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Clinical examination of the horse with cardiovascular disease and interpretation of murmurs

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Summary

Cardiac murmurs are common in the horse. Many of these murmurs are physiological and are unrelated to cardiac disease, however others may reflect cardiac pathology that may be limiting to the horses performance or life expectancy, and thus veterinarians are often faced with the problem of determining a diagnosis and an accurate prognosis when investigating cardiac murmurs in the horse. The challenge is to differentiate between pathological and non-pathological murmurs, and to determine the significance of the findings in terms of rider safety, performance capabilities and expected longevity.

I. Introduction

Cardiac murmurs are common in the horse, and in a recent study, cardiac murmurs were found in 81% of 846 Thoroughbred horses in race training (Kriz et al, 2000). Despite the high prevalence of murmurs in the horse, it has been shown that they are not necessarily associated with performance limitations (Young et al, 2008). This is because many of these murmurs are physiological and are unrelated to cardiac disease. Physiological murmurs associated with ventricular ejection and filling are audible in up to 50% and 15% of horses respectively (Patterson et al, 1965). In addition to the high prevalence of physiological flow murmurs, non-pathological regurgitation of the mitral and tricuspid valve has been shown to develop in Standardbred and Thoroughbred horses in response to training (Buhl et al, 2005; Young et al, 2000). This data supports previous studies which have found a high prevalence of valvular regurgitation in other athletes (e.g. humans and dogs) that is UNRELATED to valvular pathology. Some murmurs are significant however, and reflect cardiac pathology that may be limiting to the horses performance or life expectancy, and thus veterinarians are often faced with the problem of differentiating between pathological and non-pathological murmurs, and determining their significance in terms of rider safety, performance capabilities and expected longevity.

II. History

"An accurate HISTORY and cardiac AUSCULTATION are undoubtedly the most important initial evaluation procedures in the cardiovascular examination of the horse, because with the exception of mild abnormalities in ventricular function, normal cardiac auscultation in a horse with good exercise tolerance practically precludes significant heart disease” (Bonagura 1990).

A. Complaint

With cardiac disease in the horse, the clinical signs are often non specific and owners will usually ask you to examine the horse for exercise intolerance, poor performance, lethargy, depression, anorexia and weight loss. In the minds of many horse owners, any episode of unsteadiness or stumbling and collapse automatically is associated with the heart; yet cardiac problems are RARELY the cause of such events. The type and duration of clinical signs should be established and it may be useful to ask when the last cardiac auscultation has been performed. In cases of suboptimal performance, it is necessary to determine whether a problem really exists or whether the real issue is one of unreasonable expectation. Slowing in the last quarter to three eighths of a race is a common historical complaint. In many cases performance may only deteriorate by a few seconds. In other horses, particularly cases of atrial fibrillation, performance may decline by 20 to 30 seconds or more. Some horses may stop abruptly or even fall.

B. Exercise history

Suboptimal performance is a common reason for cardiovascular examination of the horse. It is therefore useful to know at what age the animal started training and how long it has been in consistent work since then. In the case of a performance horse, it is helpful to know the animal’s best performance time, when and under what circumstances this was achieved and for how long it was last off work. Horses with moderate to severe valvular heart disease usually start a competition well, but tire easily and have a prolonged recovery time.

C. Other

The incidence of valvular heart disease is not markedly different in horses of different breed or sex. However these factors influence the use of the horse and this is often a very significant consideration. Degenerative valvular disease is more common in older horses, but it may be found in young horses too. Cardiac murmurs caused by congenital disease are most often recognized in young animals, although in some cases congenital problems may not be recognized until the horse starts exercising. It is also important to remember that previous diseases may have a bearing upon current problems (e.g. jugular thrombosis causing valvular endocarditis).

III. Physical examination

The astute clinician should be able to detect MOST serious cardiac disorders initially by a complete physical examination and a stethoscope, keeping in mind that the cardiovascular system should not be considered in isolation. Once an abnormality is found, a complete cardiovascular examination is aimed at determining the lesion and significance of disease in terms of SAFETY, PERFORMANCE CAPABILITIES and EXPECTED LONGEVITY. The examination should be done in a standardized manner so that abnormalities are not missed. Significant myocardial disease usually is associated with heart failure, arrhythmias or a cardiac murmur, especially in advanced cases in which ventricular dilatation causes secondary insufficiency of the mitral or tricuspid valves. The presence of a cardiac murmur should alert the clinician to the presence of degenerative or infective valvular
A. General examination

The horse’s demeanor and body condition should be assessed. Excitement will affect heart rate and may affect cardiac rhythm and the character of murmurs. Horses with congestive heart failure or endocarditis are often in poor body condition and may be depressed or dyspnoic. Examination of the color and capillary refill time of the mucous membranes may be useful. CRT will be delayed with significant loss of cardiac output, however a normal CRT does not rule out significant cardiac disease. Mucous membranes may be cyanotic in cases of severe cardiac disease, but this is extremely rare and is usually only seen in neonatal foals with congenital shunts. When examining the head, it is important to note any nasal discharge. For example, a frothy whitish pink fluid may be seen in horses with pulmonary oedema (Figure 1), however nasal discharge is much more likely to be associated with primary respiratory disease, and further investigations of the respiratory tract should be performed, as poor performance caused by respiratory disease may be mistakenly attributed to cardiac disease.

![Figure 1: Frothy whitish pink nasal discharge in a horse that died of peracute pulmonary oedema secondary to a ruptured chorda tendinea.](image)

B. Arterial pulses

The arterial pulse quality, rate and rhythm should be assessed. This is done most easily by palpating the facial artery or the transverse facial artery. In some cases it may be useful to palpate the arterial pulse while auscultating the heart, as it allows detection of pulse deficits and may aid in determining if a murmur is systolic or diastolic. A weak arterial pulse may indicate hypotension associated with decreased cardiac output in cases of congestive heart failure, however it is important to remember that pulse quality reflects the DIFFERENCE between systolic and diastolic blood pressure. It does not reflect the magnitude of either systolic and/or diastolic blood pressure and is subjective. It is thus more informative to obtain MAP (mean arterial blood pressure) via a direct or indirect method if you suspect that the horse is hypotensive. MAP estimation provides an indirect indication of the heart pumping ability and is dependant upon cardiac output (CO) and systemic vascular resistance (MAP = CO X SVR where CO = SV (stroke volume) x HR). Bounding arterial pulses may indicate severe aortic regurgitation, while an irregular pulse may indicate an underlying arrhythmia.

C. Venous evaluation

Distension of the veins is often the first sign of congestive heart failure (CHF) and results from an increase in central venous pressure.

1. Jugular veins

The jugular vein should be examined with the horse’s head in a normal, erect position. Each vein should be obstructed individually at the base of the neck and filling observed (Valsalva maneuver). The time taken for filling may provide some indication of the rate of venous return, relative blood volume and blood supply to the tissues drained by the jugular veins. Filling normally takes 6-10 seconds with compression of one jugular vein only. When compression is removed, the vein collapses immediately as blood returns to the heart, usually within 1 cardiac cycle in the normal animal. If the jugular veins are abnormally full (Figure 2), they should each in turn be obstructed halfway up the neck and the blood in the caudal portion milked with the hand towards the heart to empty the vein. The vein should not refill until the obstruction has been removed. A slight pulsation noted higher in the jugular groove at this point that does not involve a fluid column is caused by the underlying carotid artery and is called a false jugular pulse. A distended jugular vein filling in pulsating manner after being milked down indicates a true jugular pulse and is caused by tricuspid valve insufficiency or atrioventricular disassociation. Pulsation will occur during systole. If however, the empty vein slowly refills in a non-pulsatile manner, it may indicate an elevated central venous pressure secondary to right heart failure (RHF) or obstruction to venous return via the cranial vena cava (e.g. a space occupying mass, pleural or pericardial effusion).

2. Peripheral veins

In the fit or excited animal some distension of the cutaneous veins may be seen as a component of thermoregulation, especially during or after exercise. Obvious distension of peripheral veins at rest is abnormal however, and may indicate increased central venous pressure secondary to CHF. At rest collapse of veins that should normally be distended, such as the cephalic and saphenous veins, is occasionally seen as a result of local vascular injury to the arterial tree and poor blood supply to the limb. This is more likely in the forelimb where there is a less extensive collateral blood supply. However in severe aortic-iliac thrombosis, the saphenous veins may be collapsed after light walking exercise.
D. Palpation and observation for peripheral oedema

Oedema may be caused by increased capillary hydrostatic pressure, capillary damage, and lymphatic obstruction and decreased colloid osmotic pressure. Edema usually “pits on pressure” that is, firm digital pressure leaves an indentation that may take several minutes to disappear. Edema may be passive, as in cardiovascular disease, in which case it is cool and non painful. Edema is described as inflammatory when it is hot and painful on palpation. Inspection of edema should be supplemented by palpation of the ventral abdomen and legs of the horse. A thin plaque on the ventrum can be missed easily. If general edema is observed, the primary differential should be hypoproteinemia (much more common rather than heart failure). Symmetrical edema of the limbs, especially the hind limbs, should suggest inactivity (standing in stable too long). Attention should be paid to regional distribution. In cases of venous obstruction, edema occurs in the drainage area of the obstructed vessel.

E. Auscultation of the lungs

Use a rebreathing bag to auscultate the lungs. This can be useful for ruling out pulmonary oedema (left sided heart failure) and pleural effusion (right sided and biventricular heart failure). With pulmonary oedema, moist crackles will be audible and free fluid may be identified in the trachea. With pleural effusion, decreased or absent airway sounds will be evident in the ventral portion of thorax.

F. Palpation of the thorax

Palpation of the thorax is done with a flat hand while the horse is standing squarely on all four feet. Palpate the cardiac impulse (or apex beat) on both sides noting strength, location and any thrills or abnormal vibrations. The cardiac impulse is a normal low frequency vibration produced during the early cardiac contraction/rotation associated with systole. The cardiac impulse is most obvious on the left side of the thorax approximately 5cm above the point of elbow in the 5th intercostal space (ICS), and is synchronous with the first heart sound (S1). The cardiac impulse can also be palpated in the right 4th ICS but it is only palpable with ease in fit or thin chested animals. A normal cardiac impulse is constant in location. A shifting impulse is always abnormal and usually indicates severe cardiac enlargement.

It is important to understand the difference between cardiac impulse and a thrill. A thrill is a palpable vibration of the thoracic wall associated with the kinetic energy of intracardiac or intravascular turbulence and is evident in horses with a loud cardiac murmur. The point of maximum intensity (PMI) of the thrill is the same as the murmurs PMI.

G. Cardiac auscultation

Auscultation of the heart is the most useful means of detecting heart disease, and in particular, cardiac murmurs.

1. Valve location (Figure 3)

- Mitral valve: left 5th ICS: 1/3 between shoulder and the olecranon under the caudal border of the triceps
- Aortic valve: left 3rd to 4th ICS below the point of the shoulder
- Pulmonic valve: left 3rd ICS between the mitral and the aortic valve
- Tricuspid: right 3rd to 4th ICS 1/3 between the shoulder and the olecranon

2. Heart sounds

Heart sounds are normally described as LUB, DUB, where LUB corresponds to S1 and represents closure of the atrioventricular valves and DUB corresponds to S2 and represents closure of the semilunar valves. The
normal sequence of heart sounds is S4 - S1 - S2 - S3. Heart sounds are louder over the left thoracic wall but are audible on both sides of the horse. All four heart sounds are generally detectable in the standing horse, but not all may be audible at the same location. The intensity of the heart sounds should be consistent when the rhythm is regular: variation of heart sound intensity occurs with arrhythmias (due to irregular cardiac filling) and with volume overloaded ventricles.

- **S4**: caused by vibrations due to blood flow from atria to ventricle during atrial contraction. Best heard in the left ventricular inlet region, just dorsal and cranial to the region of the mitral valve. S4 is most easily identified during second degree AV block.

- **S1**: heard at beginning of systole and is caused by rapid deceleration of blood against closed AV valves. S1 is best heard on the left side in the region of mitral valve and on the right side in the region of the tricuspid valve. S1 is LOUDER, has greater duration and lower pitch when compared to S2. Remember that the arterial pulse follows immediately after S1.

- **S2**: heard at beginning of diastole and is caused by blood flow reversal associated with closure of the semilunar valves. S2 is higher pitched than S1 and is best heard on the left side over the aortic and pulmonic valves.

- **S3**: heard just after S2 at the end of diastolic filling and is caused by rapid deceleration of blood in the ventricles at the end of ventricular filling. S3 has a dull thudding quality and is audible in many, but not all normal animals. It occurs and is best heard on the left side in the region of the mitral valve. S3 is often mistaken as a murmur in thin fit horses!

### 3. Stethoscope use

Correct use of your stethoscope is a prerequisite for a complete cardiac examination. Listen to the horse’s heart in a quiet environment when the horse is relaxed and preferably restrained. Place the bend of the earpieces rostrally to be aligned with your ear canals and use both the diaphragm (flat side) and the bell (concave side). The diaphragm accentuates higher frequency sounds (S1-2), while the bell enhances lower frequency sounds (S3-4) when applied lightly. When auscultating the heart, it is of critical importance to fully auscultate both sides of the thorax, as many cardiac abnormalities may only be evident on side. It is best to start on the left side where the cardiac impulse is felt. Here you will be able to hear the mitral component of S1 and in some cases you may hear S3. Once you have identified S1 and S3, move your stethoscope cranially and dorsally to listen to the aortic component of S2. Then move your stethoscope further dorsally to follow the ascending aorta. From the ascending aorta, move your stethoscope cranially under triceps muscle, and then ventrally to the region of the pulmonary valve to hear the pulmonic valve component of S2 and also S4. Once you have completed your examination of the heart on the left side, move to the right side of the horse. Place your stethoscope in the 3-4 th intercostal spaces as far under the elbow as possible and between the shoulder and the olecranon to hear the tricuspid component of S1. Finally, you should move your stethoscope ventrally to check for murmurs, particularly those resulting from a VSD.

### 4. Heart rate

The normal heart rate in adult horse is 28 - 44 bpm and in neonates it is 80 – 120 bpm. Sustained tachycardia (> 50 bpm) is most commonly seen with equine heart disease, but it is important to eliminate pain and excitement as causes of tachycardia before deciding that it is associated with primary cardiac disease. Profound bradycardia (< 24 bpm) may also an indication of underlying cardiac disease, and should be investigated.

### 5. Normal cardiac rhythm

Sinus rhythm is the most common rhythm overall, and is characterized by a regular metronome-like rhythm. Arrhythmias are characterized by an irregular rhythm. Many arrhythmias are physiologic and are related to the high vagal tone at rest and are therefore abolished by exercise or excitement. With physiological arrhythmias, there is usually a pattern that can be distinguished (i.e. regularly irregular). Common physiological arrhythmias are first and second degree atrioventricular blocks, sinus bradycardia and sinus arrhythmia. If however, there is no underlying rhythm (i.e. irregularly irregular), then it is likely that the arrhythmia is pathological and an electrocardiogram is indicated. The most important pathologic arrhythmias are atrial fibrillation (AF), supraventricular premature depolarizations (SVPDs) and atrial tachycardia (AT), ventricular premature depolarizations (VPDs) and ventricular tachycardia (VT); and third degree (complete) atrioventricular block. Cardiac arrhythmias will be discussed in more detail in the accompanying article on electrocardiography in the horse.

### 6. Murmurs

The normal flow of blood in the heart is laminar. Murmurs represent some manifestation non-laminar or turbulent blood flow and may be pathological or non-pathological in the horse.

#### Classification of murmurs

- **Timing**: used to describe where in the cardiac cycle the murmur occurs i.e. systole or diastole. It is best to simultaneously feel the pulse while listening to heart. The pulse is palpable during the time between S1 and S2, and thus denotes systole. A systolic murmur will thus occur between S1 and S2, and is associated with a palpable pulse. In contrast, a diastolic murmur occurs between S2 and S1, and is not associated with a palpable pulse.

- **Duration**: murmurs can be described as early, mid, late, holosystolic (can hear S1/S2) or pansystolic (cannot hear S1/S2)

- **Intensity and point of maximum intensity (PMI)**: the intensity or loudness of the murmur is usually graded from 1-6 on a 6 point scale with 6 being the most severe (Table 2). Pathologic murmurs are most commonly grade 3 or more, but there are
always exceptions e.g. small ventricular septal defects may be associated with loud murmurs and have little significance

- Radiation: refers to the directional decrease in murmur intensity and usually follows abnormal blood flow. When describing a murmur in terms of radiation, it is often useful to divide the heart into 4 regions i.e. left heart apex and left heart base; right heart apex and right heart base. In general, the more a murmur radiates, the more significant it is likely to be.

- Quality/Shape/Character: murmurs can also be classified according to their shape i.e. band or plateau shaped, crescento, decrescendo, crescento-decrescendo or machinery

Non-pathological (functional) murmurs

Non-pathological murmurs are common and are caused by vibrations associated with ejection of blood from the heart during early systole or from the rapid filling the ventricles during early diastole. Physiologic causes of non-pathological murmurs include fever, high sympathetic activity (e.g. colic, exercise, and pain), moderate to severe anemia and peripheral vasodilation. Non-pathological murmurs are usually SYSTOLIC, and originate from the pulmonic, tricuspid or aortic valves. These type of murmurs usually only encompass the early part of cardiac cycle (e.g. early systolic or early diastolic) and are low intensity sounds i.e. grade 1 or 2 (occasionally grade 3). Furthermore, non-pathological murmurs do not radiate and thus the sound is localized to the area around the heart valve. Non-pathological murmurs that may be encountered during a clinical examination include:

- Systolic non-pathological murmurs: common, and may be found in up to 50% of horses. They are especially common in fit racehorses. They usually occur in early systole BUT can be midsystole or late systole (rarely holosystolic). The PMI is usually over the pulmonic, tricuspid or aortic valves and there is little or no radiation. They are most commonly crescento - decrescendo in character. Systolic non-pathological murmurs are often louder after a quick trot up and this allows them to be differentiated from mitral valve regurgitation. This type of murmur is also very common in neonates and should be differentiated from pathological murmurs associated with congenital defects.

- Diastolic non-pathological murmurs: these murmurs are characteristically short in duration and usually occur in early or late diastole. The PMI is over the aortic valve and they are most commonly decrescendo in shape. A good example is the “2 year-old squeak”; a low grade early diastolic murmur common in young fit racehorses. These murmurs are often loudest at slightly elevated heart rates, and are sometimes detected after exercise when they were absent at rest.

Physiological regurgitation: these murmurs are caused by mild valvular regurgitation in the absence of valve pathology. This is common in fit performance horses and may result in a quiet (grade 3 or less) murmur.

Pathological murmurs

Pathological murmurs in the horse are caused by valvular regurgitation. Valvular stenosis is extremely rare in the horse and will not be discussed. Where valves leak due to pathology, the pathological process may be due to degeneration or inflammation, including bacterial endocarditis. This type of valvular regurgitation may affect performance and is always clinically significant. Pathological murmurs that may be encountered during a clinical examination include:

- Mitral regurgitation (MR): MR produces a plateau shaped holo- or pan-systolic murmur loudest over the left heart apex region. The murmur usually radiates dorsally and cranially and can sometimes be audible on the right side of the thorax. Most murmurs of MR are a grade 3 or louder, but softer murmurs may be detected, particularly in horses with atrial fibrillation. The mitral valve is the second most common site for valve pathology (after the aortic valve) and has been reported in 21% of national hunt Thoroughbreds in a recent study (Young et al, 2000). The prevalence of MR in the non racing horses is probably around 5% (Patteson et al, 1993). MR is the most likely murmur to be associated with poor performance. Because of the high operating pressures within the LV it is also the murmur most likely to result in congestive heart failure or cause sudden death because of pulmonary vessel rupture. It is also more likely to result in atrial fibrillation than the other valve regurgitations.

- Tricuspid regurgitation (TR): TR produces a right-sided plateau shaped holo- or pan-systolic murmur located over the tricuspid valve. There appears to be a direct relationship between the intensity of the murmur with TR and the severity of the regurgitation identified on color flow Doppler echocardiography (i.e. the louder the murmur, the more severe the regurgitation). TR is very common, particular in Thoroughbred and Standardbred racehorses, and a prevalence of 16.4% and 28% has been reported in National hunt and racing Thoroughbreds respectively (Patteson et al, 1993; Kriz et al, 2000). It is also thought to occur in approximately 12 % in non racing horses (Young et al, 2000). The tricuspid valve is least likely to have pathology and physiological regurgitation is common. TR is therefore less likely to be associated with poor performance than MR.

- Aortic regurgitation (AR): AR produces a decrescendo holo-diastolic murmur loudest over the left heart base radiating ventrally to the heart apex and also the right side of the thorax. AR is the murmur most commonly associated with valve pathology, mainly nodular or generalized fibrous degeneration. AR is therefore most common in the middle aged and older horse (Reef et al, 1987) and is the least common type of valvular regurgitation to be encountered in performance horses. In older horses it rarely affects performance, as progression occurs over many years and performance
Congenital abnormalities: the most common congenital cardiac abnormality likely to cause poor performance is a ventricular septal defect (VSD). VSDs produce two murmurs: a right sided coarse, loud plateau pan-systolic murmur over the tricuspid valve associated with the shunt and a left sided crescendo-decrescendo holo-systolic murmur associated with turbulent flow from the right ventricle into the pulmonary artery. A third murmur of AR may be present if the septal cusp of the aortic valve prolapses into the VSD. Ventricular septal defects (VSDs) are particularly common in Welsh ponies (Figure 4) but can occur in any breed. Small defects are compatible with an athletic career and horses with a VSD can perform at the highest level. The prognosis for future athletic performance can be determined using echocardiography, and will depend on the size and shape of the defect, and the velocity of the jet of blood moving through the defect from left to right ventricle.

Figure 4: A large ventricular septal defects (arrows) in a Welsh pony. Picture: Derek Knottenbelt

Please refer to Table 1 for guidelines on the significance of murmurs based upon clinical examination and auscultation.

VII. Conclusion

The most crucial point when trying to interpret the significance of cardiac murmurs is to decide whether they are pathological or non pathological. With practice and experience, careful auscultation is probably just as accurate as echocardiography for identifying the source of the murmur. If a holo-systolic murmur that is grade 3 or more is audible on the left side, it is most likely to be mitral valve regurgitation. If a holodiastolic murmur that is grade 3 or more is audible on the left side, it is most likely to be aortic regurgitation. If a holosystolic murmur is heard on the right side, then it is most likely to be tricuspid regurgitation. If a loud pansystolic murmur can be heard on the left and right side of the thorax, and is louder on the right side, it is most likely to be a VSD. Once it is determined that a murmur is associated with a cardiac abnormality, the intensity and radiation of the murmur and other relevant clinical information such as the performance history, resting heart rate and arterial pulse quality can be used to determine its clinical significance. Of course, these horses should then be subjected to an echocardiographic examination in order to characterize the murmur further and determine the extent to which the valvular regurgitation has affect overall cardiac function.

VIII. Additional reading

5. Guglick MA. Cardiac notes. In Colt notes, coltnotes@hotmail.com. 2013

IX. Selected references

### Table 1: Suggested criteria for determining the clinical significance of pathological cardiac murmurs in the horse

<table>
<thead>
<tr>
<th>Type of murmur</th>
<th>Criteria suggesting clinical significance</th>
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<tbody>
<tr>
<td>Mitral regurgitation</td>
<td>Grade 3 or louder</td>
</tr>
<tr>
<td></td>
<td>Pre-cordial thrill</td>
</tr>
<tr>
<td></td>
<td>Concurrent arrhythmia, especially AF</td>
</tr>
<tr>
<td>Tricuspid regurgitation</td>
<td>Grade 4 or louder</td>
</tr>
<tr>
<td></td>
<td>Pre-cordial thrill</td>
</tr>
<tr>
<td></td>
<td>Concurrent arrhythmia, especially AF</td>
</tr>
<tr>
<td>Aortic regurgitation</td>
<td>Young horse</td>
</tr>
<tr>
<td></td>
<td>Grade 4 or louder</td>
</tr>
<tr>
<td></td>
<td>Pre-cordial thrill</td>
</tr>
<tr>
<td></td>
<td>Concurrent arrhythmia, especially AF</td>
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<tr>
<td></td>
<td>Abnormal pulse quality (hyperkinetic ‘bounding’ pulse)</td>
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</tbody>
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### Table 2: A grading system for a murmur intensity in the horse

<table>
<thead>
<tr>
<th>Grade</th>
<th>Criteria for classification of murmur intensity</th>
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</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>A quiet murmur that can be heard only after careful auscultation over a localized area</td>
</tr>
<tr>
<td>Grade 2</td>
<td>A quiet murmur that is heard immediately once the stethoscope is placed over its localized PMI</td>
</tr>
<tr>
<td>Grade 3</td>
<td>A moderately loud murmur</td>
</tr>
<tr>
<td>Grade 4</td>
<td>A loud murmur heard over a widespread area, with no thrill palpable</td>
</tr>
<tr>
<td>Grade 5</td>
<td>A loud murmur with an associated precordial thrill</td>
</tr>
<tr>
<td>Grade 6</td>
<td>A murmur sufficiently loud that it can be heard with the stethoscope raised just off the chest surface</td>
</tr>
</tbody>
</table>

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