ARRHYTHMIAS IN THE INTENSIVE CARE UNIT

Nicole Van Israël, DVM, CESOpht, CertSAM, CertVC, DECVIM-CA (Cardiology), MSc, MRCVS
European Specialist™ in Veterinary Cardiology
Animal CardioPulmonary Consultancy (**ACAPULCO**)

The mechanisms responsible for cardiac arrhythmias are generally divided into categories of disorders of impulse formation, disorders of impulse conduction or combinations of both.
Arrhythmias may be due to acquired valvular or cardiac muscle disease, congenital cardiac disease, trauma, infection, drugs, electrolyte imbalances, endocrinopathies, hypoxia, hypothermia, respiratory, splenic, gastrointestinal or organic brain disease, pancreatitis, pyometra, gastric dilation-volvulus, shock or mechanical stimulation.

NORMAL RHYTHMS

Canine rhythm

- sinus rhythm:
  - the rhythm is regular at 70-160 BPM (60-140 for giant breeds, up to 220 for puppies and toy breeds)
  - the P-waves have a constant configuration
  - normal QRS complexes
- sinus arrhythmia:
  - all criteria of normal sinus rhythm are met except that the heart rate increases during inspiration and decreases during expiration in respiratory sinus arrhythmia
  - the P-waves are normal but may vary in height (wandering pacemaker)

Feline rhythm

- sinus rhythm:
  - rhythm is regular at a rate of 120-240 BPM
  - P-waves have a constant configuration
  - normal QRS complexes

ABNORMAL RHYTHMS

Abnormalities of impulse formation

- sinus bradycardia: this may be a normal rhythm. It may also be recognised in patients with hypothermia, hypothyroidism, hyperkalaemia, CNS lesions, and certain drugs will induce this (phenothiazine, digoxin, calcium channel blockers, morphine, GA).
- sinus tachycardia: this may be physiologic (exercise, stress) or pathologic (pain, fever, hyperthyroidism, shock, anaemia, hypoxia, CHF).

- sinus arrhythmia in the cat: respiratory sinus arrhythmia is often a sign of a pathology associated with a high vagal tone (respiratory disease, increased intracranial pressure)
- sinus arrest: a period where there is no evidence of atrial activity for a period in excess of two proceedings R-R intervals. Prolonged sinus arrest may result in syncope. Ventricular escape beats may be recognised in attempt to rescue the arrested heart.
- supraventricular arrhythmias:
    - atrial premature complexes (APC): these complexes occur early but they resemble the sinus complexes in appearance. A P-wave is associated with the premature complex but is different in shape compared to the normal sinus P-waves and in some cases may not be visible because it is hidden in the preceding T-wave or in the premature complex. APC's are a sign of atrial dilation, stretch or infiltration.
    - supraventricular tachycardia: a rapid regular rhythm originating from a focus in the atria away from the SA node. Three or more consecutive APC's are considered to be an atrial tachycardia. It may be intermittent (paroxysmal) or continuous. It is caused by atrial dilation, stretch or infiltration.
    - atrial flutter: rapid and regular atrial rhythm at a rate varying usually from 300-500 BPM. The P-waves are replaced by saw tooth waves (called f-waves). It is caused by atrial dilation, stretch or infiltration.
    - atrial fibrillation: this is a chaotic rhythm where several foci are discharging at the same time in the atria (mico re-entrant circuits). There are no recognisable P-waves. The QRS-complexes are of normal morphology as conduction is through the AV-node. The rate is frequently rapid and irregular. This rhythm is caused by atrial stretch in small animals and is commonly seen with DCM or more rarely endocardiosis in dogs. Some large breeds of dogs have slow atrial fibrillation without atrial stretch, this thought to be related to an occult form of DCM, as most dogs go on to develop DCM eventually.
- ventricular arrhythmias:
    - ventricular premature complexes (VPC): the QRS is premature,bizarre, and often of large amplitude. There is no associated P-wave. They can be cardiac in origin (DCM, CHF, myocarditis, pericarditis) but are often secondary to metabolic disease (electrolyte and acid-base imbalances, abdominal disease, CNS disease)
    - ventricular tachycardia: more than 3 premature complexes together. The ventricular tachycardia may be sustained or paroxysmal. The aetiology is the same as for VPC's.
    - ventricular flutter, fibrillation: the heart rate is rapid with irregular, chaotic, and bizarre waves. P-waves and QRS complexes cannot be recognised.
    - ventricular asystole: absence of any ventricular complexes. It represents cardiac arrest.
    - ventricular escape rhythm: ventricular escape beats occur late. They are wide and bizarre in appearance. There is no associated P-wave. These are rescue beats. They should never be suppressed.

Abnormalities of impulse conduction

- sino-atrial block: occurs when the tissue surrounding the sinus node fails to conduct the depolarisation to the atria and ventricles. A pause occurs after a sinus beat and is an exact multiple (2 or 3) of the normal P-P interval. It is normally recognised in dogs with accentuated sinus arrhythmia, often those with high vagal tone such as brachycephalic dogs with underlying respiratory disease.
- atrial standstill: is characterised by an absence of P-waves and by a regular escape rhythm with a supraventricular type QRS. This rhythm is associated with hyperkalaemia (hypoadrenocorticism, post renal obstruction, diabetic keto-acidosis) and certain muscular dystrophies.
- sick sinus syndrome: failure of the SA node to discharge impulses without the occurrence of a junctional escape rhythm and with or without a preceding tachycardia that depresses the SA node (brady-tachy syndrome). Recognised in WHWT, Cockers and Miniature Schnauzers, but also in other breeds.
- AV-block:
  - first degree: conduction across the AV node is slowed. This is due to increased vagal tone. The P-Q interval is prolonged.
  - second degree: some of the P-waves are not conducted across the AV node and do not result in a QRS complex.
    - *Mobitz Type I*: P-R interval may be variable and increasing prior to a block (Wenkebach phenomenon). This is a manifestation of high vagal tone.
    - *Mobitz Type II*: P-R interval is constant, indicates disease of the conduction system.
  - third degree: there is no conduction across the AV node. The P-waves are not associated with the QRS complexes. There tend to be a regular P-wave rate. The ventricles beat at a regular escape rate which is much lower than the p-wave rate (usually 30-60 in a dog). This condition is idiopathic or associated with fibrosis or infiltration of the AV-node.
  - bundle branch block:
    - *left:* wide QRS complexes with tall R-waves associated with a P-wave.
    - *right*: wide QRS complexes with a deep S-wave but associated with a P-wave. Occasional in normal healthy dogs but can be associated with cardiac disease
    - *left anterior fascicular block*: marked left axis deviation and deep S-waves in leads II, III and aVF. Commonly seen with HCM in cats.

MANAGEMENT OF THE MORE COMMON ARRHYTHMIAS.

Many cardiac arrhythmias are benign, clinically insignificant and require no specific therapy. Other arrhythmias can cause clinical signs and furthermore may be life-threatening.
Arrhythmias may be cardiac or non-cardiac in origin. It is vital to determine the cause of the arrhythmia before starting therapy. Treatment of the primary disease problem may result in resolution of the arrhythmia. In certain arrhythmias knowledge of the mechanism of the arrhythmias may help in drug selection. The arrhythmia should be

treated if there is poor cardiac output, syncope or likelihood of progression to a malignant arrhythmia.

Treatment of bradyarrhythmias

Animals with symptomatic bradyarrhythmias (syncope, exercise intolerance) should be carefully checked for electrolyte imbalances or systemic disease causing high vagal tone. Bradyarrhythmias due to high vagal tone may respond to medication. If there is no response to therapy then pacemaker implantation is the only option.

Vagolytic drugs: atropine, probantheline, glycopyrrolate
Sympathomimetic drugs: isoprenaline, terbutaline, methylxanthines

Treatment of tachyarrhythmias

Supraventricular tachycardia (SVT)

It is very important to distinguish supraventricular tachycardia from sinus tachycardia. SVT can occasionally be terminated by vagal manoeuvres (ocular pressure). Calcium channel blockers (verapamil, diltiazem) are the drug of choice in dogs. ß-blockers (esmolol, propanolol) can be used in patients with no evidence of CHF or myocardial failure. Bypass-tract tachycardias require often specialist attention (react to Class Ia, III, IV).
In cats ß-blockers (propranolol, atenolol) and calcium channel blockers (verapamil, diltiazem) are the drugs of choice.

Atrial fibrillation (AF)

In general AF in the dog and the cat is due to cardiac pathology and the aim of therapy is to decrease ventricular response rate rather than to convert into sinus rhythm. Drugs commonly used to achieve this include digoxin, ß-blockers and calcium channel antagonists. Combination therapy may be necessary to achieve an optimal heart rate response (aim less than 140 BPM in the dog).

Ventricular tachycardia (V-tach)

Single VPC's usually do not require therapy. Treatment decision depends on the haemodynamic significance and the malignant aspect of the arrhythmia. Treatment of ventricular arrhythmias might be recommended if VPC's are polymorphic, the coupling interval of the preceding beat is short and there are frequent runs of V-tach. The aim of therapy is to convert to sinus rhythm. Do not forget to treat the primary condition. A slow V-tach (also called an accelerated idioventricular rhythm) in an animal that is haemodynamically stable does not require therapy. Drugs commonly used in the treatment of V-tach in dogs include Class I anti-arrhythmics (first choice lidocaine as a bolus IV followed by a continuous rate infusion, or mexilitine IV followed by oral therapy, in refractory cases procainamide IV), Class II (esmolol IV, propranolol IV and PO, atenolol PO), and Class III drugs (sotalol and amiodarone). Drug combinations are sometimes used in refractory cases (Class IA and IB, Class IA or B with Class II).
In cats ß-blockers are the drugs of choice in V-tach.

References

Fox, Sisson, Moise (2000) Textbook of canine and feline cardiology (WB Saunders)

Kittleson and Kienle (1998) Small Animal Cardiovascular Medicine (Mosby)

Tilley LP (1992) Essentials of canine and feline electrocardiography, 3d Ed, Lea & Febiger, Philadelphia.