World Allergy Forum Symposium:
Allergic Diseases, Asthma and Sleep Disturbances

2011 AAAAI Annual Meeting
Saturday, March 19, 2011 - 10:45 – 12:00
Moscone West
2024, Second Floor
San Francisco, CA, USA

Moderators:
Richard F. Lockey (USA)
Mark Ballow (USA)

The Upper Airway, Asthma and Sleep Disorders in Children
Athanasios Kaditis (Greece)

Upper Airway and Sleep Disorders in Adults
Richard J. Schwab (USA)

Treatment of Sleep Apnea and Sleep Disorders in All Age Groups
W. McDowell Anderson (USA)

www.worldallergy.org

The World Allergy Organization (WAO) is an international organization of 84 regional and national allergy and clinical immunology societies. WAO’s mission is to be a global resource and advocate in the field of allergy, advancing excellence in clinical care, education, research and training through a world-wide alliance of allergy and clinical immunology societies.

WAF is an educational program of the World Allergy Organization.
The World Allergy Organization invites you to its
XXII World Allergy Congress

WAC 2011 4-8 December 2011 Cancún, México

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• 33 Workshops Sessions (ticketed)
• 39 Oral Abstract Sessions (ticketed) and Poster Sessions presenting the best of 1,000+ Abstract submissions

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www.worldallergy.org/wac2011
Allergic Diseases, Asthma and Sleep Disturbances

Program

Moderators:
Richard F. Lockey, MD FAAAAI
University of South Florida
Tampa, FL, USA

Mark Ballow, MD FAAAAI
SUNY Buffalo
Buffalo, NY, USA

1. Welcome to the World Allergy Forum Symposium and Introduction to “Allergic Diseases, Asthma and Sleep Disturbances”
   Richard F. Lockey and Mark Ballow

2. The Upper Airway, Asthma and Sleep Disorders in Children
   Athanasios Kaditis
   University of Athens School of Medicine and Aghia Sophia Children’s Hospital
   Athens, Greece

3. Upper Airway and Sleep Disorders in Adults
   Richard J. Schwab
   University of Pennsylvania
   Philadelphia, PA, USA

4. Treatment of Sleep Apnea and Sleep Disorders in All Age Groups
   W. McDowell Anderson
   University of South Florida
   Tampa, FL, USA

Upon completion of this session, participants should be able to:
Discuss the role of airway disease in disordered sleep in childhood
Assess the contribution of airways disease on sleep disorders in adults
Identify the signs and symptoms associated with sleep disorders and how these diseases are treated

2010-2011 World Allergy Form Advisory Board

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About the World Allergy Organization

The World Allergy Organization (WAO) is a global federation of 84 regional and national allergy, asthma and clinical immunology societies. Through collaboration with its member societies, WAO provides a wide range of educational and outreach programs to WAO individual members around the globe. These programs, relating to the clinical practice of allergy, allergy service provision, and physician training in allergy help better understand and address the challenges facing allergists worldwide.

Mission
WAO’s mission is to be a global resource and advocate in the field of allergy, advancing excellence in clinical care through education, research and training as a worldwide alliance of allergy and clinical immunology societies.

Meetings
World Allergy Congress™ (WAC)
WAO hosts the World Allergy Congress™ (WAC) — its main scientific meeting — biennially in different regions of the world. Please join us in Cancún, México in 2011, Rome, Italy in 2013 and Seoul, South Korea in 2015. For more details on WAC 2011 in Cancún, please visit www.worldallergy.org/wac2011

WAO International Scientific Conference
WAO is excited to launch its theme-based scientific conferences alternating with and complementing WAO’s biennial Congresses.

The 1st WAO International Scientific Conference was held in Dubai, UAE from 5-8 December 2010 and was focused on Asthma and Co-morbid Conditions.

The 2nd WAO International Scientific Conference will take place in 2012 in India.

WAO Website
www.worldallergy.org

As a leading global online destination for allergy, asthma and clinical immunology, www.worldallergy.org supports and enhances all WAO educational activities and provides materials specifically designed for continued medical training, and reviews of the scientific literature. Popular resources include the specially commissioned educational synopses on major topics posted in the Allergic Diseases Resource Center, interactive case studies that challenge allergists to diagnose unusual cases, an archive of webinars recorded at major meetings, and audio recordings of interviews with key opinion leaders around the world. The WAO website is now HONcode certified.

The World Allergy Organization Journal
www.waojournal.org

The World Allergy Organization Journal (WAO Journal) is the official publication of WAO and underscores WAO’s commitment to raising awareness and advancing excellence in clinical care, education, research and training. This international, peer-reviewed journal covers a broad spectrum of the interdisciplinary fields of allergy and clinical immunology. As an online-only journal, the publication process of the WAO Journal is efficient and quick, with articles posted each month on schedule. All WAO members have free access to the WAO Journal.

The primary goals of the WAO Journal are:
• To be a premier journal of original scientific and clinically relevant information for practicing allergists/immunologists and other physicians concerned with the practice of allergy and clinical immunology
• To publish state-of-the-art review articles and editorials on translational and clinical medicine in the field of allergy and immunology
• To present a forum for scientific interaction between allergists and immunologists worldwide

WAO Programs for Education, Research & Patient Care

Global Resources in Allergy™ (GLORIA)

GLORIA promotes best practices in the management of allergic disease through didactic programs developed by international experts. GLORIA is presented at national and regional allergy society meetings throughout the world and also at regional, state and local society meetings within the United States. All current GLORIA modules are available for free download at www.worldallergy.org/gloria

World Allergy Forum ® (WAF)

WAF brings cutting edge symposia to major allergy meetings throughout the world. Developed by international expert advisory panels, the symposia provide up-to-the-minute presentations on scientific and clinical developments in the field of allergic disease. WAF placements attract up to 1,000 attendees. WAF is supported by an unrestricted educational grant from Novartis.

View presentations for free at www.worldallergy.org/waf

Emerging Societies Program (ESP)

ESP advances the WAO mission by supporting developments that enable allergists to better serve patients now and in the future. ESP aims to disseminate information on and share experiences about new treatments for allergic disease and about new indications for available therapies. All ESP meetings and training schools are conducted with the help and support of WAO Member Societies. The American College of Allergy, Asthma and Immunology (ACAAI) partners with WAO on ESP. View all ESP activities at www.worldallergy.org/esp
WAO Projects and Publications

www.worldallergy.org/publications

Anaphylaxis:

• “Epinephrine: the drug of choice for anaphylaxis.” Kemp ST, Lockey RF, Simons FER, was published in 2008 (Allergy, 2008, 63:1061-1070), and reproduced as an e-supplement to the WAO Journal. Available at www.waojournal.org


• Global availability of medications, supplies and equipment for the assessment and management of anaphylaxis by physicians in healthcare settings. Simons, FER, for World Allergy Organization, in preparation, 2010

Cow’s Milk Allergy: The evidence-based WAO global guidelines on the Diagnosis & Rationale for Action Against Cow’s Milk Allergy, authored by the WAO Food Allergy Special Committee. (WAO Journal. 2010;3(4):57-161)

Immunotherapy: Sub-lingual Immunotherapy (SLIT) - WAO Position Paper 2009. SLIT is an exciting therapeutic strategy on the delivery of immunotherapy and is gradually being adopted by allergy communities throughout the world. Following a first meeting in Genoa in November 2008 to review experience of US trials of SLIT, WAO hosted a meeting in Paris in January 2009 to develop the first global consensus on SLIT. All WAO Regional & Affiliate Member Societies were invited to send representative delegates to this meeting and the majority were represented. They were joined by delegates representing non-member organizations including NIH, OA’LEN, EFA, ICPRG, and ARIA. A WAO Position Paper based on the Paris meeting will be published in the WAO Journal, and in Allergy. (WAO Journal. 2009;2(11):223-281)

The first State of World Allergy Report (SOWAR) appeared in the WAO Journal in June 2008. SOWAR stresses the importance of providing national allergy services for the burgeoning numbers of allergy patients in the world. This downloadable, on-line report is a useful resource for allergists and allergy societies wishing to make the case for improved local allergy service provision. Available at: www.waojournal.org. (WAO Journal. 2008;1(6):51-517)

WAO Position Papers support and promote the specialty of allergy and help set standards for clinical practice and training:

• “What is an allergist? A position statement of the WAO Specialty and Training Council.” 2008 Available at: www.waojournal.org

• “Requirements for physician competencies in allergy: key clinical competencies appropriate for the care of patients with allergic or immunologic diseases — a position statement of the World Allergy Organization.” 2008 Available at: www.waojournal.org

• “Recommendations for competency in allergy training for undergraduates qualifying as medical practitioners — a position paper of the World Allergy Organization.” 2009

Available at: www.waojournal.org

WAO White Book on Allergy is being prepared for launch in 2010. The WAO White Book will be an important resource to help individual allergists and allergy/immunology societies promote allergic diseases as a major global public health issue.

WAO Member Society Surveys

WAO’s federal structure provides a unique network to conduct effective global surveys about allergy. A number of projects have taken place over the last two years:

• The WAO Specialty and Training Council conducted surveys on general/adult and pediatric clinical allergy services and training to obtain global information on current and future allergy service provision.

• Building on the WAO’s 2007 international survey on the availability of epinephrine auto-injectors worldwide, in 2008 the WAO Special Committee on Anaphylaxis conducted a survey of Member Societies to gather data on how anaphylaxis is diagnosed and treated in healthcare settings in their respective countries. The combined results of these surveys will form the basis of the WAO international guidelines for the assessment and management of anaphylaxis, which was introduced at WAC 2009 and will launch in 2010.

• The Asthma Special Committee conducted a survey of Member Societies to find out about the major allergens involved in exacerbations of severe and chronic asthma, and to learn whether national definitions of severe asthma exist. The information obtained will form a WAO educational program based on the 2009 World Health Organization’s definition of Severe Asthma.

• The Drug Allergy Special Committee conducted a survey on in-vivo methods used in the diagnosis of allergic reactions to major drug classes. The information obtained will be the first step to reaching a global consensus about the best way to diagnose drug hypersensitivity reactions, and to sharing expertise on this clinical problem.

• The Evidence Based Medicine and Methodology Special Committee developed a survey to establish allergists’ educational needs in evidence based medicine.
WAO Member Societies

All active members of dues-paying Member Societies are Individual Members of the World Allergy Organization (WAO).

Albanian Society of Allergology and Clinical Immunology
American Academy of Allergy, Asthma and Immunology
American College of Allergy, Asthma and Immunology
Argentine Association of Allergy and Clinical Immunology
Argentine Society of Allergy and Immunopathology
Australian Society of Clinical Immunology and Allergy
Austrian Society of Allergology and Immunology
Azerbaijan Society for Asthma, Allergy and Clinical Immunology
Bangladesh Society of Allergy and Immunology
Belgian Society of Allergology and Immunology
Brazilian Society of Allergy and Immunopathology
British Society for Allergy and Clinical Immunology
Bulgarian National Society of Allergology
Canadian Society of Allergy and Clinical Immunology
Chilean Society of Allergy and Immunology
China Allergology Society and Chinese Allergists
Colombian Allergy, Asthma, and Immunology Association
Croatian Society of Allergology and Clinical Immunology
Cuban Society of Allergology
Czech Society of Allergology and Clinical Immunology
Danish Society for Allergy
Dutch Society of Allergology
Egyptian Society of Allergy and Clinical Immunology
Egyptian Society of Pediatric Allergy and Immunology
Finnish Society of Allergology and Clinical Immunology
French Society of Allergology
Georgian Association of Allergology and Clinical Immunology
German Society for Allergology and Clinical Immunology
Hellenic Society of Allergology and Clinical Immunology
Honduran Society of Allergy and Clinical Immunology
Hong Kong Institute of Allergy
Hungarian Society of Allergology and Clinical Immunology
Icelandic Society of Allergy and Immunology
Indian College of Allergy, Asthma and Applied Immunology
Indonesian Society for Allergy and Immunology
Israel Association of Allergy and Clinical Immunology
Italian Association of Territorial and Hospital Allergists
Italian Society for Allergology and Clinical Immunology
Japanese Society of Allergology
Korean Academy of Allergy, Asthma and Clinical Immunology
Latvian Association of Allergists
Lebanese Society of Allergy and Immunology
Malaysian Society of Allergy and Immunology
Mexican College of Allergy, Asthma and Clinical Immunology
Mexican College of Pediatricians Specialized in Allergy and Clinical Immunology
Mongolian Society of Allergology
Norwegian Society of Allergy and Immunopathology
Panamanian Association of Allergology and Clinical Immunology
Paraguayan Society of Immunology and Allergy
Peruvian Society of Allergy and Immunology
Philippine Society of Allergy, Asthma and Immunology
Polish Society of Allergology
Portuguese Society of Allergology and Clinical Immunology
Romanian Society of Allergology and Clinical Immunology
Russian Association of Allergology and Clinical Immunology
Serbian Association of Allergologists and Clinical Immunologists
Allergy and Clinical Immunology Society (Singapore)
Slovenian Association for Allergology and Clinical Immunology
South African Society of Allergy and Clinical Immunology
Spanish Society of Allergology and Clinical Immunology
Allergy & Immunology Society of Sri Lanka
Swiss Society of Allergology and Immunology
Allergy, Asthma and Immunology Society of Thailand
Turkish National Society of Allergy and Clinical Immunology
Ukrainian Association of Allergologists and Clinical Immunologists
Uruguayan Society of Allergology
Venezuelan Society of Allergy and Immunology
Vietnamese Association of Allergy, Asthma and Clinical Immunology
Zimbabwe Allergy Society

Regional Organizations
Asia Pacific Association of Allergology and Clinical Immunology
Commonwealth of Independent States (CIS Society)
European Academy of Allergy and Clinical Immunology
Latin American Society of Allergy, Asthma and Immunology

Affiliate Organizations
Global Allergy and Asthma European Network (GA2LEN)
International Primary Care Respiratory Group (IPCRG)
International Association of Asthmology
Southern European Allergy Societies (SEAS)

Associate Member Societies
National Association for Private Algerian Allergists
Ecuadorean Society of Allergology and Affiliated Sciences
Ecuadorean Society of Allergy and Immunology
Jordanian Society for Allergy and Clinical Immunology
Kuwait Society of Allergy and Clinical Immunology
Moroccan Society of Allergology and Clinical Immunology
Swedish Association for Allergology

For WAO membership information please contact the Secretariat
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Tel: +1 414 276 1791 • Fax: +1 414 276 3349
e-mail: info@worldallergy.org
Web site: www.worldallergy.org
Dear Colleagues,

A warm welcome to the 38th symposium in the World Allergy Forum (WAF) series: Allergic Diseases, Asthma and Sleep Disturbances.

San Francisco is a historic venue for WAF; the first symposium in the series was presented at the AAAAI Annual Meeting in San Francisco in 1997. Since then, WAF has flourished and become the longest continuing educational program of World Allergy Organization (WAO). This world federation of allergy, asthma and immunology societies is proud and grateful that the program is hosted annually by the AAAAI. The series was launched in 1997 with a symposium on the cellular mechanisms and treatment of rhinitis, with a first rate faculty — Larry Lichtenstein, Bill Busse, Estelle Simons, Peter Howarth, and Alkis Togias. They set a precedence for the many cutting edge symposia that have been presented since that time.

Today’s program considers the sleep disturbances that affect individuals with allergic airways diseases. Disturbed sleep impacts the quality-of-life, both for those directly afflicted and for their families. Disturbed sleep affects academic and work performance, the ability to participate in sports or play activities, and leads to daytime tiredness and somnolence which can be extremely dangerous. Parents, partners, siblings or caregivers who are woken at night are also affected by interrupted sleep, resulting in added tension and distress.

Athanasios Kaditis will begin the symposium by discussing the issues affecting the upper airway, asthma and sleep disorders in children. He will be followed by Richard Schwab who will review these same issues as they relate to adults. Mac Anderson will conclude the symposium with a discussion on sleep apnea and sleep disorders in all age groups. There will be an open discussion following the formal lectures.

The WAO Board hopes that you enjoy today’s program and if you would like to access the faculty materials after the session they will be available at: http://www.worldallergy.org/educational_programs/world_allergy_forum/

WAO gratefully acknowledges the unrestricted educational grant from Novartis that supports educations programs such as this conjoint program at the AAAAI meeting.

With best regards,

Richard F. Lockey, MD, FAAAI
President
World Allergy Organization

Mark Ballow, MD, FAAAI
President
American Academy of Allergy, Asthma and Immunology
Snoring is the most common clinical manifestation of obstructive sleep-disordered breathing (1). Moreover, wheezing is the most characteristic symptom of lower airway obstruction, a disorder that is frequently virus-induced and with or without an asthmatic component (2). This presentation will summarize published evidence on the interaction between obstructive sleep-disordered breathing and recurrent wheezing or asthma in childhood, and their effects on sleep quality.

**Obstructive sleep-disordered breathing and its effects on sleep quality**

The term “obstructive sleep-disordered breathing” describes a spectrum of abnormal breathing patterns during sleep characterized by snoring and increased respiratory effort (3). Enlarged tonsils and adenoid, or obesity, are common abnormalities that can increase resistance to airflow and the tendency of the pharyngeal airway to collapse during inspiration (pharyngeal collapsibility) (4, 5). Although EEG arousal is an important defense mechanism against airway obstruction, it has also a negative impact on sleep architecture and quality (6). As a result, increased frequency of daytime sleepiness, inattention, hyperactivity, cognitive problems and academic difficulties have been demonstrated in children with obstructive sleep-disordered breathing (7, 8).

**Effects of wheezing on sleep quality**

In a cross-sectional pediatric study, subjects with parental report of wheezing in the last 12 months had a 2-fold higher risk for difficulty falling asleep, a 4-fold higher risk for restless sleep and a 5-fold higher risk for daytime sleepiness as compared to those without wheezing (9).

**Association of sleep-disordered breathing with recurrent wheezing or asthma**

Several studies have demonstrated more frequent snoring in asthmatic children when compared to non-asthmatic control subjects (10-12). Redline and colleagues have shown that usual cough, occasional and persistent wheeze, and doctor-diagnosed asthma are significant risk factors for the presence of an apnea-hypopnea index greater than 10 episodes/h (13). Tonsillar hypertrophy mediates at least in part the relationship between recurrent wheezing or asthma and obstructive sleep-disordered breathing in childhood (14).

**Pathogenic links between obstructive sleep-disordered breathing and recurrent wheezing or asthma**

It has been speculated that the epidemiologic association between recurrent wheezing or asthma and obstructive sleep-disordered breathing is the result of both conditions sharing common pathogenic pathways (13). Airway oxidative stress and inflammation related to leukotrienes have been implicated in the pathogenesis of both obstructive sleep-disordered breathing and recurrent wheezing. Increased concentrations of leukotriene B4, cysteinyl leukotrienes and isoprostane-8, a marker of oxidative stress, have been found in the exhaled breath condensate of children with episodic or persistent asthma (15-18). Similar findings have been demonstrated in pediatric patients with obstructive sleep-disordered breathing (19, 20).

Of interest, sleep apneic children have increased activity and content of cysteinyl leukotrienes in adenoid and tonsils (21, 22). Cysteinyl leukotrienes induce a proliferative response in tonsillar cell cultures and they may be implicated in the pathogenesis of adenotonsillar hypertrophy (23). Airway inflammation and especially oxidative stress, could enhance the biosynthesis of cysteinyl leukotrienes within the pharyngeal lymphoid tissues promoting adenotonsillar enlargement and deterioration of upper airway obstruction.

**Key words:** leukotrienes, 8-isoprostane, oxidative stress, snoring, wheezing

**References**


The Upper Airway, Asthma and Sleep Disorders in Children

A. Kaditis, MD

Pediatric Pulmonology Unit, Sleep Disorders Laboratory
First Department of Pediatrics
University of Athens School of Medicine
and Aghia Sophia Children’s Hospital
Athens, Greece

Upper Airway, Asthma, Sleep Disorders

Snoring → Recurrent Wheezing

Sleep Quality

Upper Airway, Asthma, Sleep Disorders

Pathophysiology of Obstructive Sleep-Disordered Breathing and its effects on Sleep Quality
Obstructive Sleep-Disordered Breathing

Spectrum of abnormal respiratory patterns during sleep characterized by snoring and increased respiratory effort

- Primary snoring
- Upper airway resistance syndrome
- Obstructive hypoventilation
- Obstructive sleep apnea (OSA)

A Mechanical Model for Obstructive Sleep-Disordered Breathing

Katz et al. Genioglossus activity during sleep in normal control subjects and children with OSA. AJRCCM 2004;170:553
Upper Airway Dysfunction and Adenotonsillar Hypertrophy

Conditions affecting Upper Airway Resistance and Pharyngeal Collapsibility

- Septal deviation
- Nasal polyps
- Hypertrophied turbinates
- Obesity
- Craniofacial abnormalities
- Neuromuscular disorders

OSA symptoms

- Snoring
- Reported apneas during sleep
- Difficulty breathing during sleep
- Restless sleep
- Frequent arousals
- Daytime sleepiness
- Hyperactivity
- Decreased cognitive functioning
- Learning problems
Allergic Rhinitis and Obstructive Sleep-Disordered Breathing

- Kalra et al. Atopy as a Risk Factor for Habitual Snoring at Age 1 Year. Chest 2006;129:942-6
- 13.7 ± 2.6 months
- Independent Risk Factor for habitual snoring

SPT positive 2.0 1.2-3.0 0.01

Upper Airway, Asthma, Sleep Disorders

Effects of Recurrent Wheezing on Sleep Quality


<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Wheezing adjusted for snoring</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty falling asleep</td>
<td>2.0 (1.0-4.0)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Restless sleep</td>
<td>5.0 (2.2-11.1)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Daytime sleepiness</td>
<td>3.8 (1.8-8.0)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Daytime tiredness</td>
<td>5.1 (2.2-12.1)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
### Upper Airway, Asthma, Sleep Disorders

#### Epidemiologic Association between Snoring and Recurrent Wheezing

![Image of a person snoring]

### Redline et al. Risk Factors for SDB in Children.
*AJRCCM 199,159,1527*

<table>
<thead>
<tr>
<th>Risk factors adjusted for race, obesity</th>
<th>AHI&gt;10 OR (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occasional wheeze</td>
<td>3.29 (1.24-8.94)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Persistent wheeze</td>
<td>7.45 (2.03-27.39)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Cough</td>
<td>8.83 (2.29-34.05)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>History of asthma</td>
<td>3.83 (1.39-10.55)</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

### Kedits et al. Associations of Tonsillar Hypertrophy and Snoring with History of Wheezing in Childhood. *Pediatr Pulmonol* 2010;45:275

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Dependent variable: snoring OR (95% CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.95 (0.90-1.01)</td>
<td>0.125</td>
</tr>
<tr>
<td>Gender</td>
<td>1.67 (1.08-2.58)</td>
<td>0.020</td>
</tr>
<tr>
<td>Obesity</td>
<td>1.65 (1.02-2.66)</td>
<td>0.041</td>
</tr>
<tr>
<td>Passive Smoking</td>
<td>0.88 (0.58-1.35)</td>
<td>0.565</td>
</tr>
<tr>
<td>History of wheezing</td>
<td>1.73 (1.12-2.67)</td>
<td>0.013</td>
</tr>
</tbody>
</table>
Tonsillar hypertrophy partially explains the association of snoring with wheezing

Wheezing is significantly associated with snoring

In children with tonsillar hypertrophy
[OR = 2.76 (1.10-6.93); p=0.031],

But not in children without tonsillar hypertrophy
[OR = 1.49 (0.92-2.43); p=0.107].
Biltagi et al. Correlation of 8-isoprostane, IL-6, and cardiac functions in childhood with OSA. Acta Paediatr 2008;97:1397

<table>
<thead>
<tr>
<th>Isoprostane (pg/mL)</th>
<th>Control</th>
<th>Score 20-40</th>
<th>Score &gt;40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>34.9</td>
<td>45.25</td>
<td>58.6</td>
</tr>
<tr>
<td>SD ±</td>
<td>1.6</td>
<td>5.2</td>
<td>2.9</td>
</tr>
</tbody>
</table>


OSA  
Recurrent tonsillitis

Goldbart et al. Leukotriene Modifier Therapy for Mild SDB. AJRCCM 2005; 172: 364

OSA  
Recurrent tonsillitis
Conclusions

- Obstructive sleep-disordered breathing and recurrent wheezing/asthma: Both result in sleep-disturbance
- Obstructive sleep-disordered breathing is associated with allergic rhinitis and frequently coexists with recurrent wheezing/asthma
- Airway inflammation related to leukotrienes and oxidative stress: Probably participate in the pathogenesis of both snoring and recurrent wheezing
The Upper Airway and Sleep Disorders in Adults

Richard J. Schwab, MD
Professor of Medicine
Division of Sleep Medicine
Pulmonary, Allergy and Critical Care Division
University of Pennsylvania
Philadelphia, PA, USA

Goals
• To understand and define the spectrum of sleep disordered breathing
• To review the pathogenesis and clinical presentation of obstructive sleep apnea
• To highlight the diagnostic algorithm in obstructive sleep apnea
• To discuss medical consequences of obstructive sleep apnea

Spectrum of Sleep Disordered Breathing
Sleep disordered breathing should be considered a continuum of abnormality, i.e., a spectrum of diseases from snoring to UARS (upper airway resistance syndrome — snoring related arousals without reductions in airflow) to obstructive sleep apnea (combination of apneas (complete airflow obstruction) and hypopneas (partial airflow obstruction) to obesity-hypoventilation syndrome (Pickwickian syndrome):

Snoring ⇔ UARS ⇔ Hypopneas ⇔ Obstructive Apneas ⇔ Hypoventilation

Factors that can move individual patients down this spectrum include weight gain, increased age, sleep deprivation, alcohol (preferentially suppresses the activity of upper airway dilator muscles) and sedative use. Snoring should not be considered normal; it is often the first manifestation of sleep-disordered breathing.

Upper Airway Resistance Syndrome
The upper airway resistance is characterized by recurrent arousals secondary to increased upper airway resistance (or crescendo snoring). In this syndrome repeated arousals are noted secondary to snoring or increased upper airway resistance. These arousals may result in significant sleep fragmentation and daytime sleepiness. The upper airway resistance syndrome has also recently been associated with hypertension.

In order to accurately diagnose the upper airway resistance syndrome a polysomnogram with an esophageal balloon is necessary. Since most sleep laboratories do not use esophageal balloons a less invasive method of diagnosing the upper airway resistance syndrome is by counting arousals associated with episodes of snoring. It is likely, although unproven, that using snoring related arousals to diagnose the upper airway resistance syndrome underestimates the prevalence of this disorder. If the snoring related arousal index is > 5-10/hour, treatment should be considered for the upper airway resistance syndrome. The treatment of choice currently for the upper airway resistance syndrome is nasal CPAP although oral appliances and possibly upper airway surgery may be effective therapeutic interventions.

Epidemiology and Risk Factors for Obstructive Sleep Apnea
Sleep apnea is an extremely common disorder. The Wisconsin Sleep Cohort Study found that 9% of middle-aged males and 4% of middle-aged females had evidence for sleep apnea. If night-time and daytime symptoms (excessive sleepiness) were included in the definition of sleep apnea, 4% of middle-aged males and 2% of middle-aged females fulfilled this criterion. Epidemiological studies show a male predominance, i.e., obstructive sleep apnea is twice as common in males than females.

The major risk factor for obstructive sleep apnea, at least in adults, is obesity. Not surprisingly, it is fat in the neck that plays the largest role. In population studies, neck (or collar size) is the best predictor of the presence of sleep apnea. Approximately 30% of snoring males with a collar size > 17 inches will have obstructive sleep apnea. Neck size in women is less well investigated, but > 15 inches increases the risk for sleep apnea. Obesity is not the only risk factor for obstructive sleep apnea. Upper airway anatomy (enlargement of the tongue (macroglossia), tonsils (palatine and lingual), adenoids, soft palate, and lateral pharyngeal walls; and reduction in the size of the mandible (retrognathia/maxilla), genetic factors, endocrine disorders (hypothyroidism, acromegaly) and substances that reduce upper airway muscle tone (alcohol, sedatives or hypnotics) also play a role.

Clinical Presentation of Obstructive Sleep Apnea
Obstructive sleep apnea is not a difficult diagnosis to make and should be considered in all overweight or retrognathic (recessed jaw) patients who complain of habitual snoring and/or daytime sleepiness.

Symptoms
The cardinal symptoms of sleep apnea are excessive daytime sleepiness, sleep fragmentation and loud habitual snoring. Witnessed apneic episodes (nocturnal grunting/gasping) are frequently reported. Patients may fall asleep at inappropriate times, such as while watching television or reading, in the middle of a conversation, or while operating a motor vehicle. Patients with sleep apnea have a 3-7 fold greater rate of motor vehicle accidents than subjects without sleep apnea. Other common symptoms include personality changes (especially irritability), nocturia, morning headaches (this suggests hypercapnia and concomitant obesity-hypoventilation syndrome), intellectual impairment, reduction in libido, palpitations and memory loss.

Physical Examination
All patients with sleep apnea should have a careful head and neck examination paying particular attention to the size of the bony and soft tissue...
oropharyngeal structures. Neck size measured at the cricoid membrane should be obtained (>17 inches in men and >15 inches in women increases the risk for sleep apnea). Craniofacial risk factors for sleep apnea include retrognathia, micrognathia, a narrow hard palate, nasal obstruction, an overjet (greater than a 3 mm anterior-posterior distance between the upper and lower incisors during occlusion) and overbite (greater than a 3 mm vertical distance between the upper and lower incisors during occlusion). The nares should be examined for nasal polyps and nasal septal deviation. Retrognathia is defined as a > 0.5 cm retroposition of the gnathion (the most inferior point in the contour of the chin) relative to the plane of the nasion (the deepest point of the superior aspect of the nasal bone, i.e., the base of the nose). In general, the forehead, maxilla and mandible should be aligned; if the mandible is behind these structures, retrognathia is present. Upper airway soft tissue risk factors for sleep apnea include macroglossia, tonsillar hypertrophy (palatine or lingual) and enlargement of the soft palate/uvula and lateral pharyngeal walls. The tongue is considered enlarged if it is 15% of the mandibular occlusal plane. Tonsillar enlargement is defined as the presence of lateral impingement of greater than 50% of the posterior pharyngeal airways. The uvula is considered enlarged if it is >1.5 cm in length or >1.0 cm in width. Lateral perilatissillar narrowing is defined as impingement of greater than 25% of the pharyngeal space by the peritonsillar tissues, excluding the tonsils. Recent studies using volumetric MRI have demonstrated enlargement of the tongue and lateral pharyngeal walls are important anatomic risk factors for sleep apnea. In addition, recent studies have demonstrated heritability and family aggregation of these upper airway anatomic risk factors for sleep apnea. Such data provide strong evidence for the genetic basis of sleep apnea.

**Diagnosis of Obstructive Sleep Apnea**

The gold standard for making the diagnosis of obstructive sleep apnea is with an overnight polysomnogram demonstrating recurrent episodes of cessation of respiration (apneas) or decrements in airflow (hypopneas) during sleep associated with arousals and arterial oxyhemoglobin desaturations. Patients with sleep apnea show respiratory effort (i.e., chest wall and abdominal wall movement), unlike patients with central sleep apnea in whom there is no respiratory drive. An apnea is defined as cessation of airflow for at least 10 seconds. An apnea can be obstructive (no airflow but continued respiratory effort), central (airflow and respiratory effort are both absent), or mixed. A mixed apnea is one which starts as a central event but then becomes obstructive during the same episode. Most patients with obstructive sleep apnea have both obstructive and mixed apneas. In addition, hypopneas (a decrement in airflow of 50% or more associated with a 4% fall in oxygen saturation and/or an electroencephalographic arousal) can produce similar clinical consequences as apneas. Therefore the apnea/hypopnea index (AHI: the number of apneas plus hypopneas per hour of sleep) has become the metric to define and quantify the severity of obstructive sleep apnea. The apnea/hypopnea index is calculated from the number of apneas plus hypopneas per hour. An AHI of 0 - 5 events/hour is considered normal; an AHI 5 - 15 events/hour is considered mild sleep apnea; an AHI 15 - 30 events/hour is considered moderate sleep apnea and an AHI >30 events/hour is considered severe sleep apnea. In the hospitalized patient nocturnal oximetry demonstrating recurrent oxyhemoglobin desaturations has been used as a screening test for sleep apnea. During an apnea the PO2 will often decrease and the PCO2 will increase slightly.

**Consequences of Obstructive Sleep Apnea**

Consequences of obstructive sleep apnea can be broadly divided into those related to the excessive sleepiness and those related to the cardiovascular system. Excessive daytime sleepiness produces a number of different problems for patients with sleep apnea, among which the most serious is vehicular crashes. Studies in driving simulators indicate that sleep apnea impairs driving ability. Recently it has been demonstrated that patients with sleep apnea can be as impaired in driving skills as those who are over the legal blood alcohol concentration. Cardiovascular risks associated with sleep apnea include hypertension, myocardial infarction, cardiac arrhythmias and stroke. The sleep health heart study (6000 adults had sleep studies and were followed for cardiovascular morbidity) has demonstrated that patients with sleep apnea are at increased risk for hypertension. Obstructive sleep apnea has also been demonstrated to be an important risk factor for myocardial infarction and cerebral vascular accidents. Nocturnal cardiac arrhythmias including sinus bradycardia/tachycardia (most common arrhythmia), atrial fibrillation, atrial and ventricular tachycardia, heart block and sinus pauses have been reported during apneic episodes (the nocturnal arrhythmias are often a clue to the diagnosis). These arrhythmias often resolve with treatment of the obstructive sleep apnea so a pacemaker may not be indicated.

Pulmonary hypertension and right heart failure develop in approximately 10 to 15% of patients with severe sleep apnea.

**References**


The Upper Airway and Sleep Disorders in Adults

Richard J. Schwab, M.D.
Professor of Medicine
Pulmonary, Allergy and Critical Care Division
Division of Sleep Medicine
University of Pennsylvania Medical Center
Philadelphia, Pennsylvania

The Upper Airway and Sleep Disorders in Adults

• To understand and define the spectrum of sleep disordered breathing
• To review the pathogenesis and clinical presentation of obstructive sleep apnea
• To highlight the diagnostic algorithm in obstructive sleep apnea
• To discuss medical consequences of obstructive sleep apnea

Spectrum of Sleep Disordered Breathing

- Snoring → UARS → Hypopneas
- Obesity-Hypoventilation Syndrome → Apneas
**Snoring**

- 25% of men and 15% of women are habitual snorers
  - Alcohol increases snoring
- Consequences:
  - 30 - 50% of asymptomatic snorers have sleep apnea
  - Upper airway resistance syndrome
  - Risk factor for HTN, CVA, MI, carotid atherosclerosis
  - Socially unacceptable (marital conflicts, sleeping in the living room)

---

**Upper Airway Resistance Syndrome**

- Patients with crescendo snoring
- Excessive daytime sleepiness even without apneas/hypopneas
- Increase in upper airway resistance triggers arousal; hence sleep fragmentation
- Esophageal balloon to measure increased upper airway resistance for definitive diagnosis
- Treat with CPAP - determine an appropriate level which abolishes snoring
**Does Snoring Lead to Carotid Atherosclerosis?**

**Provocative Concept**

Heavy snoring as a cause of carotid artery atherosclerosis.

Lee SA et al, Sleep 31:1207, 2008

- 110 volunteers (snorers and nonsnorers with only mild non-hypoxic OSA)
- 3 snoring groups: 1) mild (0-25% of the night), 2) moderate (> 25-50% of the night), 3) heavy (> 50% of the night)

---

**Heavy Snoring (% of Night >50%) Increases Prevalence of Carotid Atherosclerosis but not Femoral**

*Lee SA, et al, Sleep 31:1207, 2008*

![Graph showing the prevalence of carotid atherosclerosis for different snoring groups.](image)

- Solid bar: Carotid atherosclerosis
- Striped bar: Femoral atherosclerosis

---

**Risk Factors for Carotid Atherosclerosis**

*Lee SA, et al, Sleep 31:1207, 2008*

<table>
<thead>
<tr>
<th>Snoring group model for carotid atherosclerosis</th>
<th>OR</th>
<th>95% CI</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, per decade</td>
<td>3.2</td>
<td>1.4-7.2</td>
<td>0.006</td>
</tr>
<tr>
<td>Male sex</td>
<td>4.6</td>
<td>1.4-15.2</td>
<td>0.013</td>
</tr>
<tr>
<td>Positive smoking history</td>
<td>3.9</td>
<td>1.1-13.5</td>
<td>0.032</td>
</tr>
<tr>
<td>Positive for hypertension</td>
<td>4.7</td>
<td>1.3-15.7</td>
<td>0.013</td>
</tr>
<tr>
<td>Snoring, % of sleep time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 - 50</td>
<td>1.7</td>
<td>0.4-6.9</td>
<td>0.41</td>
</tr>
<tr>
<td>&gt; 50</td>
<td>10.5</td>
<td>2.1-51.8</td>
<td>0.004</td>
</tr>
</tbody>
</table>
Spectrum of Sleep Disordered Breathing

Obstructive Sleep Apnea Syndrome

- Obstructive sleep apnea a major public health problem affecting 2 - 4% (4 - 9%) middle-aged population
- Recurrent apneic episodes secondary to upper airway occlusion in presence of respiratory effort (chest wall and abdominal wall movement)

Presentation of Obstructive Sleep Apnea

- Middle aged overweight men and women
- Loud snoring*
- Excessive daytime sleepiness* (Epworth Sleepiness Scale)
- Witnessed apneas, nocturnal awakening
- Gasping or choking episodes during sleep
- Obesity*
- Retrognathia (recessed chin)*
Presentation of Obstructive Sleep Apnea

- Increased neck size (> 17 inches in a male; > 15 inches in a female)
- Crowded upper airway - increased tongue size
- Unrefreshing sleep, morning headaches
- Irritability, memory loss, personality change
- Nocturia, decreased libido
- Automobile or work related accidents
- Systemic hypertension

Physical Findings in Patients with Sleep Apnea

- Obesity
- Increased neck circumference
- Nasal airway restriction: septal deviation, allergic rhinitis, nasal polyps
- Macroglossia/tongue ridging
- Adeno-tonsilar hypertrophy (palatine/lingual tonsils)
- Lateral peritonsillar narrowing
- Enlargement/elongation of the soft palate
- Recessed mandible (retrognathia)/maxilla
- Narrowed hard palate - overbite/overjet
- Crowded upper airway - Mallampati score

Obesity Trends* Among U.S. Adults
CDC, 1991 - 2008
(*BMI > 30, or about 30 lbs overweight for 5'4" person)
Physical Examination and Sleep Apnea
(Schellenberg AJRCCM 162:740-748, 2000)

- Hypothesized that narrowing of airway by upper
airway structures would be associated with an
increased risk for obstructive apnea
- Prospectively studied cohort of 420 patients
- Association between individual variables in clinical
model and sleep apnea were compared using
odds-ratios (OR)

Morphometric Measurements
(Schellenberg AJRCCM 162:740-748, 2000)

- Macroglossia: tongue being
above level of mandibular
occlusal plane
- Uvula enlargement: > 1.5 cm in
length or > 1.0 cm in width
- Enlargement of lateral walls: >
25% impingement pharyngeal
space by peritonsillar tissues
- Tonsillar enlargement: > 50%
lateral impingement of posterior
pharyngeal airspace

Modified Mallampati Classification

<table>
<thead>
<tr>
<th>Class</th>
<th>Image</th>
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<tbody>
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<td>Class 1</td>
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<tr>
<td>Class 2</td>
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<td>Class 3</td>
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<tr>
<td>Class 4</td>
<td><img src="http://image.com" alt="Image" /></td>
</tr>
</tbody>
</table>

- Tsai et al., AJRCCM 167:1427-1432, 2003
- Mallampati et al. (1985). A clinical sign to predict difficult tracheal intubation: a
Normal Upper Airway
(Schellenberg et al, AJRCCM 162;740-748, 2000)

Physical Examination and Sleep Apnea
(Schellenberg et al, AJRCCM 162;740-748, 2000)

Macroglossia
Tongue ridging

Physical Examination and Sleep Apnea
(Schellenberg et al, AJRCCM 162;740-748, 2000)

Enlarged Uvula
Lateral Narrowing
Physical Examination and Sleep Apnea
(Schellenberg et al, AJRCCM 162;740-748, 2000)

Adjusted Odds Ratio (OR) for Sleep Apnea

<table>
<thead>
<tr>
<th>Physical Finding</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral Narrowing</td>
<td>2.6*</td>
<td>1.7 - 4.1</td>
</tr>
<tr>
<td>Tonsillar hypertrophy</td>
<td>2.1*</td>
<td>1.1 - 4.2</td>
</tr>
<tr>
<td>Macroglossia</td>
<td>2.0</td>
<td>1.1 - 3.6</td>
</tr>
<tr>
<td>Enlarged soft palate</td>
<td>1.9</td>
<td>1.2 - 2.9</td>
</tr>
<tr>
<td>Retrognathia</td>
<td>1.3</td>
<td>0.8 - 2.1</td>
</tr>
</tbody>
</table>

*Maintained significance after adjusting for BMI/neck size

Sleep Disordered Breathing
Definitions

• Apnea: cessation of breathing for > 10 seconds
• Hypopnea: 50% decrement in airflow associated with a 4% drop in oxygen saturation and/or an arousal
• Apnea Hypopnea Index (AHI): number of apneas plus hypopneas/hour of sleep
Apnea Hypopnea Index (AHI)

- AHI 0 - 5 events/hour: Normal
- AHI 5 - 15 events/hour: Mild sleep apnea
- AHI 15 - 30 events/hour: Moderate sleep apnea
- AHI > 30 events/hour: Severe sleep apnea

Work-up of Obstructive Sleep Apnea

- Screening overnight oximetry (optional)
  - May be useful in a hospitalized patient
- Overnight polysomnography (gold standard)
  - First night diagnostic study
  - Second night therapeutic study with CPAP
- Split-night polysomnography - cost effective
- Home studies

Recurrent $O_2$ Desaturations in a Patient with Obstructive Sleep Apnea ($pCO_2$ no Change)
Sagittal Upper Airway MR Images

Normal Subject  Apneic Patient

Axial Upper Airway MR Images

Normal Subject  Apneic Patient
### Volumetric Anatomic Risk Factors for Sleep Apnea
(Cases/Controls: N = 96)
(Schwab et al, AJRCCM 168; 522-530, 2003)

<table>
<thead>
<tr>
<th>Soft Tissue Volume</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat pads</td>
<td>1.64</td>
<td>1.00 - 2.81</td>
</tr>
<tr>
<td>Lateral Walls</td>
<td>6.01*</td>
<td>2.62 - 17.14</td>
</tr>
<tr>
<td>Soft Palate</td>
<td>1.66</td>
<td>0.99 - 3.18</td>
</tr>
<tr>
<td>Tongue</td>
<td>6.55*</td>
<td>2.81 - 19.42</td>
</tr>
<tr>
<td>Total Soft Tissue</td>
<td>6.95*</td>
<td>3.08 - 19.11</td>
</tr>
</tbody>
</table>

*Adjusted for gender, ethnicity, age, craniofacial size and visceral neck fat

* = Significant

---

### Airway Closure During Sleep - Apneic
**Endocrine/Metabolic Risk Factors for OSA**

- Hypothyroidism
- Acromegaly
- Polycystic ovarian syndrome
- Testosterone replacement
- Postmenopause
- Cushing’s Syndrome
- Diabetes Mellitus
- Atherosclerosis/metabolic syndrome
- Inflammation/oxidative stress

---

**Undiagnosed Sleep Disordered Breathing in Obese Patients with Type 2 Diabetes (N=305)**

*Foster et al, Diabetes Care (2009)*

- Examined 305 obese type 2 diabetics to determine the severity and prevalence of OSA:
  - 13.4% - normal (AHI < 5 events/hour)
  - 33.4% - mild OSA (AHI 5 - 15 events/hour)
  - 30.5% - moderate OSA (AHI 15 - 30 events/hour)
  - 22.6% - severe OSA (AHI > 30 events/hour)
- Exceedingly high prevalence (86.6%) of OSA among obese patients with type 2 diabetes

---

**Consequences of Obstructive Sleep Apnea**

- Hypertension
- Right and left congestive heart failure
- Nocturnal arrhythmias
- Myocardial infarction
- Pulmonary hypertension
- Stroke
Consequences of Obstructive Sleep Apnea

- Cognitive impairment
- Sexual dysfunction
- Injury due to automobile accidents
- Injury due to work-related accidents
- Death

Tracking Errors Produced by Ethanol and Obstructive Sleep Apnea

(George et al. AJRCCM 154:175, 1996)

Sleep apnea impairs driving performance

Sleep Heart Health Study: A Cross-sectional Analysis for Hypertension

(Nieto et al. JAMA 283:1829, 2000)

Conclusion – Sleep apnea is an independent risk factor for systemic hypertension
Dose-Response Curves for CVD and SDB
(Shahar E et al., AJRCCM 163:19-25, 2001)

Cardiovascular Outcomes in Men with Obstructive Sleep Apnea

<table>
<thead>
<tr>
<th></th>
<th>Healthy men (n=256)</th>
<th>Untreated severe OSAH (n=20)</th>
<th>Untreated moderate/severe OSAH (n=125)</th>
<th>Untreated with CPAP (n=27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-cardiovascular events</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of events</td>
<td>12</td>
<td>22</td>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td>Events per 100 person-years</td>
<td>0.45</td>
<td>0.95</td>
<td>0.89</td>
<td>0.64</td>
</tr>
<tr>
<td>Cardiovascular death</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of events</td>
<td>8</td>
<td>13</td>
<td>33</td>
<td>75</td>
</tr>
<tr>
<td>Events per 100 person-years</td>
<td>0.3</td>
<td>0.34</td>
<td>0.65</td>
<td>1.64</td>
</tr>
</tbody>
</table>

OSA-H—obstructive sleep apnoea–hypopnoea syndrome; CPAP—continuous positive airway pressure. *p<0.001 versus healthy men; †p<0.001.
Table 2: Incidence of cardiovascular events during the 10-year follow-up in healthy men, sones, and patients untreated and treated for OSAH.

Marin et al. Lancet 365:1046-1053, 2005

Recurrence of Atrial Fibrillation Following Cardioversion is Higher in Patients with Untreated OSA
(Kanagala et al, Circ 107:2589, 2003)

% Recurrence at 12 Months

* p < 0.009 compared to controls
** p < 0.013 compared to treated OSA
Increased Mortality in OSA (Wisconsin Sleep Cohort)

Conclusions – OSA

- Pay attention to upper airway anatomy
- Upper airway soft tissue structures are enlarged in patients with sleep apnea
- OSA is an inflammatory disorder and may be linked to atherosclerosis
- OSA is extremely common in obese type 2 diabetics
- Sleep apnea is associated with significant cardiovascular consequences
- Atrial fibrillation commonly recurs in patients with sleep apnea

The Upper Airway and Sleep Disorders in Adults

Thank you for your attention!

Any Questions?

rschwab@mail.med.upenn.edu
Management of patients with allergic diseases of the nose, sinuses and lungs, has a great impact on their sleep quality and daytime functioning. This further complicates the treatment of obstructive sleep apnea (OSA). Avoidance of irritants, oral and nasal antihistamines as well as steroids are the mainstay of therapy. Bronchodilators are coupled with the steroids in the patient with asthma. These techniques may work well until the patient is found to have significant OSA and must begin therapy with a nasal interface for continuous positive airway pressure (CPAP). We find that these patients are often lifelong mouth breathers and often present with no prior evaluation or treatment for nose or sinus disease. Careful attention to the various mask interfaces for CPAP may improve their adherence to CPAP therapy. Furthermore, studies have shown that maximizing heat and humidity to the nose and pharynx may enhance therapy for allergic disorders as well as prove imperative to successful CPAP therapy of even the most severe cases of OSA. In children, we find that these same interventions are also necessary, however, obstruction by enlarged tonsils and adenoids may be the predominate cause of airway obstruction. This may require surgical resection in addition to the drug therapy described above. Careful follow-up of the child with OSA is needed however, as surgery may not be curative.
Obstructive Sleep Apnea and Sleep Disorders in All Age Groups

Treatment

W. McD. Anderson, M.D.
Medical Director, Tampa General Hospital Sleep Center
Professor of Medicine, USF College of Medicine
Program Director, USF Sleep Medicine

- Allergic rhinitis and sinusitis
- Asthma
- Obstructive Sleep Apnea

Allergies
Allergies
CT-SCAN OF SINUSES

M - maxillary sinus, + thickening of the maxillary sinus (4-6 mm), E - ethmoid sinuses, P - polyp, * - middle meatus

ALLERGIC RHINITIS
THERAPY

- Avoidance
- Pharmaceutical therapeutics
- Immunomodulation
  - Allergy shots/immunotherapy/vaccination
    - SCIT and SLIT
  - Monoclonal antibodies
    - Omalizumab

Prevalence of Sleep Complaints and Sleep Disorders in Patients with Allergic Rhinitis
(Ages 18-50 years)

<table>
<thead>
<tr>
<th>Complaint/Disorder</th>
<th>Control Group %</th>
<th>Mild AR %</th>
<th>Mod-Sev AR %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Complaint</td>
<td>N=502</td>
<td>N=140</td>
<td>N=451</td>
</tr>
<tr>
<td>Difficulty falling asleep</td>
<td>18</td>
<td>18</td>
<td>56*</td>
</tr>
<tr>
<td>Nocturnal awakening</td>
<td>21</td>
<td>15</td>
<td>52*</td>
</tr>
<tr>
<td>Early awakening</td>
<td>13</td>
<td>15</td>
<td>33*</td>
</tr>
<tr>
<td>Feeling lack of sleep</td>
<td>25</td>
<td>48</td>
<td>86*</td>
</tr>
<tr>
<td>Snoring</td>
<td>27</td>
<td>31</td>
<td>46*</td>
</tr>
<tr>
<td>ESS score &gt;10</td>
<td>17</td>
<td>11</td>
<td>25*</td>
</tr>
</tbody>
</table>

*p<0.05 vs. control group

Arch intern Med 2006; 166: 1744-1748
Prevalence of Sleep Complaints and Sleep Disorders in Patients with Allergic Rhinitis
(Ages 18-50 years)

<table>
<thead>
<tr>
<th>Complaint/Disorder</th>
<th>Control Group %</th>
<th>Mild AR %</th>
<th>Mod-Sev AR %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=882</td>
<td>N=140</td>
<td>N=481</td>
</tr>
<tr>
<td>Sleep Disorders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insomnia</td>
<td>16</td>
<td>15</td>
<td>42*</td>
</tr>
<tr>
<td>Severe insomnia</td>
<td>10</td>
<td>11</td>
<td>27*</td>
</tr>
<tr>
<td>Sleep apnea</td>
<td>0.6</td>
<td>2</td>
<td>3*</td>
</tr>
<tr>
<td>Hypersomnia</td>
<td>24</td>
<td>20</td>
<td>38*</td>
</tr>
<tr>
<td>Regular use of sedatives</td>
<td>3</td>
<td>4</td>
<td>11*</td>
</tr>
</tbody>
</table>

*p<0.05 vs. control group

Effect of Allergic Rhinitis and Antihistamine Use on Learning in Children

Ages 10-12 Years

* p<0.012 vs healthy

Effects of Loratadine & Montelukast on Nighttime Symptoms

Nighttime Symptoms Score

(Mean Baseline = 1.46) *p<0.001

Arch Intern Med 2006; 166: 1744-1748

Ann Allergy 1993; 71:121-26

Am J Rhinol 2005; 19: 594-8
**Olopatadine Nasal Spray:**
Significantly Improved QoL Variables

![Graph showing improvements in QoL variables with Olopatadine nasal spray](image)


---

**Intranasal Corticosteroid Improves Nasal Congestion and Sleep Quality**
(N=20 crossover)

![Graph showing improvements in nasal congestion and sleep quality with intranasal corticosteroid](image)

J Allergy Clin Immunol 2004; 114:5146-53

---

**Mometasone Nasal Spray in PAR: Change in Epworth Sleepiness Score (ESS) Scores**

![Graph showing change in ESS scores with Mometasone nasal spray](image)

Meltzer EO. Ann Allergy Asthma Immunol submitted
Nocturnal Asthma

Tiotropium

Peters SP, et al. NEJM 363:1715, 2010

---

Nocturnal Asthma

OSA & CPAP

Nasal CPAP improves PEFR in nocturnal asthma


---

Obstructive Sleep Apnea

Behavioral Treatment

- Weight loss
- Avoidance of alcohol and sedatives
- Avoidance of sleep deprivation
- Nocturnal bed positioning

Strollo NEJM 334: 102, 1996
Obstructive Sleep Apnea

Adenotonsillectomy

Obstructive Sleep Apnea in Children

Adenotonsillectomy


Obstructive Sleep Apnea

Weight Loss

Nolan J. Tampa Trib 12/28
OSA and Weight Loss
Upper Airway Volumetric MRI

Welch Sleep 25:536, 2002

Obstructive Sleep Apnea
Medical Treatment

- First-line therapy
- Positive pressure with a mask
- Second-line therapy
- Oral appliance
- Other
  - Fluoxetine or propranolol
  - Thyroid hormone (in hypothyroid patients)
  - Nocturnal oxygen

Strollo NEJM 334:102, 1996

Benefits of Nasal CPAP for OSA

Randomized placebo-controlled trials
- Decrease somnolence
- Decrease auto accidents
- Improve quality of life
- Improve mood and alertness


Cohort studies
- Improved pulmonary hemodynamics and mortality

Positive Airway Pressure

PAP

• CPAP
  Continuous Positive Airway Pressure
• BiPAP
  BiLevel Positive Airway Pressure
• AutoPAP/SmartPAP
  Automatic/Smart/Self-Adjusting Positive Airway Pressure

Modes of PAP Therapy

<table>
<thead>
<tr>
<th>Manual CPAP Mode</th>
<th>Bi-level Mode</th>
<th>Auto-CPAP Mode</th>
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<tbody>
<tr>
<td>0 pressure</td>
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<td>0 pressure</td>
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</tbody>
</table>
OSA Treatment
Mandibular Advancement Device

- Ten nonapneic adults
- 4 mandibular positions
- Most retruded, 33% - 67% and max. protrusion
- The AP width of the velopharynx increased

Tsuki Sleep 24:554, 2001

OSA Treatment
Mandibular Advancement Device

- KlearWay device
- Enlarges velopharynx
- Hyoid bone and third cervical vertebra moved forward

OSA Treatment
Mandibular Advancement Device
Obstructive Sleep Apnea
Surgical Treatment

- Upper-airway bypass
- Tracheostomy
- Upper-airway reconstruction
  - Uvulopalatopharyngoplasty
  - Genioglossal advancement
  - Maxillomandibular advancement

Strollo NEJM 334: 102 1996

OSA Treatment
Uvulopalatopharyngoplasty

- UPPP at 29 year review
- 40% success rate
- UPPP is probably overused as an isolated procedure

Sher Sleep 19:160, 1996

OSA Treatment
Genioglossal Advancement

Sher Sleep 19:160,1996
OSA Treatment
Maxillomandibular Advancement

Scher Sleep 19:160,1996

OSA Treatment
Maxillomandibular Advancement

<table>
<thead>
<tr>
<th>Geniofl. Advance &amp; Hyoid Suspension</th>
<th>Bi-max. Advancement</th>
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<tbody>
<tr>
<td>Date</td>
<td>N</td>
</tr>
<tr>
<td>1986 Riley</td>
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