How do we define poor performance?

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Outline

• Poor performance definition
• Approach to poor performance
• Adaptation to exercise and training
• Factors limiting performance
• Causes of poor performance
• Clinical evaluation of the RT
• Exercise testing
Poor Performance Definition

• Decrease in performance level
  ▫ Acceptable level of performance previously

• Exercise intolerance
  ▫ Marked decrease in performance level
  ▫ Not capable of training at previous level

• Unable to compete at expected level
  ▫ Unproven horse
  ▫ Expected level based on physical characteristics, genetic potential or training status
  ▫ Training satisfactorily
Approach to poor performance evaluation

• Agreement with owner/trainer on complaint
  ▫ Decreased performance?
  ▫ Exercise intolerance?
  ▫ Expected level?

• Exercise intensity
  ▫ High (Ex. Racehorses)
  ▫ Moderate (Ex. Reining Horse)
  ▫ Low (Ex. 4-H Horse)

• Fitness level
## Approach to poor performance evaluation

<table>
<thead>
<tr>
<th>Exercise Intensity</th>
<th>Performance</th>
<th>Disease severity</th>
<th>Sensitivity to testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>↓ performance</td>
<td>mild</td>
<td>high</td>
</tr>
<tr>
<td>Moderate</td>
<td>↓ performance / exercise intolerance</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>Low</td>
<td>exercise intolerance</td>
<td>severe</td>
<td>mild</td>
</tr>
</tbody>
</table>
Approach to poor performance evaluation

- Compare individual’s previous and current measurements
  - Objective performance criteria (running time, finishing position, etc.)
  - Physiological parameters (heart rate, respiratory rate, etc.)
    - Guide therapy
  - Clinical signs (nasal discharge, cough, respiratory effort, etc.)
    - Response to therapy

- Compare parameters measured over an extended period of time
  - Objective performance criteria
  - Physiological parameters
  - Clinical signs
Adaptation to exercise

• Respiratory
  – $V_E \times 30$, $V_E =$ Expiratory Volume

• Cardio-Vascular
  – HR $\times$ 8-10, HR = Heart Rate
  – CO $\times$ 10, CO = Cardiac Output
  – [Hb] $\times$ 2, Hb = Hemoglobin
Adaptation to exercise

- **Muscular**
  - > 80 % CO during strenuous exercise
- **Lactate**
  - Lactate is a by-product of glucose utilization without the presence of oxygen. With training, lactate levels are lower during strenuous exercise.
Adaptation to exercise

- \( \text{VO}_{2\text{max}} = 40 \times \text{VO}_{2\text{rest}} \)
- \( \text{VO}_2 \) & HR increase linearly with exercise intensity up to a maximum
- \( \text{VO}_{2\text{max}} \) = maximum oxygen consumption
- \( \text{VO}_{2\text{rest}} \) = oxygen consumption at rest
Adaptation to training

- Functional adaptations
  - Skeletal
    - Bones will respond to stresses applied to them
    - Where more force is applied, the bone responds by producing more bony tissue
    - See the picture to the right
Adaptation to training

- Cardiac Changes
  - Maximum heart rate increases
  - Increased mass of heart (cardiac muscle strengthens)
  - Number of oxygen carriers (hemoglobin) in red blood cells increase by 15%
Adaptation to training

- Muscular
  - Muscle fibers increase in size
  - Increased amount of red blood cells delivered to muscle cells (increased capillary density)

- Respiratory
  - No change with training in maximum volume of air that can be breathed per minute
Adaptation to training

- **VO$_2$max**
  - Exercise capacity
  - Athletic potential
  - Training $\uparrow$ 10 – 25 %
Adaptation to training

• Lactate
  – A product of cells using energy without the presence of oxygen
  – Causes “the burn” when exercising heavily
  – Once fitness is achieved, the amount of lactate produced decreases
Adaptation to training

- Gas exchanges
  - Exercise
  - Training
  - $\text{PaO}_2 = \text{partial pressure of oxygen}$
  - This value decreases with speed in the fit horse
Adaptation to training

- **Heart rate**
  - Speed vs. HR
  - Speed @ VO$_{2\text{max}}$ = speed @ $V_{HR\text{max}}$
  - Training
  - $V_{200}$

![Graph showing heart rate vs. speed for fit and unfit horses](image-url)
Factors limiting performance

- Extrinsic factors
- Intrinsic factors
- Training
- Genetic

Performance

Poor performance evaluation
## Factors limiting performance

<table>
<thead>
<tr>
<th>Exercise type</th>
<th>Limiting factor</th>
<th>Respiratory disease severity</th>
<th>Body system</th>
</tr>
</thead>
<tbody>
<tr>
<td>High intensity, short duration</td>
<td>Oxygen delivery</td>
<td>+</td>
<td>Respiratory</td>
</tr>
<tr>
<td>&gt; 80% VO(<em>2)(</em>{\text{max}})</td>
<td>Lactic acid production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate intensity, long duration</td>
<td>Combustible, hyperthermia, dehydration</td>
<td>++</td>
<td>Cardiovascular, Musculoskeletal</td>
</tr>
<tr>
<td>50-80 % VO(<em>2)(</em>{\text{max}})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low intensity, long duration</td>
<td>Fitness</td>
<td>+++</td>
<td>Musculoskeletal</td>
</tr>
<tr>
<td>&lt; 50 % VO(<em>2)(</em>{\text{max}})</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Clinical evaluation of the RT

- Respiratory system
  - Upper airway endoscopy at rest

Arytenoid chondritis

Subepiglottic Cyst
Clinical evaluation of the RT

- Respiratory system
  - Lower airway endoscopy post-exercise

Figure 6—Least square mean distance horses finished behind the winner as a function of severity of EIPH among Thoroughbred racehorses (n = 744) in Melbourne, Australia, examined between March 1 and June 18, 2003, for EIPH after racing. Error bars represent SE. *Significantly (P < 0.05) different from value for horses with grade 0 EIPH.

Hinchcliff et al. 2005
Clinical evaluation of the RT

• Respiratory system
  – Lower airway endoscopy post-exercise
    • Grade $\geq 2$ associated with poor performance in THB race horses (Holcombe et al. 2006)
    • Grade $\geq 3$ associated with poor performance in sport horses (Widmer et al. 2008)
Clinical evaluation of the RT

- **Respiratory system**
  - BALF neutrophilia (> 5 %)
    - IAD associated with poor performance
    - STBD (Rush 1995; Couroucé 2002)
    - THB (Fogarty 1991)
  - TW cytology
    - No association (Holcombe 2006)

Couetil et al. 1999
Clinical evaluation of the RT

- Respiratory system
  - BALF
    - EIPH
    - % hemosiderophages
    - [RBC]

Couetil et al. 1999
Advanced lung function tests

- Standard lung mechanics
- FE (forced expiration)
- FOM / IOS
Advanced lung function tests

- Open Plethysmography
  - Commercially available
    - RAO crisis
    - IAD (AHR)

-Courtesy Ambulatory Monitoring, Inc.
Exercise testing

- **Treadmill / Field**
  - **Indications**
    - Poor performance at moderate-high intensity exercise
    - Significance of abnormality found
  - **Advantages:**
    - Controlled environment
    - Standardized protocol
    - Numerous data collected
  - **Weaknesses:**
    - Gait differences
    - No rider
    - Costly
Exercise testing

- Evaluation focused on:
  - Upper airway (endoscopy)
    - Treadmill
    - Dynamic endoscopy in the field
  - Gas exchanges, ventilation
Exercise testing

Couëtil et al., Equine Vet J 1999

PaO2 (mmHg)

Control
IAD
EIPH
Exercise testing

- Cardiovascular function
  - Exercise testing
    - Field / Treadmill
    - \( V_{150} \) & \( V_{200} \)
Exercise testing

- Musculo-skeletal system
  - Fitness ($V_{La4}$)
  - Tying-up

![Graph showing lactate levels and speed for healthy and unfit horses; CPK levels before and after exercise for healthy and tying-up horses]
## Summary

<table>
<thead>
<tr>
<th>Exercise type</th>
<th>Respiratory disease</th>
<th>Diagnostic test</th>
<th>Other tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>High intensity, short duration</td>
<td>UAO</td>
<td>Endoscopy (dynamic) &lt;br&gt;BAL ± TW &lt;br&gt;Exercise testing &lt;br&gt;Sensitive LFT</td>
<td>Gait at high speed &lt;br&gt;Lactate &lt;br&gt;HR / ECG &lt;br&gt;CK pre-post &lt;br&gt;CBC</td>
</tr>
<tr>
<td></td>
<td>IAD, EIPH, Infections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate intensity, long duration</td>
<td>UAO</td>
<td>Endoscopy (rest ± dynamic) &lt;br&gt;BAL ± TW &lt;br&gt;Exercise testing &lt;br&gt;Sensitive LFT</td>
<td>Lameness exam &lt;br&gt;Lactate &lt;br&gt;HR / ECG &lt;br&gt;CBC / electrolytes</td>
</tr>
<tr>
<td></td>
<td>IAD / RAO, Infections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low intensity, long duration</td>
<td>UAO</td>
<td>Endoscopy (rest) &lt;br&gt;BAL ± TW &lt;br&gt;BG @ rest &lt;br&gt;LFT</td>
<td>Thoracic X-ray / US CBC</td>
</tr>
<tr>
<td></td>
<td>IAD / RAO, IPF, Infections</td>
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</table>
Challenging cases

- Unproven horse
  - Reference database
  - Systematic evaluation
    - Treadmill
    - Field
  - Cause of poor performance
    - Legitimate cause
    - Undiagnosed pathology
    - Limited ability / lack of fitness
    - Behavior / psychological problem
Questions?