**ECG 101**

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**Electrocardiogram (ECG)**
- What information does the ECG give us?
- Acquiring and interpreting the ECG
- Common artifacts
- Cases

**Utility of ECG – what does it tell us?**
- Non invasive and rapid assessment of heart rate and rhythm
- HR is correlated to cardiac output and volume status
- Rhythm disturbances can lower CO / BP and increase risk for sudden cardiac death
- ECG can give us information about electrolytes status, myocardial ischemia and chamber enlargement
- Useful in anesthetic, critically ill and cardiac patient

**Increased Risk of Sudden Death**
- Ventricular flutter
- V fib

**Acquisition of ECG**
- For long term monitoring, leads attached with patches on feet or chest.
- Clips attached @ elbows and knees are fine for diagnostic ECG or short term monitoring
  - file or flatten alligator clips to decrease discomfort
- Alcohol or preferably electrode paste for conductance
- For monitoring, animal can be in any position
- For diagnostic ECG, animal should be in right lateral with legs perpendicular to torso

**Approach to interpretation**
- The first and critical step in evaluating an ECG is to assess the technical quality of the recording
- Common artifacts:
  - respiratory or precordial movement (wandering baseline)
  - 60 cycle interference from other electrical devices or a poorly isolated wall outlet
  - muscle tremor and shivering
  - purring and movements of the patient
  - touching of the electrodes during the recording
Optimize the ECG

- Lead II is standard but the ECG complexes may be better visualized in another lead
- Typical speed for monitoring is 25 mm/s
- Adjust the height of the QRS
  - Decrease amplitude if QRS too big
  - Increase amplitude if QRS too small
    - Commonly needed for cats
    - May cause T waves to be counted as heart beat
    - Double counting and erroneous heart rate may ensue
- Adjust the amplitude to visualize P waves

A normal sinus beat (lead 2)

ECG Interpretation

- First determine heart rate
  - Always double check monitor’s HR
- Evaluate rhythm
  - Is it regular or irregular
- Identify P – QRS – T waves for each
  - Is there a P wave for every QRS and a QRS for every P wave
- Identify any wide and bizarre beats
First the Heart Rate

- Need to check monitor or paper speed (25 mm/s)
- Always double check the monitor’s HR
  - Can print out a paper strip and count
  - Can manually check on patient

Determine Heart Rate

If 25 mm/s
Count 30 boxes or 15 cm or pen, multiply # complexes by 10 = HR
Count 5 boxes (one marked interval) = 1 sec, multiply # complexes by 60

Recognition of Ventricular Arrhythmia

Ventricular premature complex
Wide QRS
No associated p wave

Recognition of Ventricular Arrhythmias

This is NOT ventricular tachycardia

Recognition of Ventricular Arrhythmias

This is sinus rhythm with abnormal conduction (RBBB)

Ask yourself these questions?

- Are the R-R intervals regular? Are there patterns to irregularities?
- Is there a P wave for every QRS-T?
  - The P and QRS waves of normal sinus beats are generally positively deflected in lead II.
  - The T wave can be positive, negative or bi-phasic
Rhythms – You should be able to recognize

- **Sinus rhythm** – normal initiation of heart beat and normal rate
  (Dog 60-150 bpm, Cat 140 – 220 bpm)

- **Sinus bradycardia** – normal initiation of heart beat but too slow
  (Dog < 60 bpm, Cat < 140 bpm)

- **Respiratory sinus arrhythmia** – Normal variant in the dog when
  sinus rate varies based on phase of respiration
  - Sinus rate speeds up with inspiration and slows with exhalation
  - Often p wave height varies – wandering pacemaker

- **Sinus tachycardia** – normal initiation of heart beat but too fast
  (Dog > 150 bpm, Cat > 220 bpm)

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Sick Sinus Syndrome

- Periods of sinus arrests (> 2 normal RR intervals)
- Usually followed by junctional or ventricular escape complex
- Typically idiopathic sinus node dysfunction
- Miniature Schnauzers and West Highland White Terriers
- Can be symptomatic or asymptomatic
- Medical and/or pacemaker treatment options for syncopal patient

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**Atrial Fibrillation**

11 yo M Chow, dyspnea and tachyarrhythmia

ECG (25 mm/s) and Invasive BP monitoring

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Rhythms – You should be able to recognize

- **Atrial fibrillation** –
  - no p waves, f or fibrillation waves,
  - fast ventricular rate (> 150), chaotic rhythm
  - QRS in lead 2 is typically positive, varying QRS height

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Rhythms – You should be able to recognize

- **Ventricular Premature Complexes (VPCs)**
  - No causal p waves
  - QRS is wide, bizarre, typically negative in lead 2
  - Can see fusion beats

- **Ventricular Tachycardia (VT)**
  - 3 or more VPC in a row
  - Usually fast rate > 150
  - Usually regular R-R intervals
  - If < 150, accelerated idioventricular rhythm

- **Ventricular Escape Complex**
  - Heart beat initiated by the ventricle after a prolonged period of
    either sinus arrest or 3rd degree AV Block

- **Ventricular Fibrillation (VFib)**
  - Lethal rhythm (defibrillation
  - No p waves
  - No organized ventricular activity
10 yo FS Boxer
Presents for Syncope; Tachyarrhythmia on PE

1 year old FS Lab w/ atrial standstill; pulseless rhythm (left, below) recorded during transvenous RV pacing lead placement

Rhythms – You should be able to recognize

- **Second degree AV block**
  - P waves that intermittent get blocked at AV node
  - Low grade 2 AVB is common rhythm disturbance with anesthesia
  - Usually responses to anticholingeric
    - Mobitz type 1 – progressive PR interval prolongation then dropped QRS
    - Mobitz type 2 – no relationship with PR interval, thought to be more pathologic

- **Third degree AV block**
  - Complete dissociation between atria and ventricles
  - Usually slow ventricular escape rhythm
  - P-P intervals are regular, R-R intervals are regular
  - Urgent rhythm – increased risk for sudden death
    - 25 % die within 1 month of diagnosis
    - Usually do not respond to atropine
    - Usually require pacemaker

Sinus bradycardia with low grade 2\(^{o}\)AVB

Second degree AV block (3:1 A:V conduction)
Pre and post atropine

ECG (25 mm/s) and BP
7 yr old Lhasa Apso – collapsed
Complete or 3rd degree AV Block

15 yo FS Airedale Terrier - collapsed

Recognition of supraventricular
premature complex and SVT

Supraventricular arrhythmias
(abnormal rhythm that begins above the ventricle)

Paroxym of SVT post vagal maneuver
6 yo M Mixed Breed dog, HBC and sepsis

Hyperkalemia effects on the ECG
- Complex -more pronounced in atrial than ventricular
myocytes.
- With progressive hyperkalemia, sodium channels become
inactivated
  - Bradyrhythmias, including sinoventricular rhythm (loss of P wave
  on surface ECG) and AV Block
  - With severe hyperkalemia, sinus arrest, slow idioventricular
  rhythm, asystole and ventricular fibrillation may result

6 yo MC Cat, Saddle Thrombus,
Hyperkalemia due to reperfusion
3 yr old FS Lab – collapsed Addisonian Crisis – Potassium 8.5

3 yr old FS Lab - post tx IV LRS, NaHCO₃