USEA Cardiopulmonary Research Group
Summary of Activities
Prepared by Catherine W Kohn VMD

**History**: In 2008, in response to the troubling occurrence of fatalities among horses competing in Horse Trials and Three-day events in the North America, the USEA formed the Cardiopulmonary Research Group (CPRG). The CPRG is composed of members of medical professions, including veterinarians, physicians and an EMT, who are united in their interest in advancing horse welfare through scientific investigation.

**Summary of Findings**: Based on a review of the literature on sudden death in human athletes, we concluded that cardiovascular and/or pulmonary (lung) compromise were likely causes of sudden death in exercising horses. We therefore focused our efforts on assessing the frequency of inapparent (occult) heart/lung disease in eventing horses. To date we have undertaken a number of field studies (briefly summarized below). Results of these pilot studies are the basis for our current hypothesis that horses may develop transient cardiac arrhythmias while on the Cross Country, and that, in some instances, these arrhythmias may compromise exercise tolerance and could lead to falls, injury or fatalities. Studying this hypothesis requires us to have a reliable means of recording exercising ECGs in competing horses, during warm up, the Cross Country and the first 10 minutes of the recovery period. Development of a suitable "on board" monitoring system remains our highest priority. We have had some promising prototypes, but have not yet perfected a reliable system. Our most recent study was in August of 2014, at Waredaca Horse Trials, where we were very pleased to record 8 interpretable exercise ECGs. We will continue to test our recording devices during the 2015 competition season. Eventually we will need to record ECGs during exercise in a large number of horses in all levels of competition.

**Studies of Horse Fatalities during Competition**: The USEA has taken a leadership role in obtaining autopsies of horses that die during competition. This is an extremely important aspect of our studies. We can learn a great deal from these most unfortunate losses. What was the cause of death? Did a fall occur because of underlying heart or lung disease? These are the sorts of questions that we try to answer. We cannot overemphasize the importance of autopsies and we urge owners/riders to support our efforts to insure that an autopsy is performed on every horse that dies during a competition.

**Thank you**: Our work would not be possible without the support of owners, trainers, riders and grooms. We are grateful that you volunteer to partner with us. Most of all, we thank our equine "co-investigators".

**Brief Summary of Studies to Date**

1. Research Questions: Is there evidence of inapparent (occult) heart or lung disease in event horses at rest or immediately following completion of the Cross Country course?
    a. Rationale: Although many horses are examined immediately prior to competing, either by their home veterinarian or at the competition, and by veterinarians at the event following the cross country, it is possible that occult heart or lung disease might not be evident on simple auscultation (listening to the heart and lungs with a stethoscope).
    b. Research Design: Ultrasonography and echocardiography of the lungs and heart respectively at rest and immediately following the Cross Country test at a competition. Study population: volunteers
    c. Results
        1. No sonographic evidence of lung disease at rest or following the cross country test in 20 horses.

2. No echocardiographic evidence of heart disease at rest or following cross country in 20 horses.

d. Limitations and Relevance to Mission

1. This is a pilot study with a small number of horses. The study is not large enough to predict the risk of occult disease in the general population of competing horses.

2. In this study auscultation and sonographic findings were concordant, suggesting that auscultation *infrequently* results in false negative testing (that is, predicts the absence of cardiopulmonary disease when disease is actually present).

e. Follow up: A large scale study of horses competing at varying levels is required to more accurately estimate risk of occult heart and lung disease in the general population of eventing horses.

2. Research Question: How frequently do event horses display heart arrhythmias at rest and immediately following the Cross Country?

a. Rationale: Although many (but not most) horses undergo heart auscultation at rest before competing, and immediately following the cross country (D Box), these examinations might miss some arrhythmias.

b. Research Design: Record ECG at rest and immediately following the Cross Country in competing horses. Study population: volunteers.

c. Results:

1. 233 horses were assessed at rest. Atrial premature contractions were documented in 3 horses (1.3%).

2. 142 horses were assessed following the Cross Country. We documented atrial premature contractions (APCs) in 1 horse (0.7% of horses tested) and ventricular premature contraction (VPCs) in 3 (2.1% of horses tested).

d. Limitations and Relevance to Mission

1. This is a small study population that may not reflect findings in a representative larger population.

2. APCs may be seen at rest in fit, healthy horses, and they are of no clinical significance if not seen during exercise and there are no signs of heart disease.

3. Although documented in only 3 percent of horses we studied, the presence of APCs or VPCs, (performance-limiting arrhythmias) immediately after high intensity exercise warrants further investigation.

e. Follow up: Study many more horses. However, we are hoping to perfect our device for on-board ECG monitoring that would give us exercising as well as pre and post exercise heart rhythms.

f. The AliveCor ECG device and App for the iPhone makes it possible to perform a field ECG anywhere that one has a cell phone signal. We recommend that veterinarians working at Horse Trials and Three-day events purchase the recording device. (The App is free). We performed ECGs on 38 event horses at rest at a competition using the AliveCor App. We identified one horse with Atrial Fibrillation. The arrhythmia was evident on auscultation and confirmed using the iPhone. The owner was unaware of the problem and the horse had a history of not performing well. This case demonstrates the utility of using the iPhone App, and illustrates the potential importance of pre competition auscultation. We also performed ECGs on a few horses immediately following the cross country. We identified an irregular heart rhythm in one horse with a history of irregular cardiac rhythm during exercise. While the arrhythmia was compatible with atrial fibrillation on auscultation, the iPhone ECG demonstrated the presence of P waves, and very helpfully ruled out the diagnosis of Atrial Fibrillation. We note that the iPhone ECG electrodes will not always record useful ECGs when horses are breathing hard and consequently have large excursions of the chest wall. A simple modification of the device allows one to make good quality ECG recordings.

3. Research Question: How often do horses develop transient or persistent arrhythmias while competing?

a. Rationale: Transient or persistent arrhythmias during the Cross Country could be performance-limiting and could lead to falls and fatalities.
b. Study Design: Fabricate a device that will allow us to record the horse's ECG at rest, during the warm up, while on the Cross Country and during the initial phases of the recovery period. The device must not interfere with horse or rider. This technology is not available commercially.
c. Results: We have tried 5 designs, with the most recent 2 designs giving us our best results so far. Further design modifications are being undertaken.
d. Limitations and Relevance to Mission
    1. The design problem is challenging.
    2. Results are highly relevant to mission.
e. Follow Up: More pilot studies of our newest prototypes.

4. Research Question: Could competing horses have exercise induced-heart muscle damage that could limit performance or lead to sudden death?

a. Rationale: Primary damage to the myocardium (heart muscle) could lead to sudden death.
b. Study Design: Evaluate cardiac troponin I (cTnI) at rest and following the Cross Country test.
c. Rationale: cTnI is released when the myocardium is damaged. This compound is used for assessment of heart damage due to myocardial infarction in humans.
d. Study Design: We collected blood samples from competing horses at rest and after completion of the Cross Country. We compared cTnI concentrations following exercise to the baseline concentration before exercise.
e. Results
    1. No evidence of cardiac disease, lameness or concurrent illness in any horse studied.
    2. We tested 80 upper level horses (53 at CCI4* or 2010 WEG) at 3 total competitions. Many horses showed some degree of increase in cTnI concentrations following Cross Country exercise. We found moderate to marked elevations above baseline cTnI concentrations in 4 horses.
    3. We also studied horses competing at lower levels in a 4$^{th}$ event
        a. 61 horses sampled at rest
        b. 39 horses sampled at 6 hours after Cross Country
        c. 57 horses sampled at 24 hours after Cross Country
        d. Although many horses in the study displayed modest increases in cTnI following the cross country, we found no moderate to marked elevations in cTnI.
f. Relevance and Limitations
    1. Given that all horses in these studies were apparently healthy and without obvious heart disease prior to competition, the modest elevations in cTnI that we observed in many horses suggest that the exercise itself may cause release of cTnI from cardiac muscle cells. The moderate to marked elevations in cTnI concentrations observed in 4 horses are concerning findings of unknown cause. Additional studies involving large numbers of horses are needed.
    2. Assessment of cTnI levels were made by laboratories in medical centers near the competitions. Three different assays were used, none of which has rigorously established reference values for the horse. It is also very difficult to compare results among assays due to lack of standardization.
g. Follow Up: Given the expense of the cTnI assays and the logistical problems associated with the need to use one assay for all of our studies, regardless of the location of the event, we have suspended further studies of cTnI for the moment. However, the committee feels that investigation cTnI concentrations in horses undertaking cross country competitions is very important to understanding the effects of high intensity exercise on the equine heart. The committee will seek funding for this project.