under the triceps mass, the characteristic machinery murmur will be auscultated. This murmur waxes and wanes with inspiration and expiration. As the stethoscope is moved further away from the pulmonic valve, only the systolic component of the murmur may be heard. It is abnormal for a patent ductus arteriosus to persist beyond 4-days of age. The other common congenital heart disease that produces a murmur is a ventricular septal defect (VSD). VSDs typically give a systolic murmur that is loudest on the right side of the heart towards the apex and are often accompanied by a murmur on the left side, over the pulmonic valve. This murmur is produced by blood shunted from the left to the right side of the heart through the VSD, overloading the pulmonic outflow tract. The finding of a murmur that is loud, low on the right, and is accompanied by a quieter murmur high on the left is suggestive of a VSD. Large VSDs produce problems in young foals; smaller VSDs may not be detected until late in adult life. The significance of these smaller VSDs depends on the size of the shunt and the expected performance level of the horse.

In older horses, typically those over 10-years of age, degenerative changes in the valves produce pathological murmurs. Not surprisingly, the high pressure, left side of the heart suffers most, and valvular degenerations most commonly affect either the mitral valve or the aortic valve. Differentiating these murmurs is easy in theory, since mitral valve degeneration results in regurgitation and a systolic murmur (Figure 2). Aortic valve degeneration allows back-flow of blood in diastole and produces a diastolic murmur. Unlike in dogs, where mitral valve problems predominate, these two murmurs are almost equally common in older

Figure 2: Schematic representation of a systolic murmur, gray line. Numbers represent heart sounds, time is along the horizontal axis.



horses. Surprisingly, research demonstrates that many equine practitioners have difficulty differentiating the murmurs of aortic and mitral regurgitation. There are 5 ways that these murmurs can be differentiated, but studies show that some of these methods are more reliable than others.

- The duration of the murmur theoretically gives a clue to its position in the cardiac cycle. At rest, systole is only one-third of the cycle, while diastole is two-thirds; thus a holosystolic murmur is half the duration of a hodiastolic murmur. This method is unreliable because of a perception problem - loud murmurs are perceived as being longer than they really are. This problem was first noticed when clinicians were asked to estimate the duration of a murmur on tape recordings. More recently, this perception problem has been confirmed in examinations of live horses.

- The relationship of the murmur to S1 and S2 is identified by the pitch and duration of these sounds. If a murmur ends with S2, it is systolic; if it ends with S1, it is diastolic. This method could be particularly useful when the murmur obliterates one of the heart sounds. Unfortunately, this technique is unreliable and tests show that veterinarians cannot reliably differentiate S1 from S2 when heard in isolation.

- The character of the murmur helps differentiate mitral from aortic regurgitation. Loud (grade 3 or more) aortic regurgitation murmurs tend to be musical in character, sometimes described as buzzing, sawing, crying or honking. Mitral valve murmurs tend to be noisy and sound like blowing wind. While not absolute, this difference in character is a useful clue.

- The point of maximal intensity of the murmur can be identified on the thorax and the cause ascribed to the closest valve.

- The most reliable method for differentiating systolic from diastolic murmurs requires the ability to palpate the peripheral pulse, typically in the median artery, while listening to the heart. In normal horses, the sequence is S1, pulse, S2. In horses with systolic murmurs, the sequence is S1, pulse and murmur, S2. Diastolic murmurs produce the sequence S1, pulse, S2, murmur.

Some pathological murmurs arise suddenly, while others develop slowly and start with quiet murmurs. However, pathological murmurs that are of immediate consequence to a horse's performance tend to be grade 3 or more. A common differential diagnosis is patent ductus arteriosus in young foals. Listening over the point of maximal intensity under the triceps mass in the pulmonic valve area, this defect produces a murmur that is continuous throughout systole and diastole. However, at more distant locations, only the systolic component may be audible. VSDs in foals or adult horses produce a systolic murmur over the right heart apex and may be accompanied by a quieter systolic murmur on the left, over the pulmonic valve. In older horses, loud systolic murmurs over the left heart are usually the result of mitral valve degeneration; while diastolic

murmurs are usually the result of aortic valve degeneration. Loud aortic valve regurgitation murmurs can often be heard in a quieter form over the right heart. Typically, mitral valve regurgitation is not heard on the right or, if present, is much quieter than on the left.

Case 1: Racing thoroughbred, 3-years-old, quiet murmur found on routine examination

A 3-year-old racing thoroughbred presented for a laceration on the right hind limb and is noticed to have a murmur over the left heart. Resting heart rate is 28 beats/minute; respiratory rate is 28 breaths/minute; and rectal temperature is 38.2°C. The mucous membranes are pink and capillary refill time is one second. The facial arterial pulse is strong and full and there is no abnormal jugular distension or pulsation. On careful auscultation, the murmur is characterized as grade 2 intensity; it is very short and early diastolic, occupying the space between S2 and S3. The murmur is only heard over the apical half of the heart and is high-pitched.

What is the diagnosis? Is this murmur clinically significant?

This is a diastolic filling murmur; these are more common in fit, young horses in training and are of no pathological significance. Such murmurs are more commonly heard over the right heart than over the left heart. The increase in respiratory rate may have been due to transient stress, pain from the laceration, or movement into a warm barn for treatment.

Case 2: Tennessee walking horse, 14-years-old, loud murmur found at trail-ride check

In July, a 14-year-old Tennessee walking horse was noticed to have a loud systolic murmur at one of the planned veterinary examinations in a trail ride. Two months later, the horse was presented at the clinic for evaluation. Resting heart rate was 40 beats/minute, respirations 12 breaths/minute, and rectal temperature 37.3°C. The pulse had normal strength, the mucous membranes were pink and capillary refill time was less than two seconds. There was no abnormal jugular pulse. Of the students who auscultated this horse, the majority described a grade-2 systolic murmur that sounded the loudest over the mitral valves. Some thought it was noisy, others musical. This case illustrates a major problem in the interpretation of cardiac murmurs because some experienced clinicians reported different clinical findings — a grade-2, noisy, hodiastolic murmur. The murmur was heard only on the left side of the heart and in a very limited area over the base of the heart in the aortic valve area. Simultaneous auscultation and palpation revealed that the murmur was heard in the pulse-free interval.

What should the interpretation be? What is the cause of the murmur? Is it clinically significant?

Interpretation depends on which set of clinical findings are given the most weight. The information of a systolic murmur, loudest over the mitral valves, suggests a diagnosis of mitral valve regurgitation. If the findings of more experienced clinicians are given more weight, then a diastolic murmur suggests aortic regurgitation. The only other common diastolic murmur, the diastolic filling murmur is restricted to the interval between S2 and S3. In a recent experimental study, equine clinicians who were diplomates of the American College of Veterinary Internal Medicine were better able to interpret and diagnose sound recordings of murmurs and arrhythmias than students and general practitioners. In this study, the overall diagnostic rate based on unassisted auscultation was just above 50% for diplomates, compared to 30% for students and practitioners. One area where diplomates performed significantly better was in the diagnosis of aortic insufficiency. However, given that overall diagnostic accuracy is far less than perfect, some ancillary testing is warranted. The murmur was recorded and analyzed using digital sonography, a technique similar to phonocardiography, but differing in that the sound itself is preserved rather than a trace of the sound wave.⁹ This technique allowed a more detailed analysis of the sound patterns and confirmed the presence of a holodiastolic murmur in a recording made over the aortic valve. Echocardiography showed no evidence of cardiac dilation or other structural damage to the heart. The common cause of aortic regurgitation in older horses is aortic valve degeneration. However, the degeneration in this case was too subtle to give anatomical changes that could be detected by echocardiography. The owner was informed that the murmur was not interfering with cardiac function at the present time, but that it might reasonably be expected to get slowly worse with age. It is likely that under conditions of cardiac stress, such as immediately following intense exercise in a trail ride, this murmur would become more obvious.

Case 3: Thoroughbred stallion, 25-years-old, losing weight

On examination, this stallion had a normal rectal temperature; the heart rate was 36 beats/minute and the respiratory rate 16 breaths/minute. The mucous membranes were pink and capillary refill time was less than two seconds. There was no abnormal jugular pulse. An arrhythmia was present with a regular series of 3 or 4 beats followed by a long pause. In this pause, an isolated, abnormally loud, heart sound, S4, was heard. A grade 3 to 4 holosystolic murmur was heard on the left side. The murmur was honking in character

and coincident with the peripheral pulse. An oral examination showed missing molars and severely overgrown molars with points and hooks.

What is the diagnosis? Is this murmur clinically significant? Is the murmur responsible for the weight loss?

The clinical findings of a grade 3 to 4 holosystolic murmur, only audible on the left side of the heart, suggest mitral valve regurgitation. Flow murmurs are not usually this loud. Also, flow murmurs often only occupy part of systole rather than the whole interval. Mitral valve degeneration and incompetence is more common in older horses, so this diagnosis fits the signalment. Most mitral valve murmurs are noisy in character, but some can be musical (honking) as was the case here. The arrhythmia is most likely to be a second-degree atrioventricular block, which is characterized by a regular series of beats followed by a long pause. The isolated heart sound heard during the block, S4, is produced by atrial contraction. This sound is usually quiet and it is only audible in some normal horses with atrioventricular block. The unusually loud nature of S4 in this horse indicates atrial pathology and suggests that the cardiac murmur is clinically significant. Digital sonography confirmed the location of the murmur and the abnormally loud S4 sound. On echocardiography, regurgitation through the mitral and tricuspid valves was detected. There was also atrial dilation, although contractility was normal. These findings all point to mitral regurgitation with clinically important adverse effects on the heart. However, the cardiac lesions are much more likely to produce exercise intolerance than weight loss. The stallion's teeth were floated and he gained weight. He has since required regular dental work to maintain feed intake and body condition, but the heart has not interfered with his retired life, where work is not expected, in the 18-month period of follow up.

Case 4: Quarterhorse stallion, 15-years-old, lump on hip

This horse was doing fine at pasture, but then suddenly developed a swelling over his hip. On examination, rectal temperature was 37.8°C, heart rate was 60 beats/minute, and the respiratory rate was 28 breaths/minute. There was a loud, grade 5 to 6 heart murmur, loudest over the left heart in the aortic area. The murmur was musical and appeared to occupy most, but not all, of the cardiac cycle. It completely obliterated one of the heart sounds and completely filled the interval between the two heart sounds. The murmur could also be heard over the right thorax, where it was approximately two grades less intense. Palpation of the median artery revealed that the

Table 1: A guide to the identification of common cardiac murmurs in horses¹

Etiology	Signalment	Grade	Location, character	Point of maximal intensity
Systolic outflow murmur	Any, especially foals and fit horses	1 to 3	Systolic, noisy	Left heart, aortic valve
Diastolic filling murmur	Especially younger, fit, racing horses	1 to 2	Diastolic between S2 and S3, squeak	Right or left apex
Patent ductus arteriosus	Young foals	2 to 5	Continuous, machinery	Left heart, pulmonic valve
Ventricular septal defect	Foals, adult horses	2 to 5	Systolic, noisy	Right heart apex, left heart pulmonic area
Tricuspid regurgitation (usually functional)	Especially common in adult horses in race training	1 to 3	Systolic, noisy	Right heart, tricuspid area
Mitral regurgitation (functional)	Especially common in adult horses in race training	1 to 3	Systolic, noisy	Left heart, mitral area
Mitral insufficiency (degenerative)	Especially older horses	2 to 6	Systolic, often noisy	Left heart, mitral area
Aortic insufficiency	Especially older horses	2 to 6	Diastolic, often musical	Left heart, aortic area. Loud murmurs usually radiate to the right side as well

murmur was heard in the pulse-free interval. Over the gluteals, there were two large swellings, one 30 cm × 20 cm and the other 20 cm × 20 cm. Palpation indicated that the swellings were fluctuant, painful, and communicating. An ultrasound examination of the swellings was consistent with puss and a needle aspirate revealed blood and puss. Several liters of puss were drained through a ventral incision in the abscess wall. Necrotic muscle was removed and the abscess cavity flushed.

What is the likely site of origin for the murmur? What is the cause and prognosis?

The musical character, its long duration, and the fact that the pulse wave is felt in the murmur-free interval, all indicate that this is a diastolic murmur. These usually arise from aortic regurgitation. Because the aorta is relatively centrally situated in the heart, it is common for loud aortic murmurs to be heard over both sides of the heart. In an old horse, degeneration of the aortic valves is a common cause of aortic regurgitation. A cardiac ultrasound confirmed the aortic regurgitation, found no evidence of cardiac dilation, and showed a 1 cm diameter nodular mass on one of the aortic valve leaflets. A large nodule of this type is most consistent with bacterial endocarditis. The horse was put on an oral trimethoprim sulphonamide combination for one month. He did well and no further problems were reported at follow-up one year later.

The diagnostic features of common cardiac murmurs ausculted in horses are summarized in Table 1.¹

This simplified scheme uses a small number of key features to differentiate murmurs and will improve the practitioner's diagnostic accuracy.

*The guest editor for this issue is **Dr. Anthony Carr**. Dr. Carr is an Associate Professor in the Department of Small Animal Clinical Sciences at the WCVM. He is a Diplomate of the ACVIM in the subspecialty of internal medicine. His clinical interests include cardiology, blood pressure, hemostasis and immune-mediated disease.*

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Abstract of Interest

An assessment of the ability of diplomates, practitioners and students to describe and interpret recordings of heart murmurs and arrhythmia: correlations of clinical diagnosis with the physical properties of the sounds and the underlying cardiac problem.

NAYLOR JM, YADERNUCK LM, PHARR JP, ASHBURNER, JS.

The ability of clinicians – 10 veterinary students, 10 general practitioners and 10 board certified internists – to describe and interpret common normal and abnormal heart sounds was assessed. Recordings of heart sounds from 7 horses with a variety of normal and abnormal rhythms, heart sounds, and murmurs were analyzed by digital sonography. The perception of the presence or absence of the heart sounds, S1, S2 and S4 was similar for clinicians irrespective of their level of training and agreed with the sonographic interpretation on 89, 82 and 78% of occasions, respectively. However, practitioners were less likely to correctly describe the presence of S3. The heart rhythm was correctly described, as being regular or irregular on 89% of occasions and this was not affected by level of training. Differentiation of the type of irregularity was less reliable. The perception of the intensity of a heart murmur was accurate and correlated with the grade assigned in the living horses, $R2 = 0.68$, and with sonographic measurements of the murmur's intensity, $R2 = 0.69$. Clinicians overestimated the duration of cardiac murmurs, particularly of the loud systolic murmur. Only diplomates could reliably differentiate systolic from diastolic murmurs. The ability to diagnose the underlying cardiac problem was significantly affected by training: diplomates, practitioners, and undergraduates made the correct diagnosis on 53%, 33%, and 29% of occasions, respectively. The poor diagnostic ability of practitioners and the lack of improvement in diagnostic skill after the second year of veterinary school emphasizes the need for better teaching of these skills. Digital sonograms, which combine sound files with synchronous visual interpretations, may be useful in this regard.

J Vet Intern Med 2001;15:In Press.

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An illustrated guide to canine cardiology complete with interpretive videos of heart murmurs and heart arrhythmias

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