The cardiac cycle may be described as follows:

**Systole**

The atrioventricular valves (AV), the mitral and tricuspid valves close as the right and left ventricles contract to forcefully propel blood out of the heart to the lungs via the pulmonary artery (right ventricle) and to the body via the aorta (left ventricle). This allows the atria to fill with blood returning from the body via the vena cava (right atrium) and pulmonary vein (left atrium) the first heart sound is created by the passive closing of the mitral and tricuspid valves. “Lub”. It is longer, louder, and lower pitched than the second heart sound.

**Diastole**

The tricuspid and mitral valves open during diastole, the relaxation phase of the cardiac cycle. This allows the ventricles to fill with blood. The pulmonic and aortic valves close during diastole to facilitate this filling. The second heart sound is produced by the closure of the aortic and pulmonic valves. It should be short, high pitched and sharp. “Dup”

The tricuspid, mitral, pulmonic and aortic valves are one-way valves. That means that, under normal conditions, they should not allow “back-flow” or regurgitation of blood across them. For example, the mitral valve, when open during diastole, allows blood to flow from the left atrium to the left ventricle. When closed, during systole, the mitral valve should not allow any blood flow backwards from the left ventricle to the left atrium. Any back-flow that occurs is referred to as a leak in the mitral valve. This leak can produce a murmur that occurs during systole (in between lub and dup).

**Technique of Cardiac Auscultation**

The room must be quiet (barking, purring, panting, and client conversation can effect the cardiac auscultation). Animals must be restrained properly. Proper utilization of the stethoscope. Proper placement of the ear pieces so that they are aligned with the ear canals and an air tight seal is achieved.

The diaphragm is applied firmly with a “gentle” touch to accentuate the higher frequency sounds (most cardiac murmurs). The diaphragm is the flat side of a two headed stethoscope. The bell is utilized to auscult lower frequency sounds (diastolic murmurs, third and fourth heart sounds). The bell is the concave side of the two headed stethoscope. Gentle firm application forms an air seal which helps detect the lower pitched sounds. Auscultate over all valve areas while palpating the femoral artery.

Upon auscultation of the heart, two sounds are heard; lub and dup. The first heart sound (S1) is lub and is associated with closure of the mitral and tricuspid valves. The second heart sound (S2) is dup and is associated with the closure of the pulmonic and aortic valves. The first heart sound is created by the passive closing of the mitral and tricuspid valves. It is longer, louder, and lower pitched than the second heart sound.
**Patient positioning**

The patient should be standing allowing the heart to assume normal position. If the patient is lying down, positional murmurs may be heard as the heart rubs against the chest wall.

**Valve location for auscultation**

- Aortic valve: Left side – 4th intercostal space at costochondral junction
- Mitral valve: Left side – 5th intercostal space at the costochondral junction
- Pulmonic valve: Left side – between 2nd & 4th intercostal space just above the sternum
- Tricuspid valve: Right side – 3rd to 4th intercostal space near the costochondral junction

**Grading Murmurs**

- Grade 1 = low intensity, very soft murmur only ausculted after careful evaluation in a very localized region
- Grade 2 = soft murmur, ausculted immediately when the stethoscope is placed on a single valve area
- Grade 3 = murmur of moderate intensity that may be ausculted in more than one valve area
- Grade 4 = high intensity murmur which radiates without a precordial thrill
- Grade 5 = high intensity murmur with a precordial, palpable thrill present
- Grade 6 = high intensity murmur with a palpable thrill that is ausculted when the stethoscope is slightly removed from the thoracic wall

**Common Artifacts**

- Rumbles due to shivering and twitching.
- Crackling due to the rubbing of hair.
- Respiratory clicks

**Causes of Murmurs**

The sound heard and recognized as a murmur is caused by the turbulent blood flow through the heart and vessels. These murmurs can be broken down into three basic categories with numerous causes.

Physiologic murmurs are due to a known cause and are high frequency murmurs which occur during the early to mid-systolic phase. They are located over the aortic and pulmonic areas and uncommonly radiate to other areas. They are known to be caused by an increase in cardiac output and/or decreased blood viscosity. Examples would include: anemia, hypoproteinemia, fever, hyperthyroidism, pregnancy and the athletic heart.

Innocent murmurs are typically soft systolic murmurs occurring in young animals. They may be directed over any valve but more often over the mitral and aortic areas. They have no known cause and are related to no cardiac disease. These murmurs usually disappear by the age of five months.

Pathologic murmurs are a direct cause of an underlying cardiac disease or dysfunction. Their location is directly related to the causative dysfunction. Murmurs of this type include the congenital defects as well as acquired diseases. Examples of the congenital would include: patent ductus arteriosus, pulmonic stenosis, subaortic stenosis, atrial and ventricular septal defects, mitral or tricuspid valve dysplasia and Tetrology of Fallot. Acquired diseases would include: mitral and tricuspid valve regurgitation, and endocarditis (commonly found on the aortic valve).
**Point of maximum intensity (PMI)**

Simply put, this describes the site at which the murmur is loudest. It should be stated that the PMI is located at …. valve and radiates to other area.

**Chronic valve disease** -

The most common acquired murmur likely to be ausculted in the veterinary small animal practice is the murmur associated with chronic valve disease. The incompetent valve allows back flow of blood from the ventricle to the atrium. This can give rise to arrhythmias due to stretching of the atrium so that nerve fibers become irritable. As the atrium dilates, the muscle becomes weaker and less able to move blood in a forward direction. In addition, as the size of the atrium increases, the valves are less able to close properly and more blood is forced back into the atrium during systole.

68% of cases involve the mitral valve

**Breed Predilection** - Small breeds—cocker spaniels, poodles, schnauzers, Chihuahuas, etc.

**Sex predilection** - Males slightly more prone with a 1.2:1 ratio

**Age** - Mid-life to old age. Severity typically increases with age

<table>
<thead>
<tr>
<th>Class</th>
<th>Disease confirmed by radiographs, echocardiography. No clinical signs of failure, may be receiving medications</th>
<th>ASA category II those not receiving drugs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td></td>
<td><strong>ASA category III</strong></td>
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<tr>
<td></td>
<td></td>
<td>Those receiving cardiac medications</td>
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<tr>
<td></td>
<td></td>
<td>Safe to sedate or anesthetize without stabilization</td>
</tr>
<tr>
<td>Class II</td>
<td>Mild to moderate signs of failure at rest/mild exertion</td>
<td><strong>ASA category IV</strong></td>
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<tr>
<td></td>
<td></td>
<td>Should be stabilized with cardiac medication and be free of signs of heart failure for several days prior to receiving sedation or anesthesia. Drug therapy to continue during anesthesia and recovery phase. Higher risk of debilitation/death during perianesthetic period</td>
</tr>
<tr>
<td>Class III</td>
<td>Signs of fulminate heart failure, may present in</td>
<td><strong>ASA category V</strong></td>
</tr>
<tr>
<td>shock</td>
<td>Aggressive therapy to stabilize before anesthesia is considered. Once stable, ASA category IV-V as patient may decompensate and death may occur during perianesthetic period.</td>
<td></td>
</tr>
</tbody>
</table>

*Table adapted from guidelines provided by the International Small Animal Cardiac Health Council

Applying American Society of Anesthesiologists ratings to International Small Animal Cardiac classifications