

Veterinary Bioscience: Cardiovascular System



WEEK 6 – SUPPORTING THE FAILING HEART

LECTURER: PROFESSOR KENNETH WILLIAM HINCHCLIFF

A graduate of the Melbourne Veterinary School, Kenneth is Dean of the Faculty of Veterinary Science at the University of Melbourne. After several years in practice in Victoria, he completed an advanced training program in large animal internal medicine at the University of Wisconsin-Madison, and a PhD at the Ohio State University. Kenneth was a faculty member in the College of Veterinary Medicine at OSU, rising to professor, before joining the University of Melbourne in 2007. He is a registered specialist in equine medicine and the author of over 150 peer-reviewed scientific publications, several scholarly books including the 9th and 10th (2006) editions of “Veterinary Medicine”, the first edition (2004) of “Equine Sports Medicine”, the 2nd edition of “Five Minute Veterinary Consult – Equine” (2009) numerous book chapters, and other scholarly works. Professor Hinchcliff’s research is focused on exercise science in horses, dogs, and humans.

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INTENDED LEARNING OUTCOMES

At the end of this lecture you should be able to:

- Describe the cardiovascular responses that occur at the onset of heavy exercise, particularly, in qualitative terms:
- Changes in cardiac output
- Changes in mean systemic arterial pressure
- Effect on ventricular filling pressures
- Changes in sympathetic and parasympathetic activity
- Explain the mechanisms underlying the increase in cardiac output during exercise
- Explain the effects of repetitive exercise (ie training) on:
- Resting heart rate
- Maximal cardiac output during exercise

KEYWORDS

Exercise, cardiac output, exercise training, sympathetic nervous system, blood volume

LECTURE 28 – CARDIAC RESERVE AND THE RESPONSE OF THE HEART TO PHYSIOLOGICAL STRESS (EXERCISE)

The lecture will consist of a participatory demonstration involving all those members of the class who wish to participate. Information obtained from the demonstration will be used to introduce and elaborate on the cardiovascular responses to physiological stress with an emphasis on understanding the cardiovascular responses to exercise (note – you will NOT be asked or required to undertake physical exercise during this lecture). The material contained in this lecture is based on previous lectures in cardiovascular physiology. The emphasis of the lecture will be on understanding the integrated, cardiovascular responses to physiological stress as demonstrated by gravitational stress.

KEY CONCEPTS:

Responses to exercise can be categorised as:

- central command – activation of the sympathetic nervous system by the brain (ie central) to increase heart rate, contractility and peripheral vasoconstriction
- reflexes that originate in contracting skeletal muscle – tension and stretch receptors and chemoreceptors (pH, PCO₂, etc) in muscle cause vasodilation in response to local stimuli (contracting muscle),
- baroreceptor reflex – Sympathetic stimulation causes increased peripheral vascular tone (in most vascular beds) and in particular increases in tone in venous capacitance vessels (increased venous return) and resistance vessels (arterioles – increased blood pressure).

Exercise causes an increase in heart rate, contractility and cardiac filling pressure, which together result in an increase in cardiac output.

Repetitive exercise results in adaptive changes that are apparent at rest:

- Decreased resting heart rate (why?)
- Increased blood volume.
- Lower mean systemic arterial pressure
- Differential effects on cardiac hypertrophy – endurance exercise vs weight lifting.

FURTHER READING

Berne RM, Levy MN, et al. Physiology 5th edition. 2004. Interplay between central and peripheral factors in the control of circulation. Pages 433-437.