Exercise-Induced Bronchoconstriction

EIB
Case 1

• 14 yo boy, freshman in high school
• Complains of shortness of breath 2 minutes into a mile-run in his first gym class
• Same complains in his 2\textsuperscript{nd} gym class
• Parents requesting albuterol inhaler
• No history of asthma
• Normal physical exam
Case 2

- 20 yo woman who is on the soccer team at a Division 1 college
- Complains of chest tightness and shortness of breath 15 minutes into her practices and games
- No problems when she played soccer in high school
- History of allergic rhinitis with positive skin tests for tree and grass pollens
- No history of asthma
Case 3

- 16 yo girl who is a junior in high school
- Complains of shortness of breath 3 minutes into each of her first 2 games on the varsity team
- No problems during practices
- No problems in the previous 2 basketball seasons on the freshmen and sophomore teams
- No history of asthma
Definition of EIB

• Exercise-induced bronchoconstriction (EIB) is the transient narrowing of the lowers airways after vigorous exercise
• Occurs in asthmatics and non-asthmatics
• Should not use the term exercise-induced asthma
Duration of EIB Symptoms

• Symptoms begin during or after exercise and usually worsen 5 to 20 minutes after stopping activity

• Some people experience a “late-phase reaction” 4 to 12 hours after exercising
Prevalence of EIB

• EIB is found in:
  ❖ A majority of asthmatics (up to 90%)
  ❖ 45% of people with allergic rhinitis
  ❖ 50% of elite athletes
  ❖ 12% of the general population
Categories of Athletes

• Elite athletes are highly competitive person who train and compete consistently at higher levels
  – Olympians, professional athletes

• Competitive athletes are persons who engage in strenuous aerobic activity at any level from grade school age and older
  – High school teams, travel teams

• Recreational athletes
  – Most of us?
  – “weekend warriors”
EIB in Elite Athletes

- Prevalence higher in swimmers, ice skaters, hockey players

- Evidence of chronic airway inflammation caused by many months or years of intense training and inability to adequately humidify extremely large volumes of air
Etiology of Dyspnea in Athletes (Mix of Elite, Competitive)

• 148 athletes referred to tertiary care center for respiratory complaints with exercise
• 40% have diagnosis of asthma prior to referral
• Diagnoses after evaluation at tertiary center were:
  ❖ 17% asthma
  ❖ 70% vocal cord dysfunction
  ❖ 52% EIB
  ❖ 8% EIB plus asthma
  ❖ 31% EIB plus vocal cord dysfunction
  ❖ 6% asthma plus vocal cord dysfunction
Medications for treating EIB in Elite/Competitive versus Recreational Athletes

• Elite and competitive athletes might require maintenance therapy whereas recreational athletes might only require intermittent therapy
Pathophysiology of EIB

• When we exercise, we need to heat and humidify very large volumes of air
• The most important determinants of EIB are the water content of the inspired air and the level of ventilation
• Respiratory water loss at high ventilation is associated with airway cooling and dehydration and an increase in osmolarity of the airway surface
Pathophysiology of EIB

- Exercise itself is not necessary to cause narrowing to the airways
- Voluntary hyperpnea of dry air can induce bronchoconstriction
- EIB is accompanied by release of mediators such as eosinophil cationic protein, leukotrienes, prostaglandins, and histamine
Diagnosis of EIB

• Self-reported symptoms alone are not reliable for diagnosis of EIB
• Exercise challenge (treadmill or ergometric cycle) is not very sensitive
  - Environmental conditions in the clinic not the same as where the patients exercise
  - Field challenge is more sensitive but portable equipment is needed
• Eucapnic voluntary hyperpnea is the preferred test for elite athletes
  - Elite athletes have high VO$_2$max
  - Unable to reach high enough intensity with exercise challenge in clinic
• Hyperosmolar (4.5% saline) challenge might be of value
# Criteria for Positive Bronchial Challenge

<table>
<thead>
<tr>
<th>Protocol Type</th>
<th>Protocol</th>
<th>Criteria</th>
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</thead>
<tbody>
<tr>
<td>Bronchodilator</td>
<td><strong>FEV(_1) pre and post inhalation of permitted (\beta_2) agonist</strong></td>
<td>(\geq 12%) from the baseline (\text{FEV}_1) and exceeding 200 mL</td>
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<tr>
<td>Bronchial provocation</td>
<td><strong>Eucapnic voluntary hyperpnea (6 min of dry air)</strong></td>
<td>(\geq 10%) decrease in (\text{FEV}_1) within 30 min of challenge</td>
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<tr>
<td></td>
<td>Exercise challenge in the laboratory or field (heart rate (&gt; 85%) for at least 4 min)</td>
<td>(\geq 10%) decrease in (\text{FEV}_1) within 30 min of challenge</td>
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<td></td>
<td>Hypertonic aerosol (22.5 mL of 4.5 gm % saline)</td>
<td>(\geq 15%) decrease in (\text{FEV}_1)</td>
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<tr>
<td></td>
<td>Metacholine test (inhalation of solution 4 mg·mL(^{-1})—PC20)</td>
<td>(\geq 20%) decrease in (\text{FEV}_1)</td>
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</table>

Exercise Challenge and FEV1
Equipment for Eucapnic Voluntary Hyperpnoea Test

1, Compressed gas mixture; 2, regulator; 3, demand resuscitator, 30–150 litres/min; 4, high pressure tubing; 5, demand valve; 6, rotameter, 30 to >200 litres/min; 7, meteorological balloon, 100–300 g or a Douglas Bag of 150 litres capacity; 8, metal connector with tap that allows gas to simultaneously enter and leave the balloon (for example, Morgan PKM 90750105 000); 9, low resistance, low dead space volume; 10, gas meter accurate to 1 litre or any other device; 11, hoses, minimum diameter 1.25 inches.

A subject is shown undergoing a eucapnic voluntary hyperpnoea challenge

Differential Diagnosis of EIB

- Exercise-induced laryngeal dysfunction
  - Vocal cord dysfunction
- Exercise-induced hyperventilation
- Skeletal defects (pectus excavatum)
- Diaphragmatic paralysis
- Physiologic limitation
- Psychological factors
Treatment of EIB
Beta-2 Agonists

• In asthmatics, ensure optimal control of asthma
• For patients with EIB:
  ❖ Beta-2 agonists are the most effective
  ❖ Inhaled short acting Beta-2 agonists before exercise and after exercise if symptoms occur
  ❖ Long acting Beta-2 agonists provide protection for up to 12 hours
Treatment of EIB
Beta-2 Agonists

• Be cautious in daily use of beta-2 agonists
• Daily use can lead to tolerance manifested as a reduction in duration, magnitude, or both of protection against EIB and a prolongation of recovery in response to SABAs after exercise
Treatment of EIB
Leukotriene Inhibitors

- Montelukast or zafirlukast
- Daily therapy with leukotriene inhibitors does not lead to tolerance
- Has been shown to attenuate EIB in 50% of patients
- Can be used for intermittent (taken in hour before exercise) or maintenance prophylaxis
- Not effective for reversing airway obstruction
Treatment of EIB
Mast Cell Stabilizers

• Consider inhaled cromolyn 20 minutes before exercise
• Shorter duration of action than beta-2 agonists
• No bronchodilator activity
• Can also be added on if beta-2 agonists not completely effective
Treatment of EIB

Inhaled Corticosteroids (ICS)

- Consider ICS in combination with other therapies
- ICS can decrease frequency and severity of EIB but not necessarily eliminate it
- ICS might not prevent the occurrence of tolerance from daily beta-2 agonist use
Treatment of EIB

Anticholinergic Agents

• Consider inhaled ipratropium for patients who have not responded to other agents

• Its ability to attenuate EIB is inconsistent
Treatment of EIB
Other Medications

- Theophylline
- Roflumilast (phosphodiesterase 4 inhibitor)
- Caffeine
- Antihistamines
- Calcium channel blockers
Treatment of EIB
Non-pharmacologic Therapy

• Pre-exercise warm-up
• Diet
  – Reduction of sodium intake
  – Fish oil
  – Ascorbic acid (vitamin C)
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