THE UNIVERSITY OF MELBOURNE

FACULTY OF VETERINARY & AGRICULTURAL SCIENCES

VETERINARY BIOSCIENCE: CARDIOVASCULAR SYSTEM

Larry Loses Heart

Case study wrap-up

August 3, 2023

Poor Performance in Horses

Larry Loses Heart

"Irregular rhythm with variable strength pulse"

- What determines heart rhythm?
- What determines the strength of the pulse?

“Irregular rhythm with variable strength pulse”

- What determines heart rhythm?
  - The sinoatrial (SA) node
  - The fastest pacemaker will set the rate for other tissues because it will depolarise other cells before they decay to threshold
  - Anatomically different conducting tissues have different decay rates to threshold

SA node > AV node > Bundle of His > Purkinje fibres

  - The rate set by SA node is referred to as SINUS RHYTHM

“Irregular rhythm with variable strength pulse”

Problem with generation of the action potential in pacemaker tissue

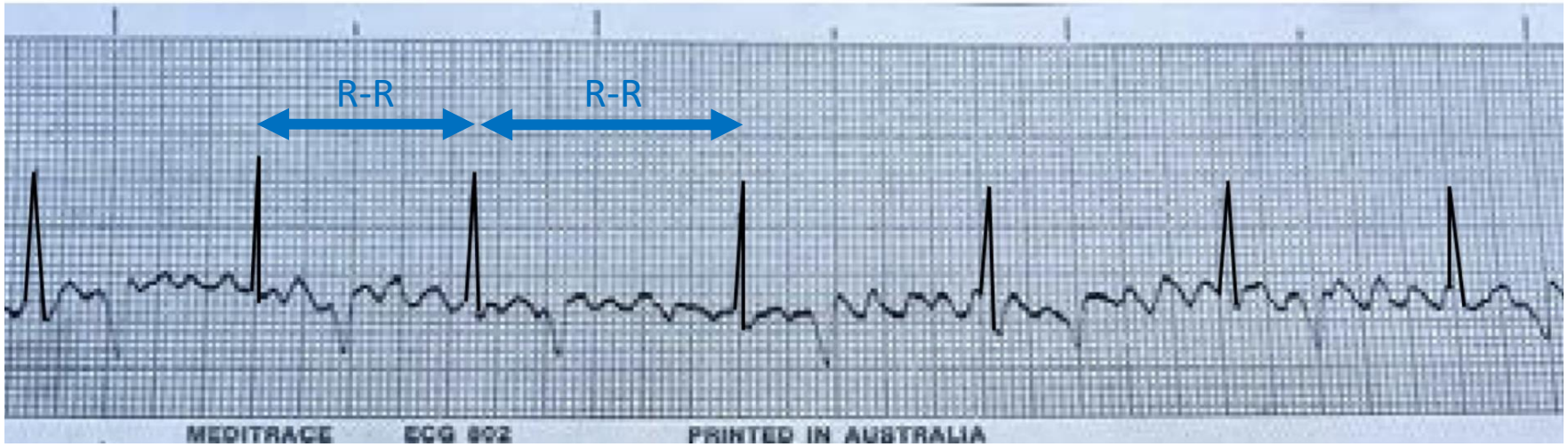
OR

Problem with conduction to the ventricles

How do we differentiate between these two possibilities?

Larry's ECG trace

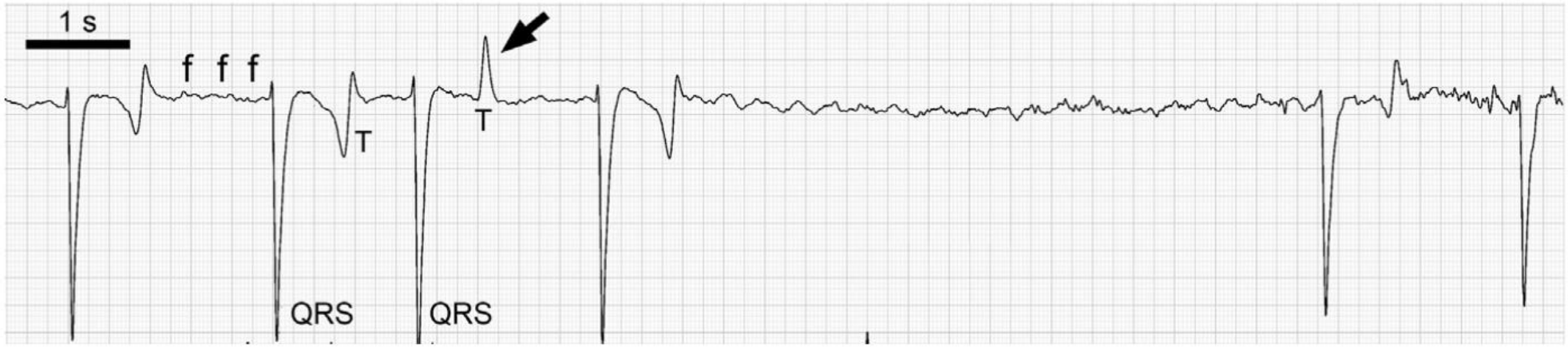
- Can you identify the R wave? Yes
- Is the R-R interval constant? No
- Can you identify a P wave? No
- Is every P wave related to a QRS complex? Well…
- Does the form of the QRS complex appear normal? Yes



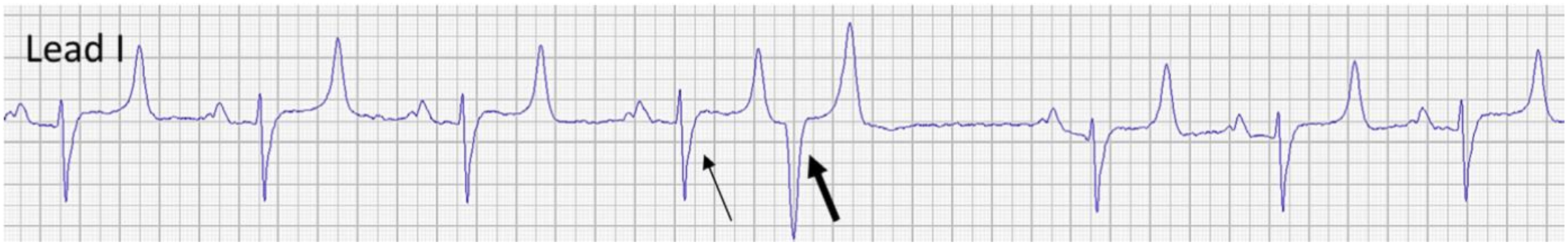
Larry's ECG trace

- Can you identify the R wave? Yes
- Is the R-R interval constant? No – irregular heart rhythm (beats / pulse)
- Can you identify a P wave? No – lack of synchronous atrial depolarisation
- Is every P wave related to a QRS complex? No P waves
- Does the form of the QRS complex appear normal? Yes – normal ventricular conduction / depolarisation

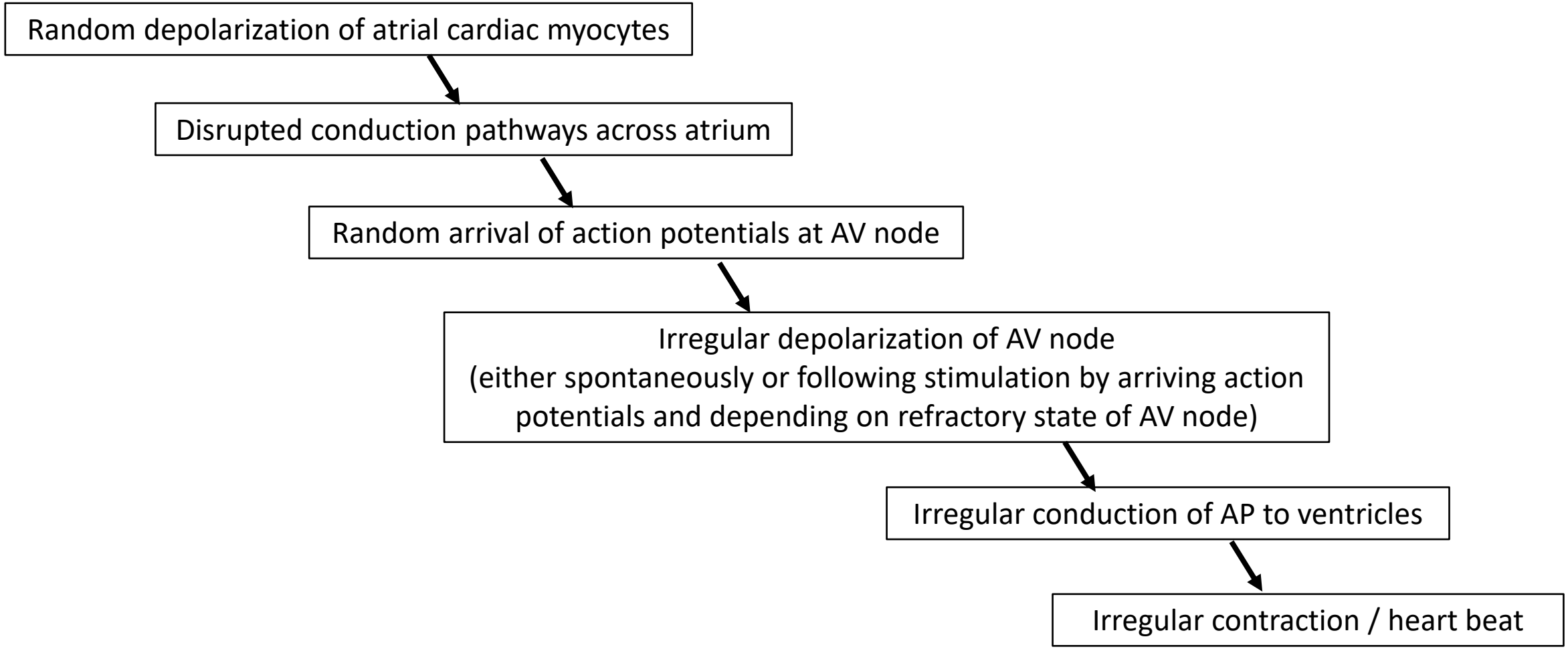
Atrial fibrillation (another case with more exaggerated example of inconsistent R-R interval)



Ventricular premature contraction (different QRS morphology when contraction originates within ventricle)

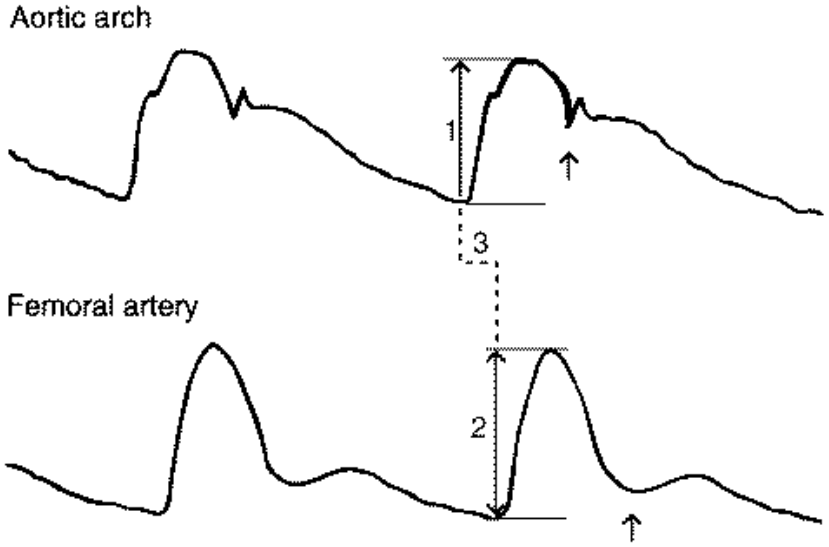


Why does atrial fibrillation result in an irregular heart rhythm?



“Irregular rhythm with **variable strength pulse**”

- What determines pulse strength?
  - The strength of the pulse we feel depends on the AMPLITUDE of the pulse
  - Pulse amplitude depends on STROKE VOLUME
  - So, what determines stroke volume?



Importance of ventricular filling

- Stroke volume = end diastolic volume – end systolic volume
  - i.e. the volume of blood ejected with each heartbeat

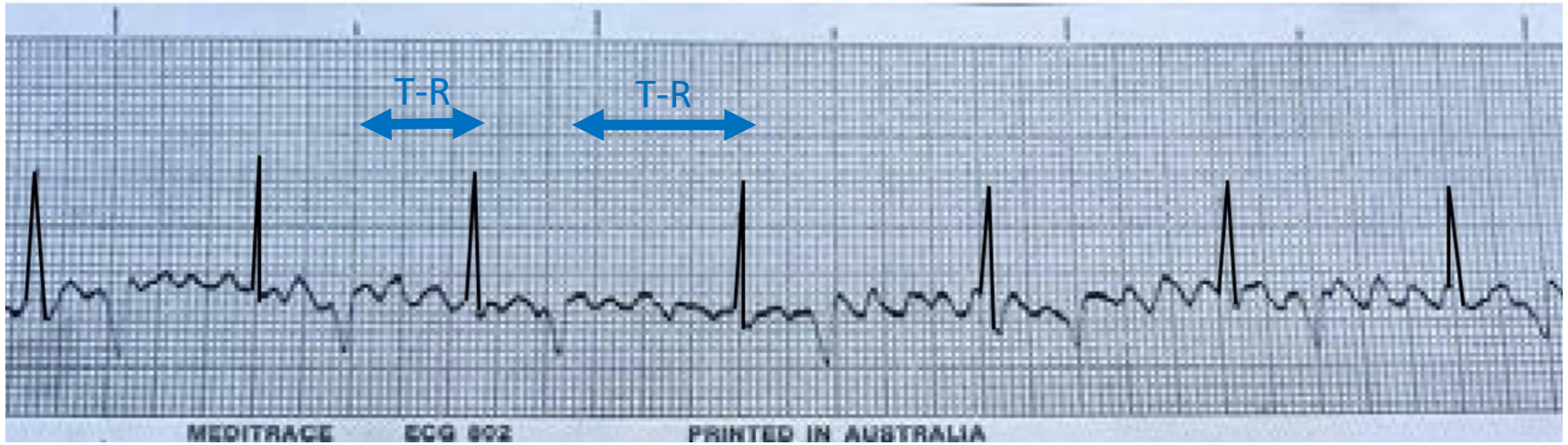
- To have appropriate stroke volume:

  - Adequate venous return
    - (Remember Case Study 1 and TRP)

  - Adequate filling time

  - Also remember: How does atrial contraction (atrial systole) contribute to ventricular filling – and when is this likely to become significant?

Importance of ventricular filling

- To have appropriate stroke volume:
  - Adequate venous return – not a problem with Larry
  - Adequate filling time – variable diastolic period (T-P / T-R interval)
  - 

Importance of ventricular filling

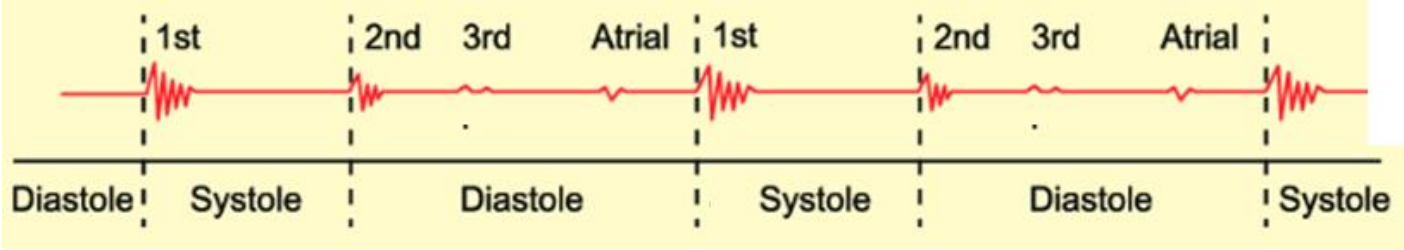
- To have appropriate stroke volume:
  - Adequate venous return – not a problem with Larry
  - Adequate filling time – variable diastolic period (T-P / T-R interval)
  - Contribution of atrial systole to ventricular filling
    - Very little at rest – mostly passive filling during ventricular diastole
    - Important part of ventricular filling during exercise – up to 25% contribution
    - CO = HR x SV
    - So, reduced stroke volume = reduced cardiac output = poor performance!

What is a pulse deficit?

- A heartbeat occurs but is not accompanied by a palpable arterial pulse
- This is different from saying “absence of a pulse” or “dropped beat”
- Pulse deficit occurs when ventricular filling time is shortened such that stroke volume is insufficient to generate a palpable pulse

Heart sounds

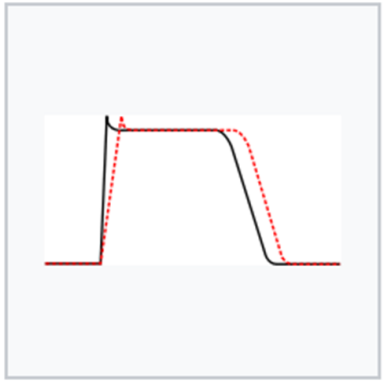
Sound	Aetiology
S1 **“<u>lub</u>** dub**”**	Closure of the AV valves
S2 **“**lub **<u>dub</u>”**	Closure of the semilunar valves
S3 **“**lub dub-**<u>da</u>”**	Rapid early ventricular filling
S4 **“<u>ba</u>**-lub dub**”**	Atrial contraction



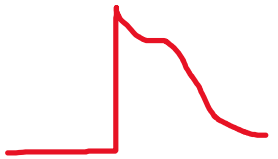
Horses vs. dogs

- AF in horses often occurs (and resolves) spontaneously – why?
    - Large heart size – more atrial mass to maintain / propagate AF
    - High vagal tone – increases spatial dispersion of cardiomyocyte refractoriness
- AF in dogs is the consequence of underlying cardiac disease
    - Cardiac remodelling / fibrosis

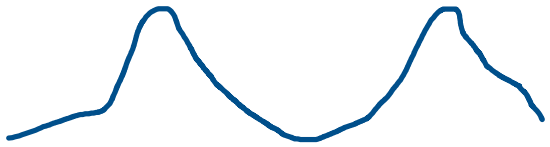
Treatment of atrial fibrillation



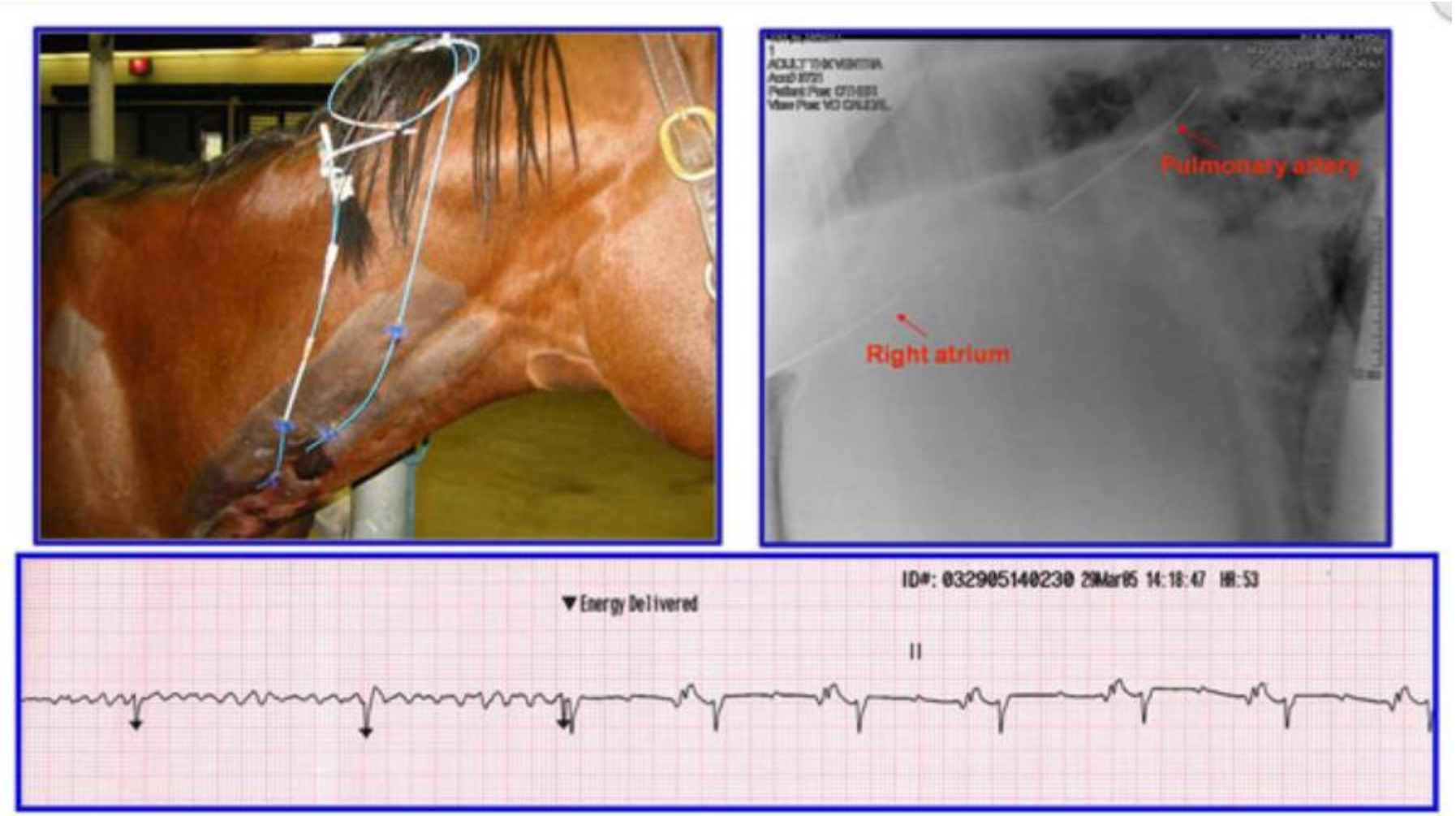
- What is the ionic basis of treatment with quinidine?
  - Quinidine blocks voltage gated sodium channels
  - Suppresses depolarisation of cardiac myocytes, in particular “rogue” or “ectopic pacemaker” cardiac myocytes that are generating the fibrillation



  - Quinidine will have no effect on pacemaker tissue – these cells lack VO Na channels – hence allowing pacemaker tissue to restore control of rhythm



Transvenous electrocardioversion (TVEC)



Weekly quiz

- To be completed by 11:59pm Tuesday August 8

- 16 questions worth 21 marks (MCQ, drop down menu)