Practical Approach to Arrhythmias

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October 27, 2018

Outline

- Conduction System
- ECG Acquisition
- ECG Interpretation
  - Heart rate
  - Rhythm
- Arrhythmias
  - Bradyarrhythmias
  - Tachyarrhythmias
    - Supraventricular Tachyarrhythmias
    - Ventricular Tachyarrhythmias

Cardiac Conduction System

Depolarization & ECG

Electrocardiography
ECG Acquisition

Electrocardiography

ECG Interpretation:
Calculating the Heart Rate

25mm/s
10 small boxes 1500 / 10 = 150 bpm
At 25mm/s: 1500 / number of small boxes = Instantaneous heart rate
At 50mm/s: 3000 / number of small boxes = Instantaneous heart rate

ECG Interpretation:
Calculating the Heart Rate

10 QRS complexes within 6 seconds represents 100 bpm (10 cycles x 10)

ECG Interpretation:
Calculating the Heart Rate

ECG Interpretation:
Calculating the Heart Rate

10 small boxes
1500 / 10 = 150 bpm
ECG Interpretation: Calculating the Heart Rate

- **Paper Speed at 50 mm/s**
  - Average HR:
    - Count number of complexes in 3 second time frame and multiply by 20
  - Instantaneous HR:
    - Count number of small boxes from one R wave to the next R wave and divide into 3000

- **Paper Speed at 25 mm/s**
  - Average HR:
    - Count number of complexes in a 6 second time frame and multiply by 10
  - Instantaneous HR:
    - Count number of small boxes from one R wave to the next R wave and divide into 1500

ECG Interpretation: Rhythm Assessment

- Evaluate the heart rhythm
  - Regular, Regularly irregular, or Irregularly irregular
- What is the relationship between the P and QRS?
  - Is there a P-wave for every QRS complex?
  - Is there a QRS complex for every P-wave?
  - Are the P waves and QRS complexes consistently related?
- Are the P waves and QRS complexes the same?
  - Where are they originating from?
  - Supraventricular or Ventricular

ECG Interpretation: Rhythm Assessment

- Sinus Rhythm
- Sinus Arrhythmia

ECG Interpretation: Rhythm Assessment

- 2:1 Atrioventricular Block
- Ventricular Bigeminy

Common Arrhythmias

- **Bradyarrhythmias**
  - Sinus bradycardia
  - Atrioventricular block
  - Sick sinus syndrome
  - Atrial standstill
- **Tachyarrhythmias**
  - Supraventricular tachycardia
  - Atrial fibrillation
  - Ventricular tachycardia
Bradyarrhythmias

Causes

• Sinus bradycardia
  – Primary: Sinus node disease (Sick sinus syndrome)
  – Secondary: Increased vagal tone, hypothyroidism, hyperkalemia, hypoadrenocorticism

• Sinus Arrest/Sick Sinus Syndrome
  – Primary: Sinus node disease (Sick sinus syndrome)
  – Secondary: Increased vagal tone, hypothyroidism, hyperkalemia, hypoadrenocorticism

• Atrioventricular block
  – Primary: AV node disease
  – Secondary: Increased vagal tone

• Atrial Standstill
  – Primary: Atrial myocardial disease
  – Secondary: Hyperkalemia

Bradyarrhythmias - Vagotonia

Increased Vagal Tone

• Gastrointestinal/Abdominal disease
• Respiratory disease
• CNS disease
• Ophthalmologic disease
• Vagal nerve stimulation

Bradyarrhythmias

Sinus Bradycardia

• Primary Causes
  – Sick Sinus Syndrome

• Secondary Causes
  – High vagal tone (Respiratory, GI, CNS disease)
  – Hypothermia, hypoglycemia
  – Hypothyroidism
  – Electrolyte abnormalities
  – Drugs

Bradyarrhythmias

Sick Sinus Syndrome

• Middle-aged to older females
• Breed predisposition
  – Miniature Schnauzer
  – Cocker Spaniel
  – West Highland White Terrier
  – Pug
  – Bull Terrier
• Sinus node dysfunction
  – Sinus arrest
  – Escape beats
  – Brady/tachyarrhythmias

Bradyarrhythmias

Atrioventricular Block

• Atrioventricular Block
  – Impaired conduction from the atria to the ventricles

  • 1st Degree AV Block – Good prognosis
  • 2nd Degree AV Block
    – Low Grade: Good prognosis
    – High Grade: Guarded prognosis
  • 3rd Degree AV Block
    – Guarded prognosis
Bradyarrhythmias
Atrioventricular Block

1st Degree AV Block
- Prolonged PR Interval (Normal < 0.14 seconds)
- No dropped beats
- Good prognosis

2nd Degree AV Block
- Unconducted P waves
- Low Grade – Conduction ratio of 2:1 or better
- High Grade – Conduction ratio of 3:1 or worse
- Guarded prognosis – Risk of sudden death

Atropine Response Test
- Atropine 0.04mg/kg IV
- Repeat ECG in 15 minutes
- OR
- Atropine 0.04mg/kg SQ
- Repeat ECG in 30 minutes
- Normal response: Increase HR > 140 bpm

3rd Degree AV Block
- Atrioventricular dissociation
- Guarded prognosis – Risk of sudden death
- Chronically may present with congestive heart failure

Treatment - Medical
- Treatment of Secondary Cause
- Sympathomimetics
  - Theophylline 5-10 mg/kg BID-TID
  - Terbutaline 0.2 mg/kg BID-TID
- Vagolytics
  - Hyoscyamine 0.003-0.006mg/kg BID-TID
  - Propantheline Bromide: 7.5 – 30mg BID-TID
    - < 5 kg: 7.5mg, < 12 kg 15mg, 12 kg+: 30mg q8
Bradyarrhythmias
Treatment - Pacemaker

- Indications
  - High grade 2nd Degree AVB
  - 3rd Degree AVB
  - Sick Sinus Syndrome
- Complications
  - Lead Dislodgement
- NO jugular venipuncture, neck leads/collars, MRI

Tachyarrhythmias

- Tachycardia
  - Wide QRS
  - Narrow QRS
  - Ventricular SVT with aberrancy
  - Sinus Tachycardia
  - Atrial Fibrillation/Flutter
  - Atrial/Junctional SVT

Tachyarrhythmias

- Excessively elevated heart rate interferes with diastolic filling resulting in a drop in stroke volume
  - HR x SV → Cardiac Output → Blood Pressure

Supraventricular Tachycardia
Sinus Tachycardia

- Physiologic Response
  - Pain
  - Anxiety
  - Excitement
  - Hyperthyroidism
  - Cardiac tamponade
  - Congestive heart failure
  - Hypotension
  - Drugs
  - Fever

Supraventricular Tachycardia
Atrial Fibrillation

- Loss of atrial contraction
  - Normally contributes 10-15% total cardiac output
- Tachycardia reduces diastolic filling time while increasing myocardial work and oxygen demand
- Chronic tachycardia results in myocardial failure
- Structural and electrical remodeling
Supraventricular Tachycardia
Atrial Fibrillation

• ECG Characteristics:
  – Irregularly irregular rhythm
  – Narrow QRS complexes
  – Absent P waves
  – Presence of fibrillation waves (F waves)
    • Fine baseline undulations (may not always be apparent)
  – +/- Tachycardia

Supraventricular Tachycardia
Atrial Fibrillation - Treatment

• Rhythm Control - Cardioversion
  – Restoration of sinus rhythm
  – Electrical or pharmacological cardioversion
  – Patients may revert back to atrial fibrillation

• Rate Control
  – Slow the heart rate
  – Improves diastolic filling
  – Target HR: 120-160 bpm

Supraventricular Tachycardia
Atrial Flutter

• ECG Characteristics
  – Rapid regular atrial activation - Flutter waves
  – Narrow QRS complexes
  – May have a regular pattern of atrioventricular block

• More amendable to radiofrequency catheter ablation

• May degenerate to atrial fibrillation

Supraventricular Tachycardia
Other Tachyarrhythmias

• Other Supraventricular Tachyarrhythmias
  – Focal atrial tachycardia
  – Focal junctional tachycardia
  – Permanent junctional reciprocating tachycardia
  – AV nodal reentrant tachycardia
  – Atrioventricular reciprocating tachycardia

Supraventricular Tachycardia
Emergency Treatment

• Diltiazem
  – 0.1-0.25mg/kg IV over 5 minutes
  – 2-6 mcg/kg/min CRI

• Esmolol
  – 0.25-0.5mg/kg IV over 1 minute
  – 50-200 mcg/kg/min CRI

• Lidocaine
  – 2mg/kg IV over 3 minutes
  – Little effect on atrial conduction/refractoriness

• Procainamide
  – 5-8 mg/kg IV over 5 minutes
  – 20-50 mcg/kg/min CRI
  – Depresses conduction in normal and abnormal tissue

Supraventricular Tachycardia
Chronic Therapy

• ABCD for SVT

• Calcium Channel Blockers
  – Diltiazem
    – 0.5 – 3 mg/kg PO TID
  – Esmolol
  – 0.003 mg/kg PO BID (dog), ¼ of 0.125mg tablet EOD (cat)

• Beta-blockers
  – 1-2 mg/kg BID

• Digoxin
  – 0.5 – 1 mg/kg BID

• Sotalol
  – 5-8 mg/kg PO TID

• Amiodarone
  – 10 mg/kg BID then wean to 5mg/kg SID over 2-3 weeks

• Atenolol
  – 0.5 – 1 mg/kg BID
**Ventricular Tachycardia When to Treat**

- Symptomatic patients
  - Weakness
  - Lethargy
  - Exercise Intolerance
  - Syncope
- Development of tachycardia induced cardiomyopathy
- Risk of sudden death
  - Multiform ventricular arrhythmias
  - Rapid sustained ventricular tachycardia
  - R on T phenomenon

**Ventricular Tachycardia Differentials – Non-Cardiac**

- Stress/Anxiety (catecholamine induced)
- Abdominal disease
  - Splenic mass, adrenal mass, GDV
- Hypoxemic states
  - GDV, anemia
- Metabolic derangements
  - Acidosis, hypokalemia
- Neoplasia
- Circulating cytokines
- SIRS/Major illness or trauma
  - Circulating cytokines
- Idiopathic

**Ventricular Tachycardia Differentials - Cardiac**

- Structural Cardiac Disease
  - Cardiomyopathies
    - Dogs: DCM, ARVC
    - Cats: HCM, RCM/UCM, DCM, ARVC
  - Advanced DVD
  - Cardiac tumors
  - Congenital disease/Inherited arrhythmia
- Drugs
  - Antiarrhythmics
- Myocarditis
  - Tick borne disease, Neospora, Toxoplasmosis, Chagas disease

**Ventricular Tachycardia Acute Treatment**

- **Lidocaine**
  - 2 mg/kg IV slow bolus
  - 1 ml/20 lbs (2% lidocaine)
  - CRI: 40-80 mcg/kg/min
- **Procainamide**
  - 5-8 mg/kg IV over 3-5 minutes
  - (Up to 16-20 mg/kg)
  - CRI: 25-50 mcg/kg/min
- **Sotalol**
  - 1-2 mg/kg PO q12h
- **Amiodarone (Nexterone)**
  - 2.5 – 5 mg/kg IV over 10 min followed by 0.8 mg/kg/hr CRI

**Ventricular Tachycardia Chronic Treatment**

- **Sotalol**
  - 1-4 mg/kg PO q12 hr
- **Mexiletine**
  - 4-8 mg/kg PO q8-12 hr
- **Atenolol**
  - 0.5-1.0 mg/kg PO q12hr
- **Amiodarone**
  - 10-15mg/kg PO q12h x 1 week, then 5-7.5mg/kg PO q12h x 2 weeks then 5-7.5mg/kg PO q24h thereafter