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

- \( VO_{2\text{max}} = 40 \times VO_{2\text{rest}} \)
- \( VO_2 \) & HR increase linearly with exercise intensity up to a maximum
- \( VO_{2\text{max}} = \) maximum oxygen consumption
- \( VO_{2\text{rest}} = \) 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

The cannon bone (shin) of a properly trained horse is thicker and denser at the front of the bone than at the sides or back.
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

- **VO₂max**
  - Exercise capacity
  - Athletic potential
  - Training ↑ 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$_{200}$
Factors limiting performance

Extrinsic factors
Intrinsic factors
Training
Genetic

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% VO₂max</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</td>
</tr>
<tr>
<td>50-80 % VO₂max</td>
<td></td>
<td></td>
<td>Musculoskeletal</td>
</tr>
<tr>
<td>Low intensity, long duration</td>
<td>Fitness</td>
<td>+++</td>
<td>Musculoskeletal</td>
</tr>
<tr>
<td>&lt; 50 % VO₂max</td>
<td></td>
<td></td>
<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
    - \([\text{RBC}]\)

Couetil et al. 1999
Advanced lung function tests

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

![Graphs showing lung function test results](image)
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
Exercise testing

• Cardiovascular function
  – Exercise testing
    • Field / Treadmill
    • $V_{150}$ & $V_{200}$
Exercise testing

• Musculo-skeletal system
  – Fitness ($V_{La4}$)
  – Tying-up
<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 IAD EIPH Infections</td>
<td>Endoscopy (dynamic) BAL ± TW Exercise testing Sensitive LFT</td>
<td>Gait at high speed Lactate HR / ECG CK pre-post CBC</td>
</tr>
<tr>
<td>Moderate intensity, long duration</td>
<td>UAO IAD / RAO Infections</td>
<td>Endoscopy (rest ± dynamic) BAL ± TW Exercise testing Sensitive LFT</td>
<td>Lameness exam Lactate HR / ECG CBC / electrolytes</td>
</tr>
<tr>
<td>Low intensity, long duration</td>
<td>UAO IAD / RAO IPF Infections</td>
<td>Endoscopy (rest) BAL ± TW BG @ rest LFT</td>
<td>Thoracic X-ray / US CBC</td>
</tr>
</tbody>
</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?

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