Improved identification of racehorses at risk of arrhythmias and sudden cardiac death

UNIVERSITY OF MINNESOTA
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Grayson Jockey Club Vet Chat

February 10th 2022

Outline

- Review of the equine heart
- What we know about arrhythmias
  - Study overview
  - Research to identify horses at risk
- What we know about sudden cardiac death
  - Research to identify horses at risk

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The equine heart is one of the most efficient pumps of any species

thehorse.com


airtelfootball.ug/

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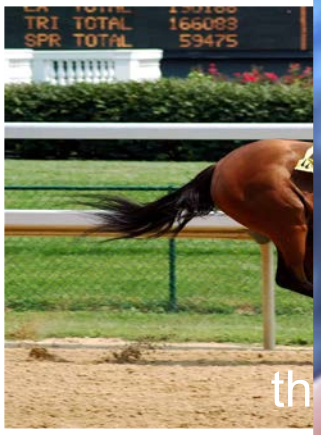
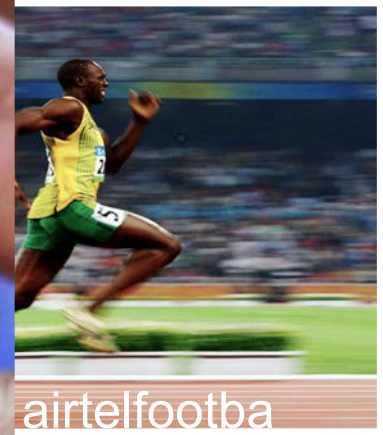
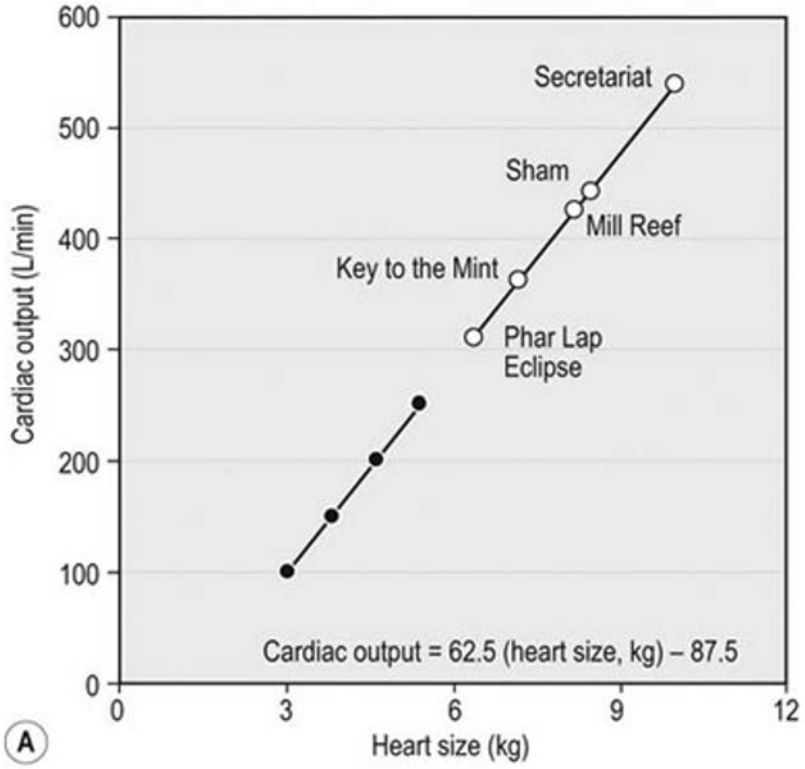


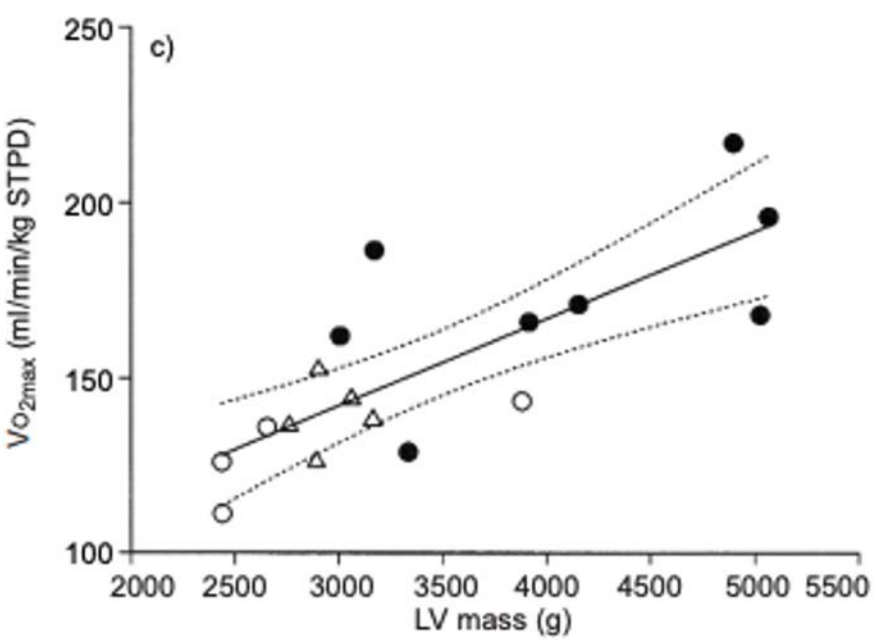


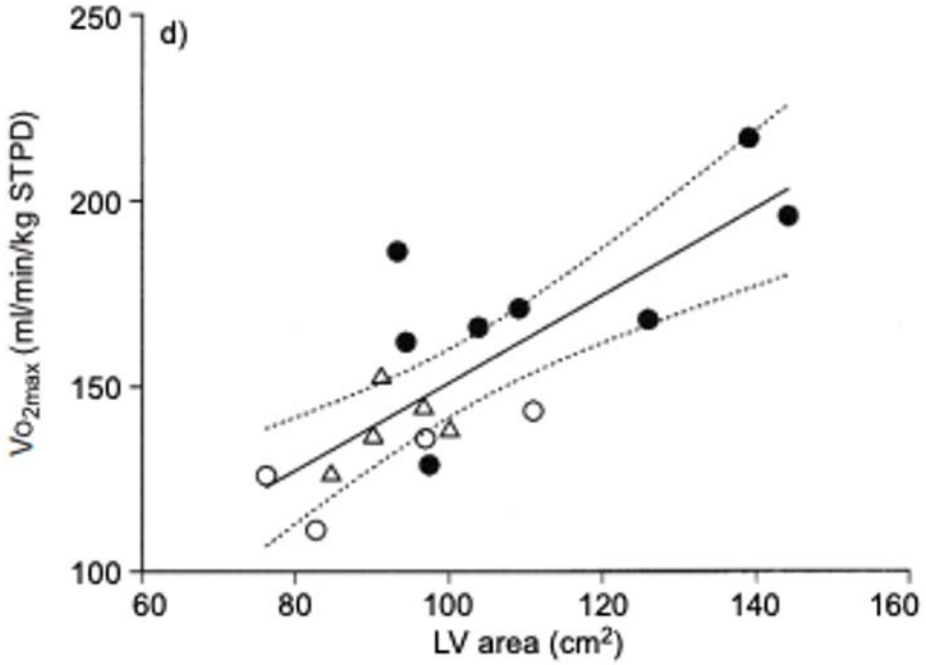
- Heart rate: 20 – bpm
- Cardiac output: – 100 ml/kg/min
- Aerobic capacity ~ 200 ml/kg/min
- Aerobic capacity ~ 40 ml/kg/min

The equine heart weighs ~ 1% BW



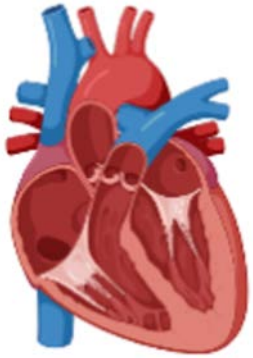
Evans and Rose. J. exp. Biol. 134, 397-408 (1988)





Young *et al*. Equine exercise physiology 6, Equine vet J. supp 24 (2002) 467-471

Upside of large hearts?



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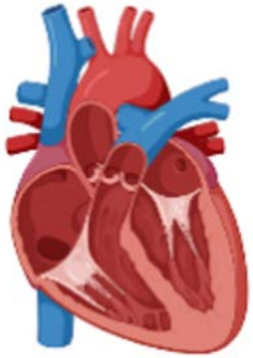

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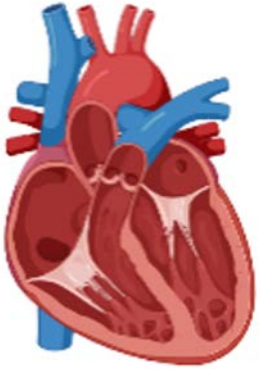
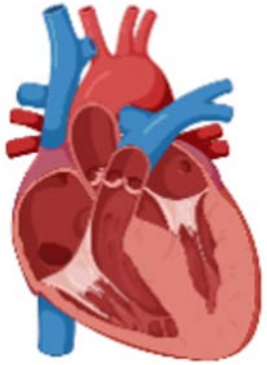
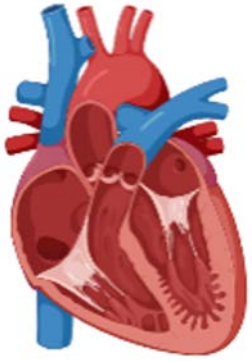


Dilated cardiomyopathy



Hypertrophic cardiomyopathy



Localized cardiomyopathy

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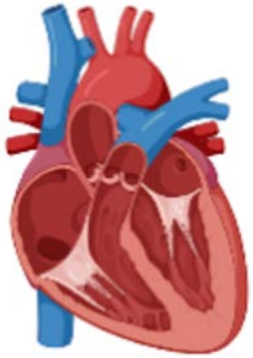

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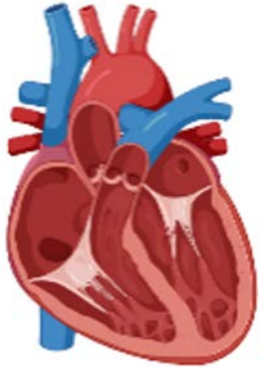

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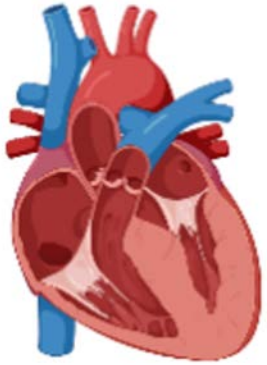

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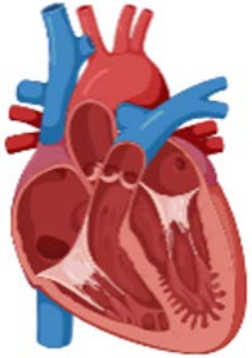

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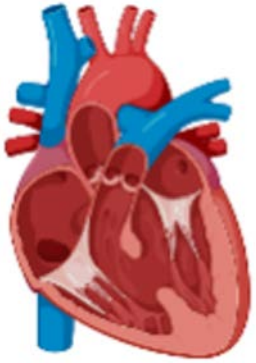
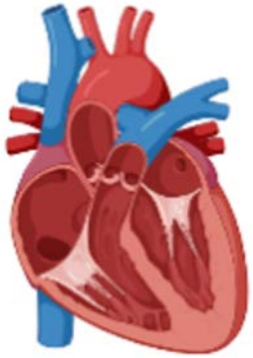


Ventricular septal defect

Upside of large hearts?



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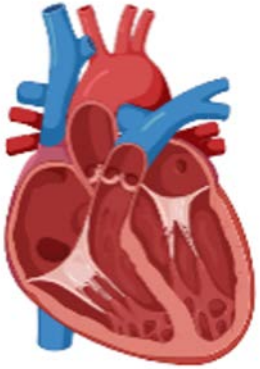

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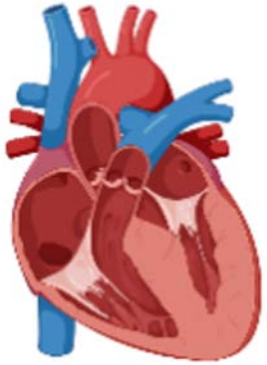

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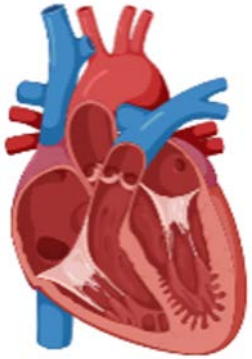

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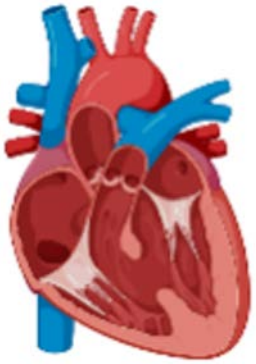

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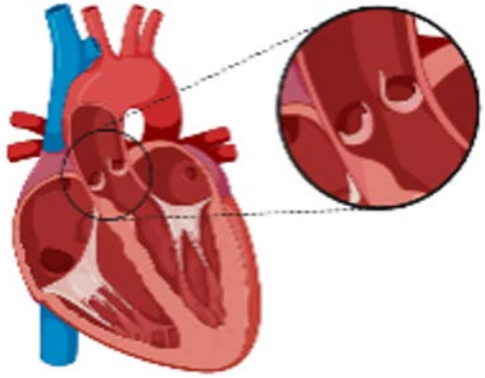
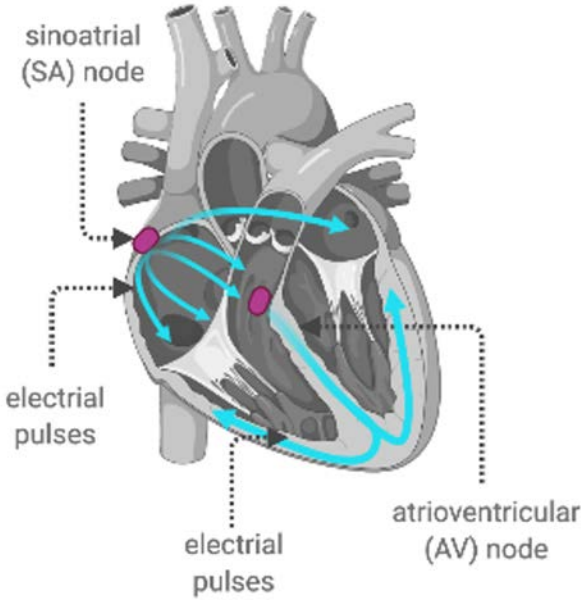
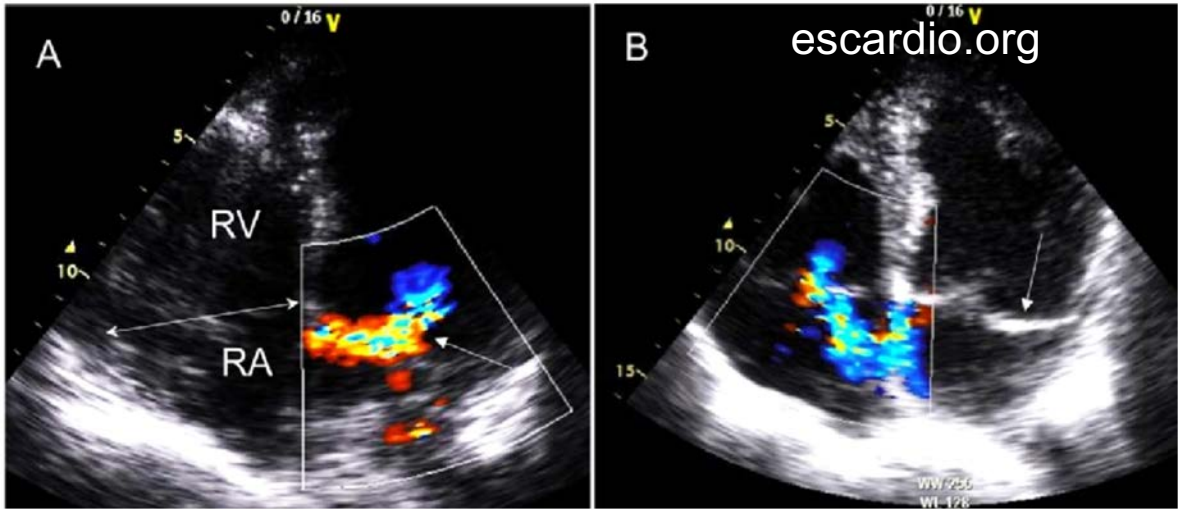


Aortic regurgitation

Downside of large hearts?





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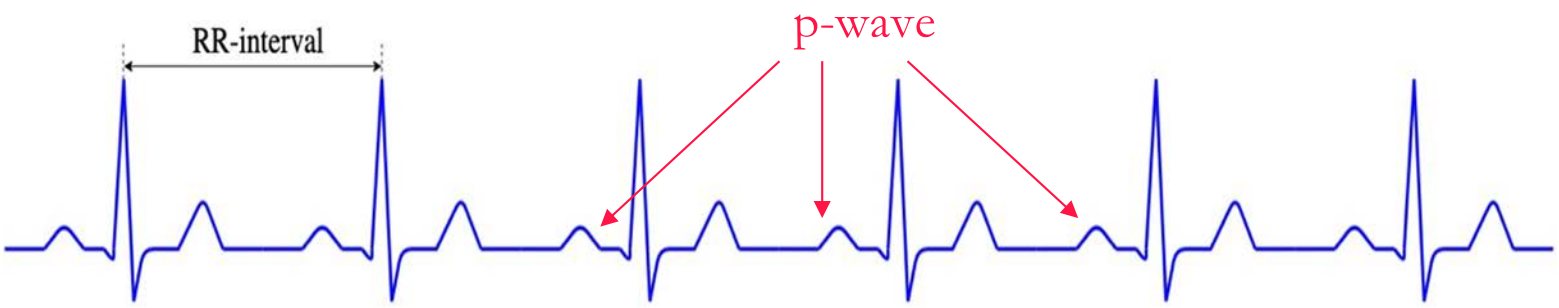
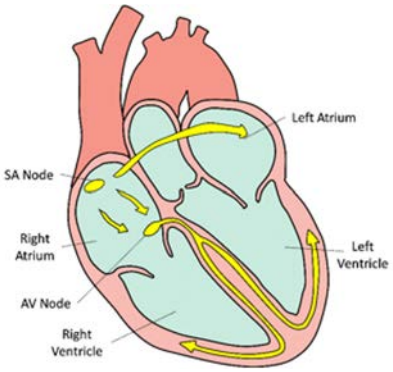
Arrhythmia detection using ECGs





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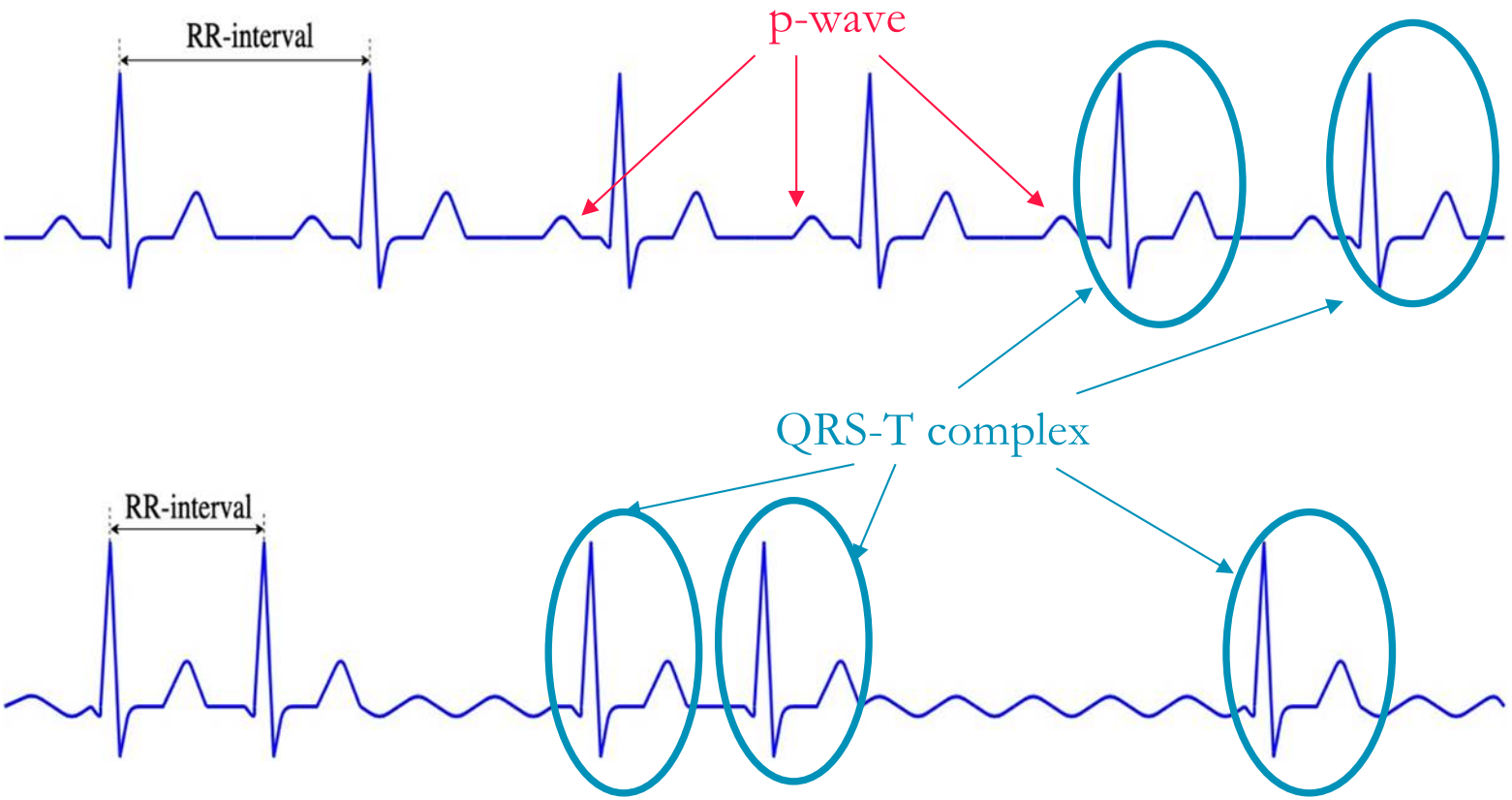
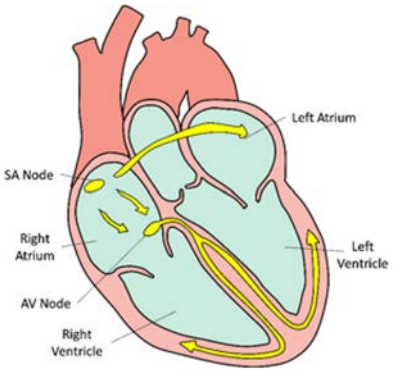
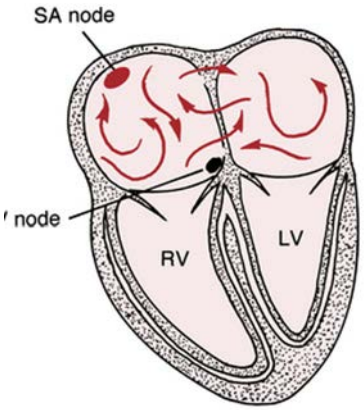






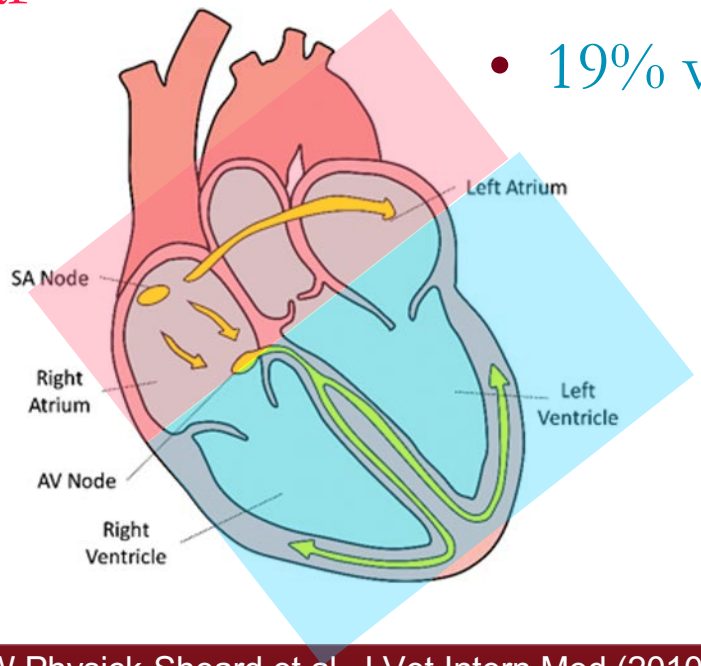
>20% racehorses have ventricular arrhythmias during/after exercise

Thoroughbred[1]

- 22% supraventricular
- 29% ventricular

Standardbred[2,3]

- 46% supraventricular
- 19% ventricular



1. N Ryan et al Equine Vet J. (2005), 2. PW Physick-Sheard et al. J Vet Intern Med (2010), 3. Slack et al. Equine Vet J. (2015)

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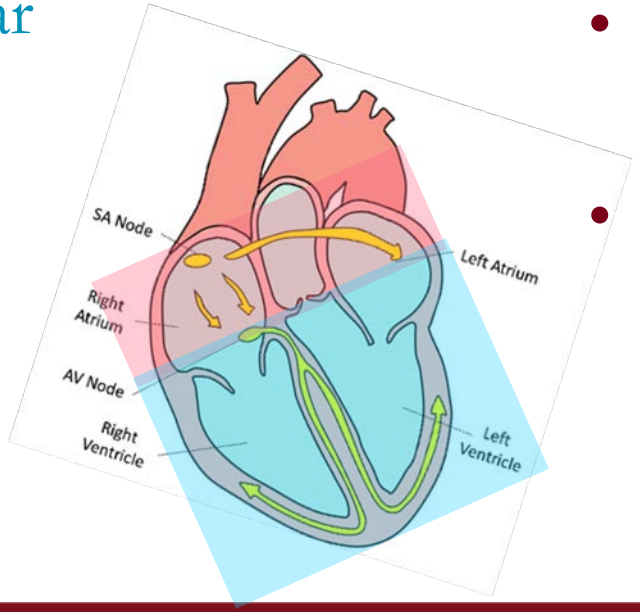
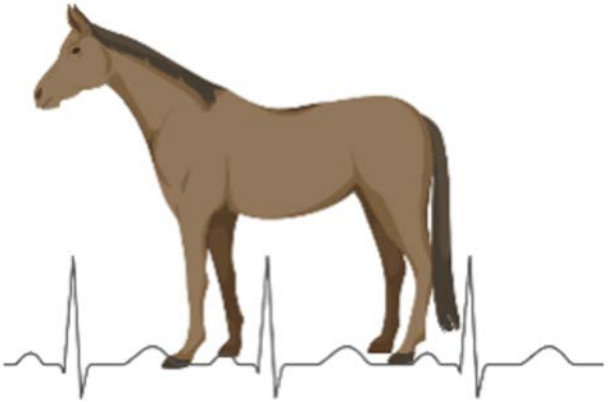


- 16% complex ventricular arrhythmias e.g. Torsades-like polymorphic ventricular tachycardia

1. N Ryan et al Equine Vet J. (2005), 2. PW Physick-Sheard et al. J Vet Intern Med (2010), 3. Slack et al. Equine Vet J. (2015)

Clinical significance of arrhythmias in racehorses?

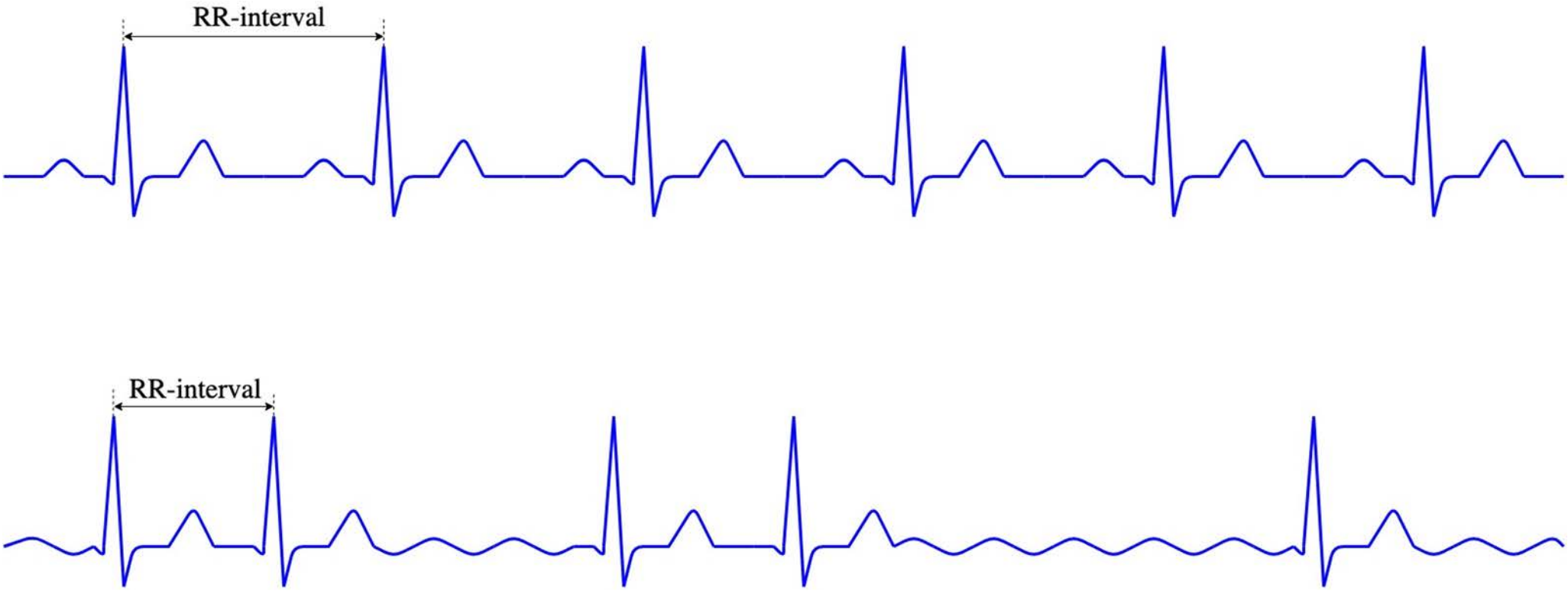
- ???
- Poor performance
- Sudden cardiac death



Cause of cardiac arrhythmias in racehorses?

- **Physiologic**
- **Lone (idiopathic)**
- Structural heart disease
- Metabolic/endocrine disorders
- Systemic inflammation
- Hypotension
- Toxicosis
- Drugs

Atrial fibrillation is the most common pathologic arrhythmia in horses.



Atrial fibrillation is the most common pathologic arrhythmia in horses

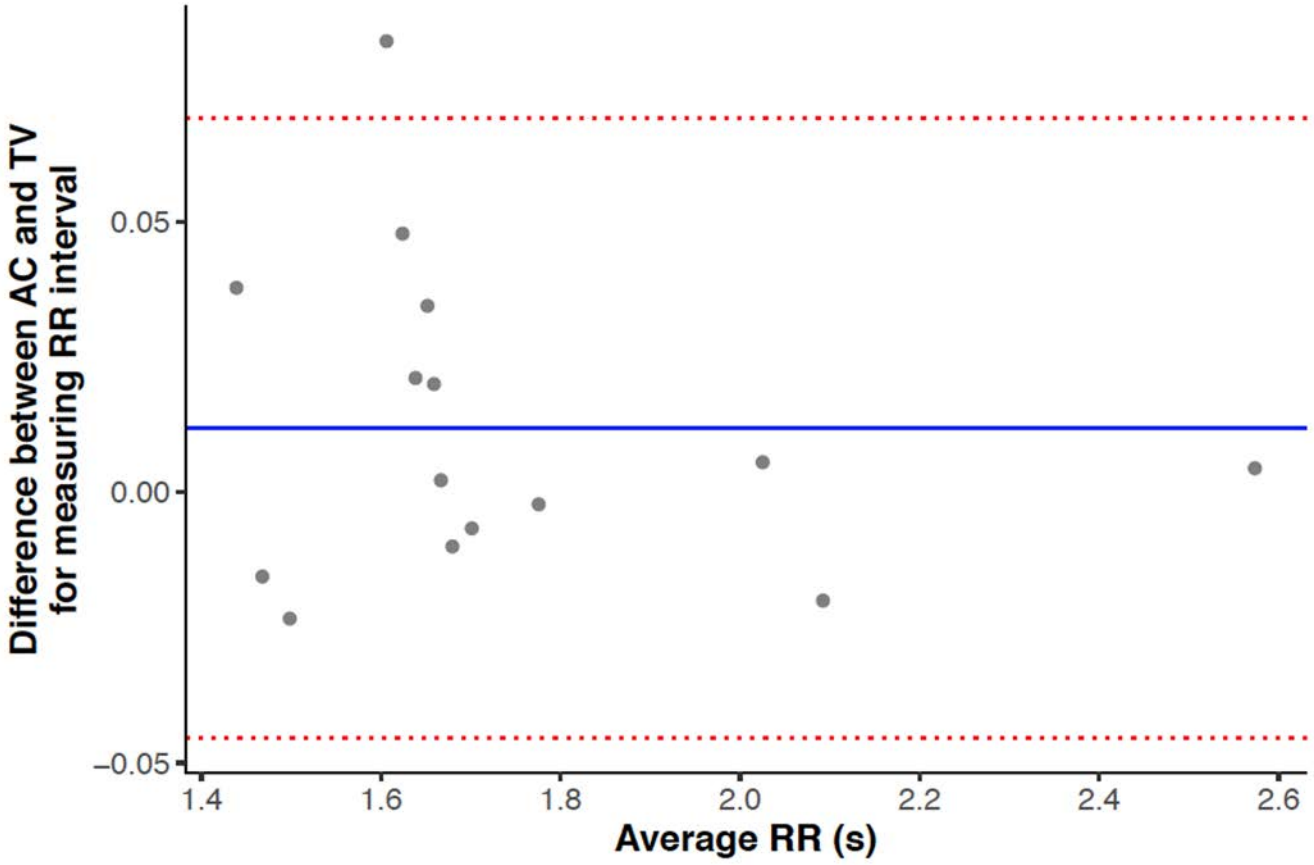
- •Horses with poor performance:
  - 1.2% Thoroughbreds[1]
  - 1.3 – 2.0% Standardbreds[2]
- Many horses spontaneously convert
- Difficult to predict when arrhythmia will occur

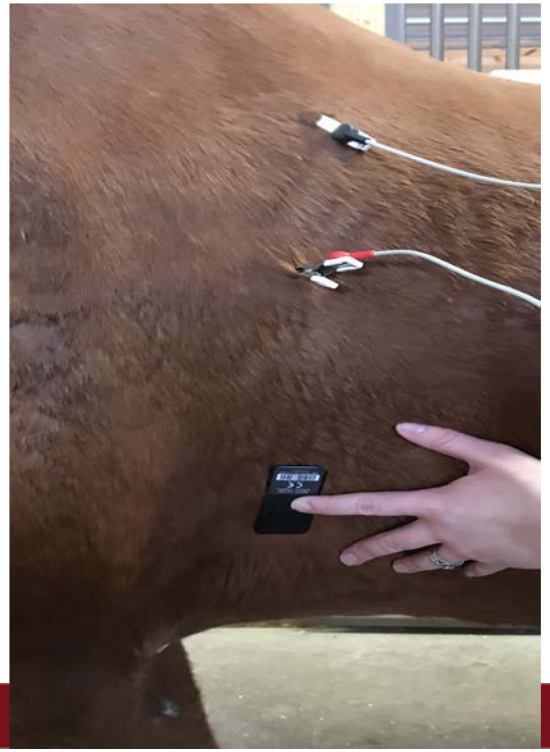
1. Ohmura et al. JAVMA (2003) 2. Slack et al. Equine Vet J. (2015)

Key questions about arrhythmias

- Which horses will develop arrhythmias?
  - ECG predictions
  - Genetics
- Which arrhythmias are important?
  - Poor performance
  - Clinical disease
  - SCD

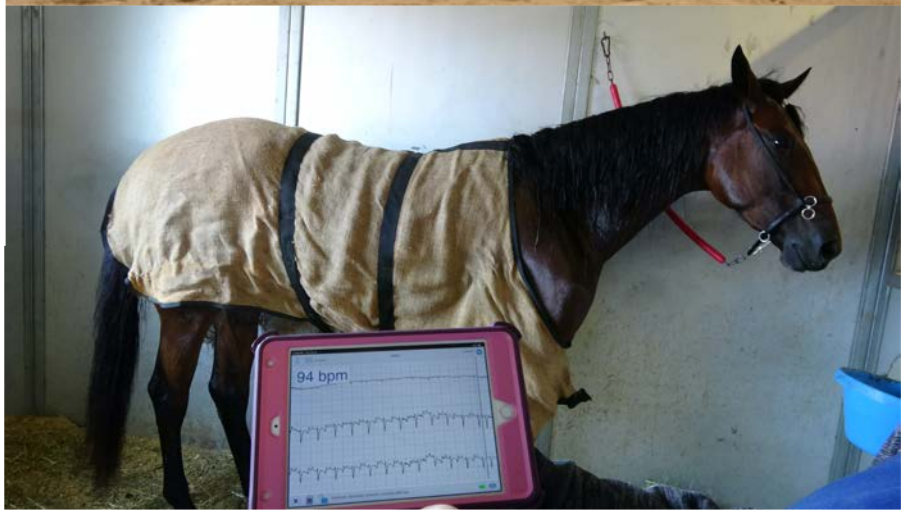
Electrocardiogram





B Welch-Huston *et al. Vet. Record* 2021

Electrocardiogram

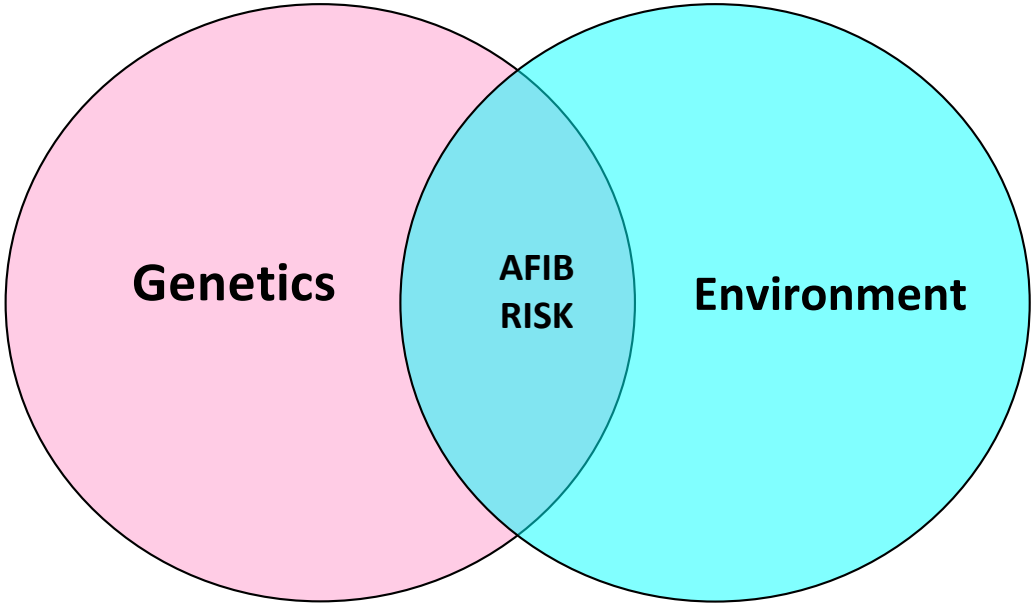


Echocardiogram

- Rule out primary structural heart disease
- Structural changes - easier to monitor but do not occur in lone arrhythmias

Genetics of atrial fibrillation

- 30% heritable in horses[1] and humans[2]



- Exercise-associated arrhythmias – highly heritable

1. M Kraus Equine Vet J. (2017) 2. LC Weng Cardiovasc Genet. 2017

Key questions about arrhythmias

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Outline

- Review of the equine heart
- What we know about arrhythmias
  - **Study overview**
  - **Research to identify horses at risk**
- What we know about sudden cardiac death
  - Research to identify horses at risk

Research to identify which horses will develop arrhythmias

- Cardiac exam on 1,000 racehorses
  - Auscultation
  - Electrocardiogram (ECG/EKG)
  - Echocardiography

- 100 horses with atrial fibrillation

Key questions about arrhythmias

- **Which horses will develop arrhythmias?**
  - **Genetics**
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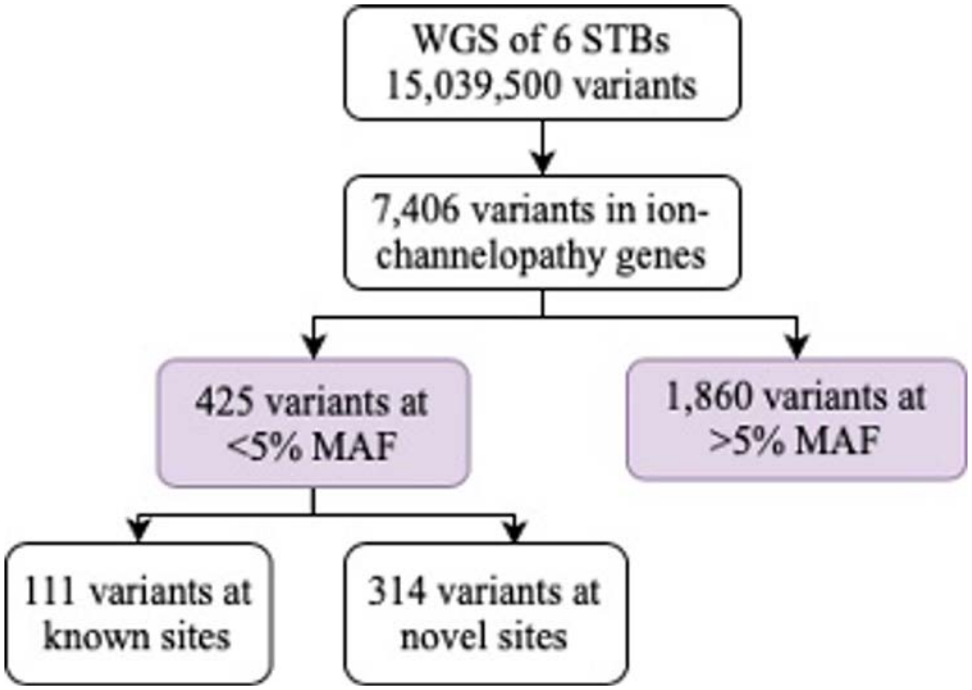
Identification of arrhythmia-causing variants

- WGS 6 Standardbred horses with familial AFIB
- Biologic candidate genes
- Amino acid positions associated with arrhythmias in humans
- 425 variants for follow-up



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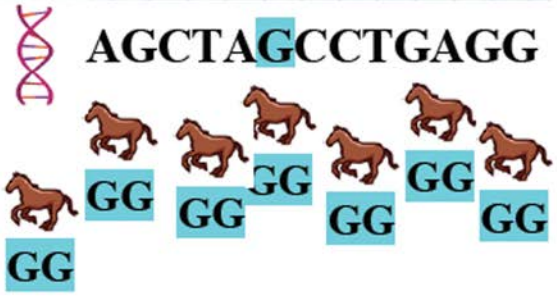
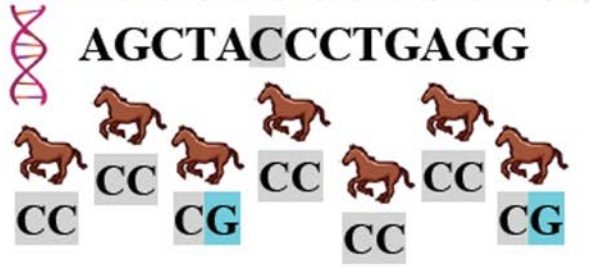
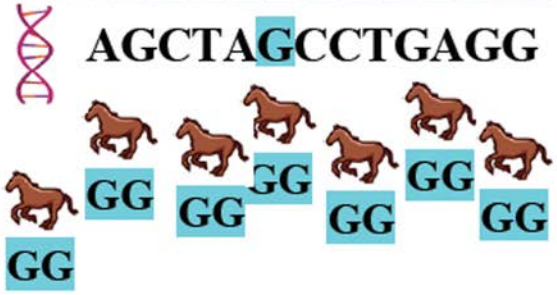
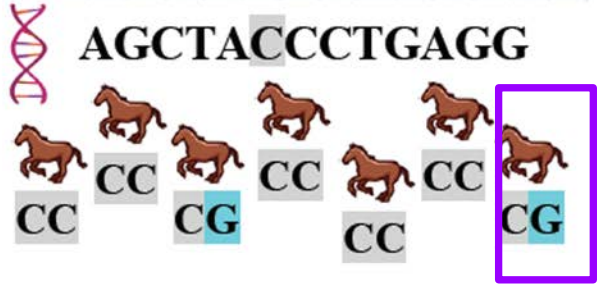




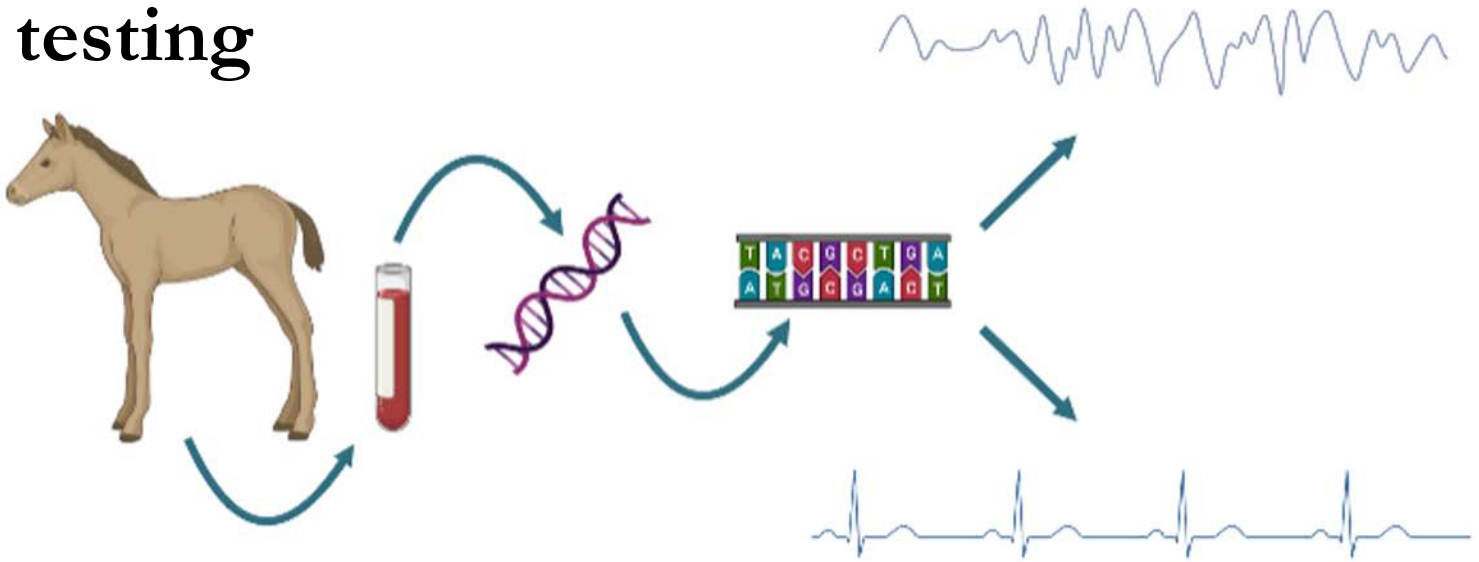
Identification of arrhythmia-causing variants





Advantages of knowing the underling variant(s)

Genetic testing



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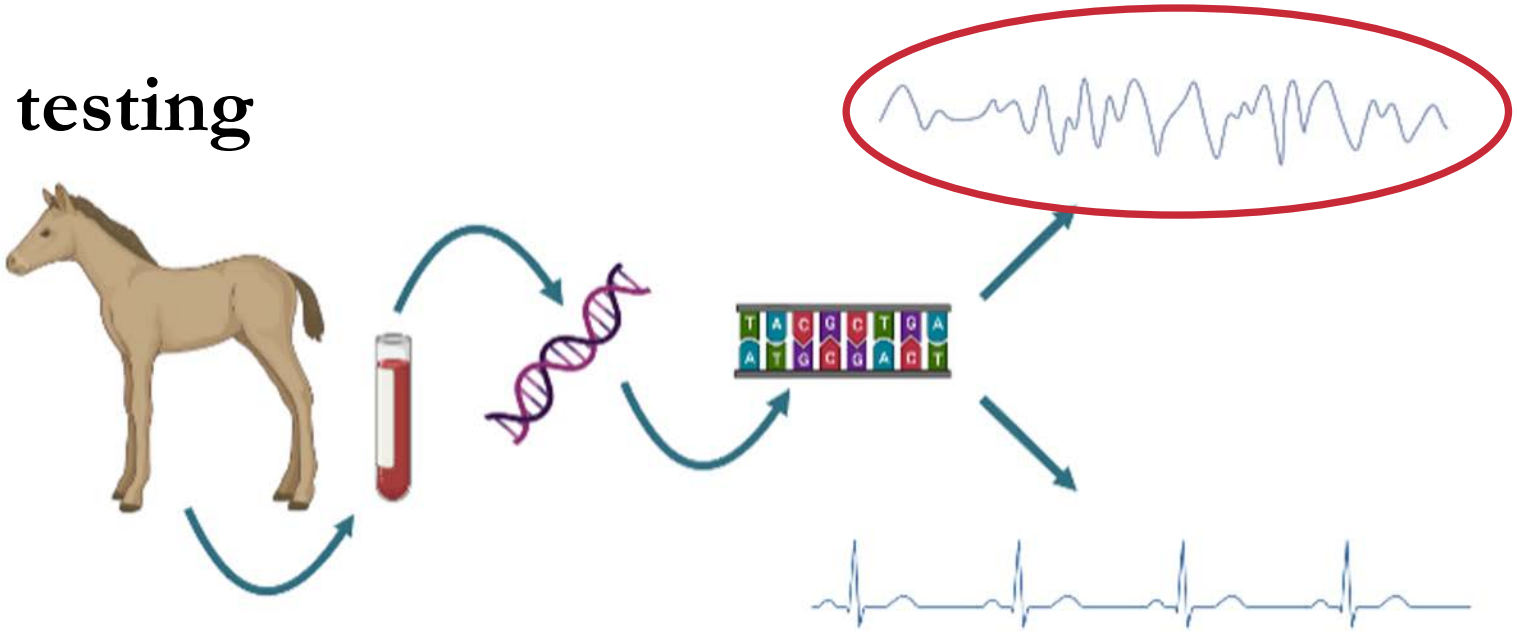


Advantages of knowing the underling variant(s)

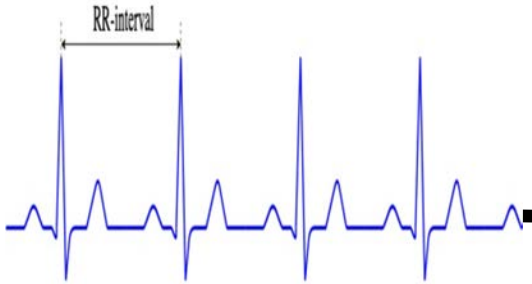
Increased screening

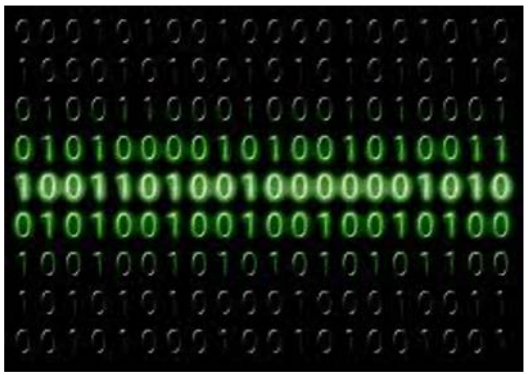
Educated breeding decisions

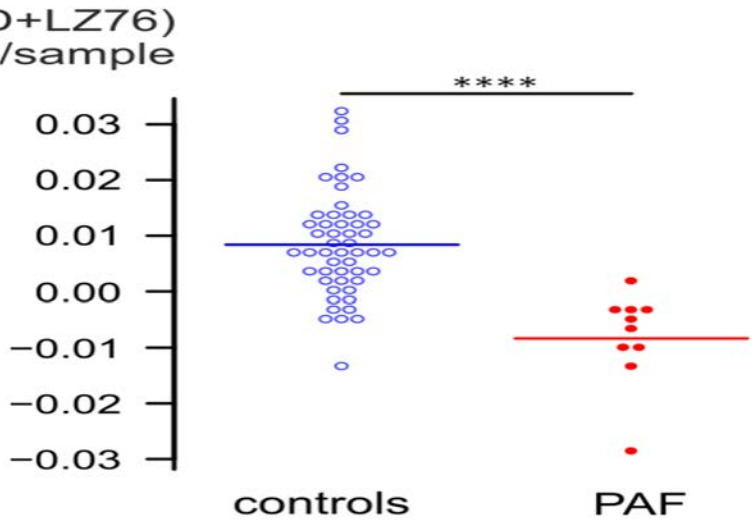
Key questions about arrhythmias

- **Which horses will develop arrhythmias?**
  - Genetics
  - **ECG predictions**
- Which arrhythmias are important?
  - Poor performance
  - Clinical disease
  - SCD

Identify horses that will get arrhythmias







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- Review of the equine heart
- **What we know about:**
  - Arrhythmias
  - **Sudden cardiac death (SCD)**
- EGGL research
  - Study population
  - ECG analysis
  - Genetics

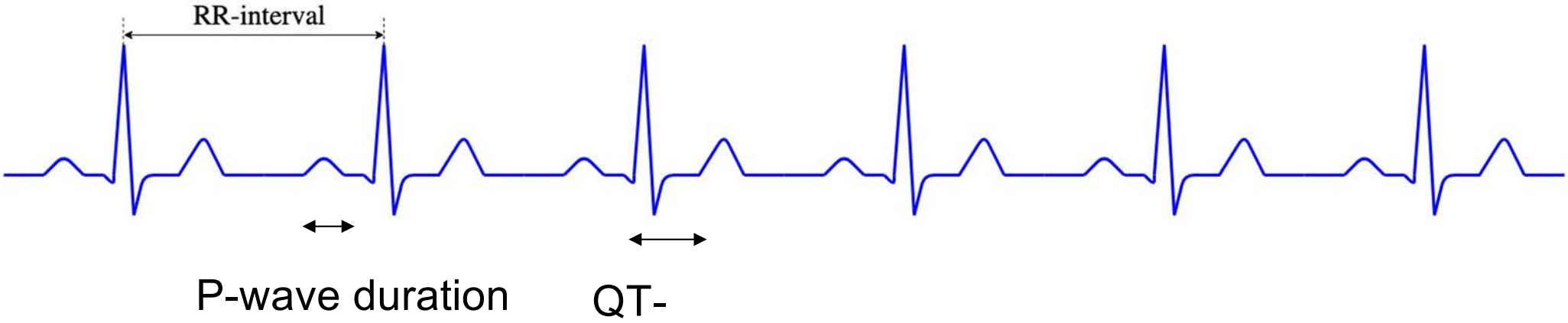
Sudden death is not common

- ~ 1.1 deaths in 1,000 starts[1]
  - 19% sudden death[1]
    - 47% have no diagnosis at necropsy[2]

- How many are caused by arrhythmias?

47% of sudden death necropsies reveal no underlying cause

- Arrhythmias are usually undetectable at necropsy
- Major issue!
  - How to determine what arrhythmias lead to sudden death?



Key questions about SCD

1. How often do arrhythmias lead to SCD?
2. Why do certain horses with arrhythmias develop SCD?
3. What can we do to stop arrhythmias developing into SCD?

Research to identify which horses will develop arrhythmias

- Cardiac exam on 1,000 racehorses
  - Auscultation
  - Electrocardiogram (ECG/EKG)
  - Echocardiography
- 100 horses with atrial fibrillation
- **100 horses with SCD**

How do this help us to answer these questions?

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← Improved identification of horses at risk of arrhythmias.

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Improved identification of horses at risk of arrhythmias

Increased monitoring of at risk horses.

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Improved identification of horses at risk of arrhythmias

Increased monitoring of at risk horses.

Identify risk factors for SCD

MINNESOTA RACING COMMISSION

ECGs and genetics on 500 TB racehorses

Advanced ECG analysis on 1,100 racehorses

Grayson-Jockey Club Research Foundation

GOAL: Reduce the rate of SCD

AAEP FOUNDATION

ECGs and genetics on 500 STB racehorses

Morris Animal FOUNDATION

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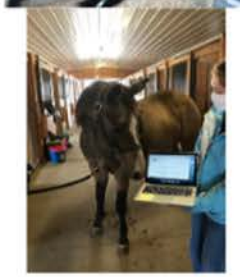
Advanced echocardiography analysis on 1,100 racehorses



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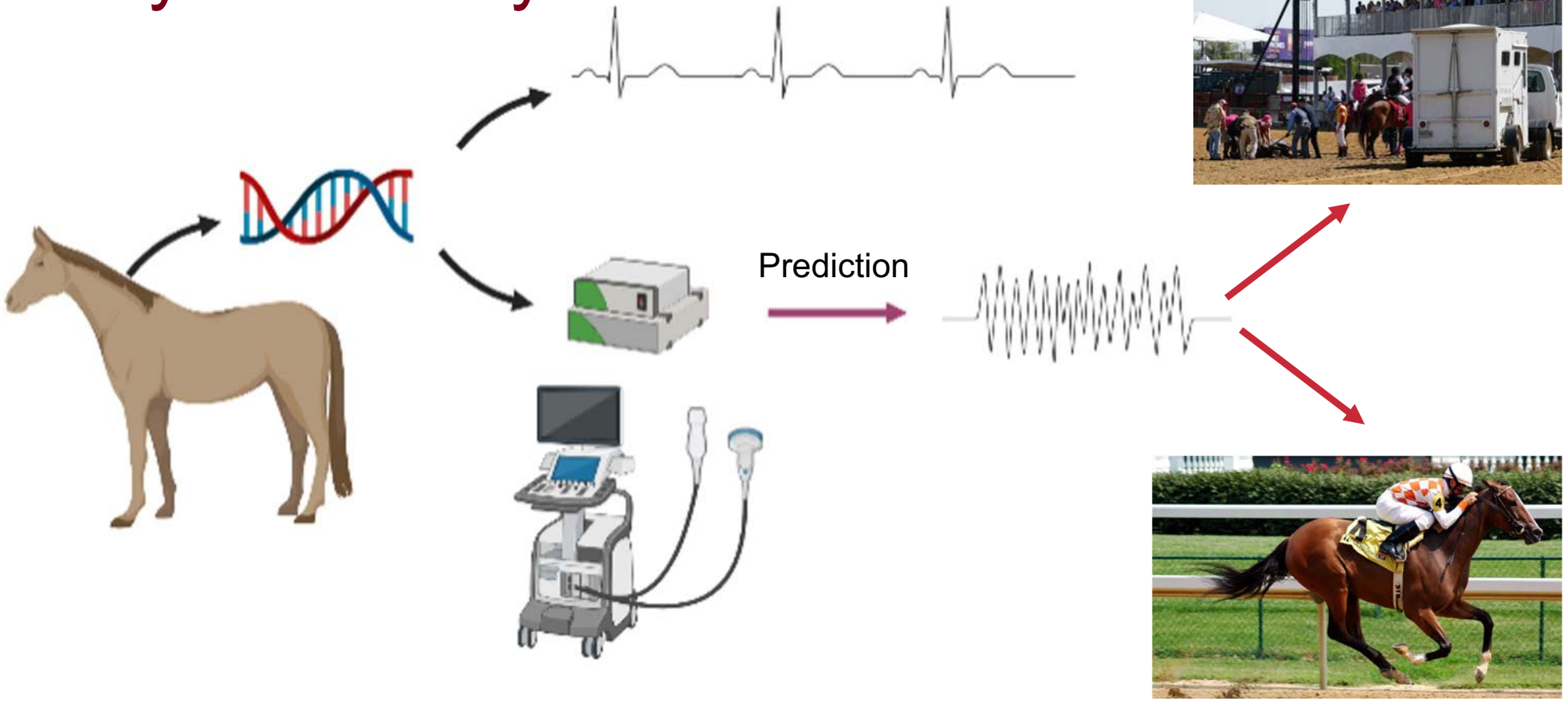
Key Takeaways



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