Exercise Induced Bronchoconstriction

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Speaker does not have any relevant commercial financial arrangement related to the content of this presentation.
Objectives

• Describe the impact of EIB
• Describe diagnostic testing for EIB
• Examine the prevalence of EIB in college athletes
• Role of the Respiratory Therapist
Exercise Induced Bronchoconstriction (EIB)

• Health Implications
  – Up to 90% of asthma population has tested (+) EIB.

  – 10-12% of general population with no history of asthma has tested (+) EIB.

  – EIB can be a deterrent to physical activity.
    • Association between obesity and asthma/EIB.

Exercise Induced Bronchoconstriction (EIB)

- **Sports Performance**
  - EIB is up to 5x more prevalent in Elite and Olympic athletes compared to the general population.
  - EIB varies greatly in athlete populations.
  - Symptoms not associated with positive test.
  - Not an effective screening tool.
  - Unknown: Performance improves after proper diagnosis and treatment?

EIB: Morbidity & Mortality

• Morbidity
  – Increased respiratory tract infections
  – Inactivity
  – Psychosocial
    • Overall QoL
    • Physical activity related QoL

• Mortality
  – 7 year study revealed 61 deaths (1993-2000)
    • During competition or training
    • 81% < 21 years of age


EIB: Mortality
Perception of Young Athletes

- 55/61 (90%) had a history of asthma
- Only 3/55 on any asthma medication

Suggests:
- Those who died from an asthma attack may have had well-controlled asthma.

What is most Likely Cause of EIB?

A. Deconditioning
B. Allergic Response
C. Airway drying and cooling
D. Physiological stress induced by exercise
Pathophysiology of EIB

- Airway drying and cooling (heat evaporation)
- Mast cell mediators
  - Histamine
  - Leukotrienes
  - Prostaglandins
- Irritant receptors affecting vagal nerve
EXERCISE AND ALLERGY

Exercise
  ↓
Increased oxygen demand
  ↓
Increased minute ventilation
  ↓
Increased mouth breathing
  ↓
Respiratory heat and water loss

Stimulates afferent "irritant" receptors
  ↓
Triggers reflex vagal efferents
  ↓
Primary Bronchospasm

Stimulates mast cell mediator release
  ↓
Histamine Leukotrienes Prostaglandins PAF
  ↓
Chemotactic Factors
  ↓
Inflammation
  ↓
Secondary "Late-Phase" Response
http://www.youtube.com/watch?v=3kklOqG--7o
Diagnosis
You are seeing a 17 year old high school long distance runner who complains of SOB, coughing, and chest tightness after exercise. A test to most likely help you establish a diagnosis is:

A. Methacholine challenge
B. Pre/Post Bronchodilator
C. WPF in the field
D. Treadmill exercise provocation test
E. Eucapnic voluntary hyperventilation
EIB Testing: Methodology

Student Athletes

USOC Questionnaire

Spirometry

Exclude if < 70% Pred. FEV1

EIB Testing

Post-Spirometry
Baseline Spirometry

American Thoracic Society (ATS)

• Acceptable effort (**EFFORT DEPENDANT**)
  – Good start of test with no excessive hesitation
  – No coughing
  – No variable flow
  – At least 6 second plateau
    • No early termination of test
  – No evidence of glottis closure or extra breaths

• Repeatability
  – Obtain at least acceptable efforts
  – 2 best efforts within 150 mL of each other (FEV1 and FVC)

**NOTE: No respiratory meds 24 hours prior to testing**
Diagnosis of EIB

• Serial lung function measurements after a specific exercise or hyperpnea challenge are used to determine if EIB is present and to quantify the severity of the disorder. It is preferable to assess FEV1, because this measurement has better repeatability and is more discriminating than peak expiratory flow rate.

• The difference between the pre-exercise FEV1 value and the lowest FEV1 value recorded within 30 minutes after exercise is expressed as a percentage of the pre-exercise value. The criterion for the percent fall in FEV1 used to diagnose EIB is >10%.

• Must assess the spirometry test to be be good effort.
  • Check FVC and FEV1/FVC

Spirometry:
FVC Reduced Because of Poor Effort or Restrictive Airway Process

- Reduced volumes
  - FVC ↓
  - FEV1 ↓
  - %FEV1/FVC N
  - FEV (25-75%) N,↓

Note: The FEV1 is reduced because of the decreased volume; NOT because of obstruction. Maybe it’s a poor effort of not good technique by tester or patient??
Spirometry:
TRUE Obstructive Process

• Reduced flows
  – FVC N,↓
  – FEV1 N,↓
  – %FEV1/FVC ↓

• Small airways
  – FEF 25-75% ↓
  – Mid flows ↓

NOTE: In true obstruction as in EIB; FEV1 AND FEV1/FVC will be reduced. Check and make sure the FEV1/FVC is reduced to confirm it’s obstruction and not bad effort or technique.
Exercise Provocation Test

• Reach 80-90% of predicted HR max (220-age)
• Want to see VE 40-60% of MVV
  – MVV calculate by 35 x FEV1
• Goal is to reach target HR and VE within 2-4 minutes from start
• Continue test for 4-6 minutes after reaching target HR and/or VE
  – Varies based on fitness level
• Breath dry air (< 10 mg H₂O/L) (45-50°C Day)

* Goal is to have patient reach target HR and/or VE within 4 minutes of start and completed by 8 minutes.
Post-Test Spirometry

- Immediate post exercise
- Every 5 minutes post exercise
- Stop at 30 minutes post exercise
- Make sure Good Effort

** Discontinue testing if FEV1 drops by > 10%
   (Clinical versus statistically significant)
Flow Volume Loop

Baseline

15 Minutes After Exercise
### Spirometry

<table>
<thead>
<tr>
<th>Stage</th>
<th>Baseline</th>
<th>Imm. Post</th>
<th>5 Min</th>
<th>10 Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC (L)</td>
<td>3.82</td>
<td>3.91</td>
<td>3.41</td>
<td></td>
</tr>
<tr>
<td>% Pred</td>
<td>107</td>
<td>111</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>% Change</td>
<td>+0</td>
<td>+2</td>
<td>-10</td>
<td></td>
</tr>
<tr>
<td>FEV1 (L)</td>
<td>2.65</td>
<td>2.83</td>
<td>1.90</td>
<td></td>
</tr>
<tr>
<td>% Pred</td>
<td>85</td>
<td>90</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>% Change</td>
<td>+0</td>
<td>+6</td>
<td>-28</td>
<td></td>
</tr>
<tr>
<td>FEV1/FVC (%)</td>
<td>*69</td>
<td>72</td>
<td>*56</td>
<td></td>
</tr>
<tr>
<td>% Pred</td>
<td>80</td>
<td>84</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>% Change</td>
<td>+0</td>
<td>+4</td>
<td>-19</td>
<td></td>
</tr>
<tr>
<td>FEF 25-75% (L/sec)</td>
<td>*1.75</td>
<td>*2.23</td>
<td>*0.50</td>
<td></td>
</tr>
<tr>
<td>% Pred</td>
<td>48</td>
<td>62</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>% Change</td>
<td>+0</td>
<td>+27</td>
<td>-71</td>
<td></td>
</tr>
<tr>
<td>FEF Max (L/sec)</td>
<td>6.51</td>
<td>*5.25</td>
<td>*4.12</td>
<td></td>
</tr>
<tr>
<td>% Pred</td>
<td>98</td>
<td>79</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>% Change</td>
<td>+0</td>
<td>-19</td>
<td>-36</td>
<td></td>
</tr>
</tbody>
</table>

### Diagrams

- FEV1 vs. Time
- FEF 25-75% vs. Time
Even with today's guidelines we are not controlling EIB!
MISSION
KU Asthma Center

Our goal is to provide advanced, comprehensive and compassionate care to all patients living with asthma. Our institute strives to achieve this goal through excellence in teaching, research, patient care, and community engagement. We focus on the importance of asthma education for the patient and provide exceptional medical education to students, residents and other health professionals. *We are committed to providing world class clinical services to the community and throughout the State of Kansas* while remaining dedicated to innovative research to expand the frontiers of medical knowledge.
High School and College Athletes

Phase I: Self-report Questionnaire
- Assess the impact of asthma and EIB by self-report
- Collect self-report questionnaire for validation to standardized testing

Phase II: Standardized EIB testing
- Perform a within-group exercise challenge with serial spirometry

Phase III: Develop a validated EIB screening tool
- Create a predictive model for a simple EIB screening tool

Phase IV: Collaborative and Effective EIB Screening Program
- Pulmonary Medicine, Respiratory Care, and Sports Medicine working together to screen, diagnose, and treat EIB in college student-athletes
Purpose: Phase 1 - Questionnaire

1. Investigate the prevalence of EIB by self report.
2. Help in development of an effective screening tool to stratify at-risk athletes.
   (Hx., symptoms, demo, sport, etc.)
3. Better inform our research team on the perceptions and needs of the EIB athlete.

* More Qualitative analyses
Results/Conclusions

<table>
<thead>
<tr>
<th>Age (mean, range)</th>
<th>19.8 (18-23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (female, male)</td>
<td>86; 110</td>
</tr>
<tr>
<td>History of EIB and/or Asthma</td>
<td>56/196 (28.6%)</td>
</tr>
<tr>
<td>No history of EIB, but report EIB symptoms</td>
<td>46/140 (32.9%)</td>
</tr>
<tr>
<td>Athletes who report history of EIB and/or Asthma, but do not report using a respiratory med</td>
<td>14/56 (25%)</td>
</tr>
<tr>
<td>Reported to be concerned that EIB adversely affected their sports performance.</td>
<td>19/196 (9.7%)</td>
</tr>
</tbody>
</table>

EIB Findings: EIB Testing
Purpose

• Aim 1: Determine prevalence of EIB by a standardized test that can be done on most college campuses
• Aim 2: Interaction of questionnaire data (history, symptoms, and respiratory medication use) for predicting a positive EIB test
## Demographics and Baseline

<table>
<thead>
<tr>
<th>Variable</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants ((n))</td>
<td>80</td>
</tr>
<tr>
<td>Gender ((%) male)</td>
<td>56%</td>
</tr>
<tr>
<td>Age ((\text{mean};\ \text{range}))</td>
<td>20 (18-23)</td>
</tr>
<tr>
<td>History of asthma or EIB ((n))</td>
<td>17</td>
</tr>
<tr>
<td>Symptoms of asthma or EIB ((n))</td>
<td>22</td>
</tr>
<tr>
<td>Use of a respiratory medication ((n))</td>
<td>17</td>
</tr>
</tbody>
</table>

EIB = exercise induced bronchoconstriction

Positive for EIB by Standardized Testing

EIB

42%

Positive
Negative
### EIB Testing Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>EIB Positive Athletes</th>
<th>EIB Negative Athletes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( n = 34 )</td>
<td>( n = 46 )</td>
</tr>
<tr>
<td><strong>FEV\textsubscript{1} at baseline</strong> (Liters)</td>
<td>3.83 ± .81</td>
<td>3.97 ± .88</td>
</tr>
<tr>
<td>(mean; SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FEV\textsubscript{1} at baseline</strong> (% predicted)</td>
<td>93.3 ± 13.9</td>
<td>91.3 ± 13.0</td>
</tr>
<tr>
<td>(mean; SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Max Heart Rate</strong> (BPM)</td>
<td>174 ± 7.2</td>
<td>174 ± 6.5</td>
</tr>
<tr>
<td>(mean; SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Max VE</strong> (L/min)</td>
<td>89 ± 29.5</td>
<td>92.5 ± 29.3</td>
</tr>
<tr>
<td>(mean; SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Change in FEV\textsubscript{1}</strong> (% change from baseline)</td>
<td>-16.9% ± 5.6</td>
<td>4.2 ± 3.7</td>
</tr>
</tbody>
</table>

FEV\textsubscript{1} = forced expiratory volume in one second  
BPM = beats per minute  
VE = minute ventilation
Proportion of EIB positive athletes (n = 34) reporting either positive or negative history, symptoms, or use of respiratory medications.
Interactions between a positive EIB tests with history, symptoms, and resp. med.

- History: P = 0.93
- Symptoms: P = 0.12
- Resp. Med: P = 0.66
Findings

• Symptoms and history not predictive for a (+) EIB test
• Young athletes with history of asthma/EIB not taking meds (25%)
• EIB (+) athletes not taking meds (79%)
  – No idea they were positive
Adolescents’ Perception

- 83% perceived to have their asthma under control
- Majority of participants did not feel they needed extra information about asthma.
- Believed they had sufficient knowledge regarding how and when to use meds.
- Reported to be lazy and unwilling to use meds as Rx.
- What about behavior modification in well-controlled patients?

EIB: Mortality Perception of Young Athletes

- 55/61 (90%) had a history of asthma
- Only 3/55 on any asthma medication

Suggests:
- Those who died from an asthma attack may have had well-controlled asthma.

Even with today's guidelines we are not controlling EIB!
EIB Treatment: RT’s Role

Ongoing Treatment: RT’s Role

• Pulmonary Function Monitoring
• Education
  – Awareness
  – Adherence to Treatment
Role of the RT

- Education: Community Awareness
- Diagnostic Testing
- Treatment: Physician Extender
  - Self-management education
- Collaboration (Clinical and Research)
  - Schools
  - Sports Medicine
  - Pediatrics
Thank You
Questions!

THE UNIVERSITY OF KANSAS
ASTHMA CENTER
Objectives and Future Plans

1. Determine the proportion of college student-athletes who self-report a history of asthma/EIB.

2. Determine the proportion of college student-athletes who test positive when performing a standardized EIB test.

3. Determine the association between college student-athletes who self-report a history of asthma/EIB and diagnosis by a standardized EIB test.
   - Effective screening tool to predict who is at most risk for EIB

4. Determine if an improvement in performance is associated with proper diagnosis and treatment of EIB.
Questionnaire

• United States Olympic Committee
  – Sports Medicine Division
• Based on respiratory symptoms during exercise
  – Wheezing
  – Unusual shortness of breath
  – Chest tightness
  – Coughing
  – Meds

Compare symptoms to test
<table>
<thead>
<tr>
<th><strong>Obstruction: Reduced flows</strong></th>
<th><strong>Reduced volumes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• FVC ↓, N</td>
<td>• FVC ↓</td>
</tr>
<tr>
<td>• FEV1 ↓, N</td>
<td>• FEV1 ↓</td>
</tr>
<tr>
<td>• %FEV1/FVC ↓</td>
<td>• %FEV1/FVC N</td>
</tr>
<tr>
<td>• Small airways</td>
<td>• FEV (25-75%) N, ↓</td>
</tr>
<tr>
<td>– FEF 25-75% ↓</td>
<td></td>
</tr>
<tr>
<td>– Mid flows ↓</td>
<td></td>
</tr>
</tbody>
</table>
EIB Positive Student-Athletes

- 107 athletes in 22 different sports at OSU
- 42 of 107 tested positive = 39%
- Of the 42 who tested positive, 36 had NO known history of asthma or EIB

Treatment Barriers: Adolescents’ Perception

• Subjects
  – Well-controlled and Poorly controlled

• Perception of current and internet-based asthma self-management
  – Intrinsic Barriers to current asthma management
  – Barriers and benefits of internet-based asthma self-management

Victor van der Meer, MD; Henk F. van Stel, PhD; Symone B. Detmar, PhD; Wilma Otten, PhD; Peter J. Sterk, PhD; and Jacob K. Sont, PhD