

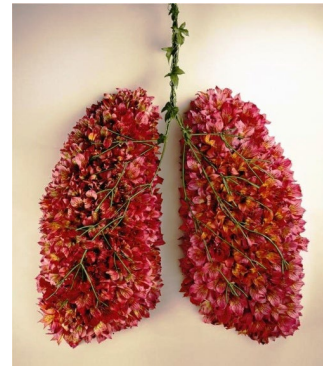
2022 Jim Steere Memorial Veterinary Student Scholarship Runner Up

Patrick Crannell

Michigan State University College of Veterinary Medicine Class of 2022



Patrick is a 4th year veterinary student with an interest in general large animal medicine. During his veterinary school training, he spent considerable time in both applied research of herd health and general practice for the equine practitioner. Endurance sports are a personal passion of his and he is particularly interested in the physiology of endurance training as is evident by this essay topic.



Healthy Lungs

Endurance exercise depends on cardio-respiratory fitness. Fitness depends on how much oxygen can be consumed to meet the muscle's needs for oxygen. A human Olympian athlete that engages in aerobic exercises such as marathons, cycling or Nordic skiing, as a few examples, can maximally consume 80ml/kg/min of oxygen. The horse however can consume 200 ml/kg/min of oxygen and run at speeds in excess of 30 miles per hour. To accomplish the oxygen demands of such intense exercise, the horse's minute ventilation will increase from 60 L/min to 1800 L/min, a 30-fold increase. Meeting these ventilation demands is further aided by higher airflow rates through diaphragmatic contractions. It may come to no surprise then that the horse becomes exercise limited by its lung rather than the heart, like it is in other athletic animals. If the horse's lungs are not properly functioning, then peak performance becomes jeopardized. Sometimes, a horse may not give any clues about an underlying disease because when at rest, the horse acts normal and is breathing comfortably. It is only until the lungs are being challenged and more alveoli are recruited for consuming oxygen that pathology may become suspect.

One particular way that gas exchange becomes compromised is through inflammation. Inflammation is nefariously good. It is necessary for healing and protecting, but it can also create harm. Within the lungs, inflammation will cause constriction of the airways, mucus accumulation/edema, tissue damage and fibrosis. Inflammatory airway disease is a well-recognized problem among performance horses characterized by an increase in tracheal mucus and neutrophilic inflammation in the lower airways (bronchi and bronchioles). Recent research suggests that horses with mild to moderate tracheal mucus accumulation perform worse than horses without mucus; horses with a mucus score of 0 – 1 were twice as likely to place better in a race than horses scoring 2 – 4.



This relationship is best explained through physiological measurements as mucus accumulation will impair gas exchange. Impaired gas exchange results in lower arterial PaO₂, higher heart rates and higher blood lactate concentrations. The ventilation-perfusion mismatch that occurs from inflammation will limit ventilation and reduce athletic performance.

Why do the lungs become inflamed? Environmental insults appear to be the likely etiology. Poor ventilation, aerosolized particles, inorganic dust, noxious gases, bacteria, molds or even endotoxin are all triggers for inflammatory airway disease. Depending on how long a horse is breathing within an antigenic environment is another component to this multifactorial disease complex. In asthmatic humans, clinical signs and bronchoconstriction are seasonally related and exacerbated by high exposure to pollen and aeroallergens. In one study, horses breathing organic dust had increased number of cells, histamine release and airway resistance within 20 minutes when compared to horses breathing fresh air. The risk for developing inflammatory airway disease then increases with how long a horse is housed in a dusty, indoor environment.

While the pathogenesis may be difficult to define, the treatment is simple in theory but sometimes difficult to implement in practice and that is, improve air quality. Methods to do so include soaking hay or wetting dusty grain before feeding. Feeding hay from the ground and not from a hay net. Preventing stored hay dust from trickling down on horses by laying a tarp underneath the hay. Wetting aisle ways before sweeping, or removing horses from the barn while cleaning stalls, moving hay or removing cobwebs and/or other dust collectors. Modifying a horse's environment is often the primary treatment choice for reducing the risk of lower airway inflammation. For horses that do not respond favorably to improved air quality more aggressive treatments such as non-steroidal anti-inflammatories, corticosteroids, antimicrobials or nebulization therapy are warranted.

In summary, the horse is a spectacular athlete with a superior cardiorespiratory system to other athletes. Any small changes however that impact lung function can result in poor performance of a superior athlete. Protecting the horse's lungs from inflammation is essential if we want to practice good horsemanship and participate in events or competitions that are designed for healthy lungs.

References:

Couëtil LL, Hoffman AM, Hodgson J, et al. Inflammatory airway disease of horses. *J Vet Intern Med.* 2007;21(2):356-361. doi:10.1892/0891-6640(2007)21[356:iadoh]2.0.co;2

Deaton CM, Deaton L, Jose-Cunilleras E, et al. Early onset airway obstruction in response to organic dust in the horse. *J Appl Physiol (1985).* 2007;102(3):1071-1077. doi:10.1152/jappphysiol.00264.2006

Holcombe SJ, Robinson NE, Derksen FJ, et al. Effect of tracheal mucus and tracheal cytology on racing performance in Thoroughbred racehorses. *Equine Vet J.* 2006;38(4):300-304. doi:10.2746/042516406777749191

Ivester KM, Couëtil LL, Moore GE. An observational study of environmental exposures, airway cytology, and performance in racing thoroughbreds. *J Vet Intern Med.* 2018;32(5):1754-1762. doi:10.1111/jvim.15226