I. INTRODUCTION

A. Sleep Problems in Our Society
   1. Sleep deprivation
      • 75% of Americans report at least one sleep symptom
      • 60% of adults drove while drowsy during the past year
   2. Snoring and sleep apnea
      • Approximately 67% of adults snore
      • 9% of men and 4% of women have signs of OSA on testing
      • 4% of men and 2% of women have signs and symptoms of OSA
      • Current research shows 17-20% prevalence of OSA in US due to obesity
      • Only 10-15% of patients with OSA have been diagnosed
      • OSA is as prevalent as diabetes or asthma

II. OVERVIEW OF SLEEP MEDICINE

A. Normal Sleep
   1. Daily cycle and rhythms
   2. Normal sleep architecture
      • Non-REM sleep
      • REM sleep
   3. Healthy sleep duration (7-8 hours/night)

B. Prevalence of Sleep Disorders
   1. Insomnia
   2. Obstructive Sleep Apnea
   3. Narcolepsy
   4. Periodic Limb Movement Disorder (and Restless Leg Syndrome)
C. Anatomy and Physiology of Upper Airway  
1. Normal  
2. In presence of snoring and OSA

Normal airflow  
Snoring  
Apnea

D. Terminology

1. **Apnea** is a decrease in airflow of more than 80% for at least 10 seconds, ending with an arousal from sleep  
2. **Hypopnea** is at least a 30% decrease in airflow with oxygen desaturations greater than or equal to 4% and an arousal from sleep  
3. **Respiratory Effort Related Arousal (RERA)** is an abnormal respiratory event associated with an arousal that does not meet the definition of a hypopnea  
4. **Apnea-Hypopnea Index (AHI)** is the average number of apneas plus hypopneas per hour of sleep  
5. **Respiratory Disturbance Index (RDI)** is the average number of apneas plus hypopneas plus RERAs per hour of sleep  
6. **Snoring** is a partial airway obstruction that reduces airflow but does not cause arousal from sleep  
7. **Upper Airway Resistance Syndrome (UARS)** is exaggerated breathing effort and snoring created by high resistance to airflow in the upper airway. This causes fragmented sleep and significant daytime drowsiness (no evidence of apnea on testing)  
8. **Obstructive Sleep Apnea Syndrome (OSAS)**  
   • Stoppage of breathing for 10 seconds or more at least 5 times per hour  
   • Oxygen desaturations are more than 4% during apnea events  
   • Apnea events end with an arousal from sleep  
   • Arousals lead to chronic daytime sleepiness and other symptoms  
9. **Severity of apnea** is defined by:  
   • Length of time of apnea event  
   • Percentage of oxygen desaturation
• Apnea-hypopnea index of
  – 5-15 events per hour = Mild OSA
  – 15-30 events per hour = Moderate OSA
  – >30 events per hour = Severe OSA

E. Signs and Symptoms of OSA
1. Restless sleep
2. Snoring with intermittent pauses
3. Excessive daytime sleepiness (EDS)
4. Awakenings due to gasping or choking
5. Fragmented, non-refreshing sleep
6. Poor memory and clouded intellect
7. Personality changes
8. Decreased sex drive
9. Morning headaches

F. Physiologic Effects of OSA
1. Cessation of breathing leads to:
   • Reduced oxygen levels in the blood
   • Increased carbon dioxide levels in the blood
   • Acidosis
2. Sleep fragmentation during apnea leads to:
   • Constant arousals in sleep and excessive daytime sleepiness (EDS)
3. Cardiovascular consequences of OSA:
   • 45% of patients with OSA have hypertension
   • OSA patients have 5 times greater incidence of heart attack
   • Individuals with chronic snoring have 3 times greater risk of dying during sleep than non-snorers (most likely due to accompanying apnea)

G. Risk Factors of OSA
1. Increased rate of motor vehicle accidents
2. Increased risk of loss of employment
3. Uninsurability
4. Marital discord
5. Cardiovascular consequences

H. Predisposing Factors for OSA
1. Increased age
2. Increased weight/obesity
3. Male gender
4. Disproportionate upper airway anatomy
5. Alcohol or sedative hypnotics
6. Hypothyroidism

I. Medical Assessment for OSA
1. Physician’s evaluation may include:
   • Health history and history of symptoms related to snoring and obstructive sleep apnea
2. Head and neck examination
3. A polysomnogram will be indicated if a sleep disorder is suspected

J. Treatment Options for Snoring and OSA
1. Behavioral treatment and avoidance of risk factors
   • Sleep hygiene
     - Consistent pre-sleep routine
     - Limit daytime naps
     - Minimize light, noise, and extreme temperatures in bedroom
     - Avoid large meals before bedtime
     - Avoid strenuous exercise within 2-3 hrs. of bedtime
     - Avoid caffeine, nicotine, other stimulants within 4 hrs. of bedtime
   • Weight loss
   • Body positioning
   • Avoidance of CNS depressants (ie. valium, alcohol, etc.)
   • Avoidance of upper airway irritants (ie. smoking)
2. Over-the-counter (OTC) snoring treatments
3. Continuous positive airway pressure (or bi-level; auto-set)
4. Oral appliance therapy
5. Surgery
   • Tracheotomy
   • Tonsillectomy/adenoidectomy
   • Nasal surgery
   • Uvulopalatopharyngoplasty (UPPP)
   • Laser-assisted Uvulopalatoplasty (LAUP)
   • Somnoplasty
   • Pillar procedure
   • Maxillofacial surgery
6. Effectiveness of medical treatments:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Snoring</th>
<th>OSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPAP</td>
<td>98%</td>
<td>98%</td>
</tr>
<tr>
<td>UPPP/LAUP</td>
<td>85%</td>
<td>40-50%</td>
</tr>
<tr>
<td>Telegnathic surgery</td>
<td>N/A</td>
<td>70-90%</td>
</tr>
<tr>
<td>Somnoplasty</td>
<td>80%</td>
<td>N/A</td>
</tr>
<tr>
<td>Pillar procedure</td>
<td>80%</td>
<td>N/A</td>
</tr>
</tbody>
</table>
III. COMPREHENSIVE PATIENT EVALUATION

A. Patient Questionnaires (refer to samples)
   1. General questionnaire for sleep disordered breathing
   2. Epworth sleepiness scale
   3. Patient medical/health history
   4. Sleep partner questionnaire

B. History of Current Symptoms
   1. Snoring
      • Frequency
      • Effect on sleep of others
   2. Daytime drowsiness
      • Refreshed/unrefreshed upon waking
      • Effect on daily activities
      • Cognitive impairment
      • Near-misses while driving
   3. Quality of sleep
      • Number of times awakened during night
      • Wake gasping and choking
      • Witnessed apneas
   4. Usual sleep position
      • Snoring in all positions or only on back
   5. Hours of sleep per night
   6. Change in weight
   7. Nasal congestion
   8. History of previous sleep disorders evaluation
      • Previous physician/dentist evaluations
      • Previous sleep studies or other testing
      < Dates and results
      • History of previous treatment
      < CPAP, surgery, oral appliances, other treatments

C. Patient Examination
   1. Jaw range of motion
      • Maximum opening (40-60 mm)
      • Lateral and protrusive movement (≥ 8 mm)
   2. Dental/skeletal relationship
      • Overbite and overjet
      • Angle classification
      • Position of dental midlines
• Wear facets
3. Occlusal contact
4. Periodontal condition
   • Gingival recession and/or pocketing
   • Tooth mobility
   • Interproximal contacts
5. Intraoral soft and hard tissue pathology
6. TMJ evaluation
   • Palpation of TMJ capsules
   • Auscultation (stethoscope)
7. Muscles of mastication
   • Palpation of the masseters and temporalis (at a minimum)
8. Oropharyngeal tissues
   • Size of tongue
   • Length of soft palate
   • Size of uvula
   • Crowding of palatopharyngeal area
9. Neck size

D. Anatomy of Oro-pharyngeal Area
1. Dental arch anatomy and influence on airway
2. Supra-hyoid muscles
3. Infra-hyoid muscles
4. How these muscles effect the upper airway

E. Home Unattended Testing Options
1. Pulse oximetry
2. Watch_PAT test
3. Other home tests
4. Indications in clinical practice

IV. IMAGING OF THE UPPER AIRWAY

A. Cephalometric x-rays
1. Widely available
2. Relatively inexpensive
3. Must standardize angulation to visualize all of pharyngeal area
4. Usually performed sitting or standing, two-dimensional image (no volumetric analysis)
5. Image is in mid-sagittal plane
6. Cannot be performed during sleep
B. Other imaging options
   1. Acoustic reflection
   2. Nasopharyngoscopy
   3. CT scans
   4. MRI scans

V. OVERVIEW OF SNORING AND OSA IN CHILDREN

A. Etiology and Prevalence of Snoring and OSA in Children
   1. Etiology = interplay between neuromuscular, anatomic, and genetic factors
   2. Snoring prevalence = 3-12%
   3. OSA prevalence = 2-3%

B. Pathophysiology of OSA in Children

C. Health Risks of Snoring and OSA in Children
   1. Obesity
   2. Large tonsils and adenoids
   3. Craniofacial abnormalities
   4. Neuromuscular disorders

D. Screening for Snoring and OSA in Children

E. Treatment of Snoring and OSA in Children
   1. Tonsillectomy
   2. Adenoidectomy
   3. Jaw expansion (RME)
   4. CPAP
   5. Oral appliance therapy (Functional appliances)

VI. OVERVIEW OF ORAL APPLIANCE THERAPY

A. Indications for Use of Oral Appliance Therapy
   1. Primary/heavy snoring
   2. Mild to moderate OSA (and some cases of severe OSA)
   3. Poor tolerance of nasal CPAP
   4. Failure of UPPP
   5. Use of appliance during travel
   6. Use in combination with other treatments (nasal CPAP, etc.)
B. Classifications of Oral Appliances
   1. Mandibular repositioning devices
   2. Tongue retaining devices

C. Mechanism of Action of Oral Appliances
   1. Tongue retaining devices
      • Advances the base of the tongue
      • Actively holds tongue forward to open airway
      • Reduces fluctuations in genioglossus muscle activity
   2. Mandibular advancement devices
      • Repositions and stabilizes the mandible, tongue, and hyoid bone (and sometimes the soft palate)
      • Increases baseline genioglossus muscle activity
      • Increases size of the airway in a medial-lateral dimension more than AP dimension

D. Research Evidence Evaluating Oral Appliance Therapy
   1. Tongue Retaining Device (TRD)
      • Literature review: Effectiveness of TRD (see references in handout)
        - Cartwright, Samelson, JAMA 1982; 248:705-709
        - Cartwright, Arch Otol. 1985; 111:385-388
        - Cartwright, et al., Sleep 1991; 14:546-552
   2. Mandibular Advancement Devices (MAD)
      • Literature review: Effectiveness of MAD from 1995-2000 (see references in handout)
        - Menn, et al., Sleep 1996; 19:794-800
        - Marklund, et al., Chest 1998; 113:707-713
        - Pellanda, et al., Clin Otol 1999; 24:134-141
        - Pancer, et al., Chest 1999; 116:1511-1518
        - Parker, et al., Sleep 22 (Suppl 1) 1999; S230-231
        - Lowe, Sleep 23 (Suppl 3) 2000; S172-178
Summary of research 1995-2000 listed above:

<table>
<thead>
<tr>
<th>Severity of OSA</th>
<th>Responders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild OSA (5-20 events/hour)</td>
<td>76% 41/54</td>
</tr>
<tr>
<td>Moderate OSA (20-40 events/hour)</td>
<td>61% 50/82</td>
</tr>
<tr>
<td>Severe OSA (&gt;40 events/hour)</td>
<td>40% 27/68</td>
</tr>
</tbody>
</table>

• Literature review: Randomized control trials evaluating effectiveness of MAD from 2000-2008 (see references in handout)
  - Bloch, et al., AJRCCM 2000; 162:246-251
  - Mehta, et al., AJRCCM 2001; 163:1457-1461
  - Gotsopoulos,et al. Sleep 2004; 27:934-941

Summary of the Research Results:

- Success rates vary from about 40% for severe OSA to 76% for mild OSA
- Success rates increase by 30% if the patient has a titration polysomnogram with the oral appliance
- Must advance the mandible to achieve a successful outcome in most patients
- More advancement of the mandible results in more effective outcomes
- Success rates are higher in women than men
- Prefabricated (boil & bite) appliances are not recommended as a therapeutic option or a screening for OSA
- MADs can have a significant positive effect on high blood pressure
- A non-custom TRD (TSD) may be a simple inexpensive although somewhat less effective treatment option
- CPAP is more effective than a MAD in managing OSA, but there is only a 8-12% difference in treatment success
- MADs are significantly more successful than UPPP after 12 months of treatment
- Maxillary occlusal appliances may increase severity of OSA
VII. TREATMENT WITH ORAL APPLIANCE THERAPY

A. Coordinating Care with the Sleep Medicine Physician
   1. Develop protocol with physician in your community

B. Protocol for Oral Appliance Therapy

   Dental Evaluation and Consultation (including informed consent)
   ↓
   Impressions and Bite Registration
   ↓
   Insert Oral Appliance
   (include instructions on care and use of device)
   ↓
   Follow-up Evaluation(s)
   (may recommend home unattended sleep test)
   ↓
   Referral to Sleep Physician & Titration Polysomnogram with Oral Appliance
   (if patient has moderate or severe OSA)
   ↓
   6-month Follow-up Evaluation

C. Protocol for Adjustable Mandibular Advancement Device (MAD)
   1. Informed consent (refer to sample)
   2. Impressions and bite registration
      • Use of George Gauge
      • Other bite registration techniques
   3. Insertion of appliance
      • Post-insertion instructions
   4. Follow-up evaluation
      • Update progress
        - Change in symptoms
        - Compliance
        - Side effects
        - Change in Epworth Sleepiness Score
      • Examination
        - Fit of appliance
        - Occlusal evaluation
        - TMJ/muscle evaluation
      • Next follow-up evaluation
D. Protocol for Tongue Retaining Device (TRD)
1. Informed consent (refer to sample)
2. Impressions and bite registration
   • Use of Kelgauge
3. Insertion of appliance
   • Customizing TRD
   • Post-insertion instructions
4. Follow-up evaluation
   • Same as MAD evaluation (above)

VIII. ORAL APPLIANCE DIRECTORY: REVIEW OF 8 APPLIANCES

<table>
<thead>
<tr>
<th>Name of Appliance</th>
<th>Inventor</th>
<th>Characteristics of Appliances</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tongue Retaining Device (TRD)</td>
<td>Charles Samelson, MD Chicago, IL</td>
<td></td>
</tr>
<tr>
<td>2. Silent Nite</td>
<td>Hans-Peter Kopp, DMD Pfalzgrafenweiler, Germany</td>
<td></td>
</tr>
<tr>
<td>3. Elastic Mandibular Advancement (EMA)</td>
<td>Donald Frantz, DDS Webster, TX</td>
<td></td>
</tr>
<tr>
<td>4. Adjustable PM Positioner</td>
<td>Jonathan Parker, DDS Minneapolis, MN</td>
<td></td>
</tr>
<tr>
<td>5. SUAD</td>
<td>Patrick Strong Ontario, Canada</td>
<td></td>
</tr>
<tr>
<td>6. Klearway Appliance</td>
<td>Alan Lowe, DMD, PhD Vancouver, BC</td>
<td></td>
</tr>
<tr>
<td>7. Thornton Anterior Positioner (TAP)</td>
<td>W. Keith Thornton, DDS Dallas, TX</td>
<td></td>
</tr>
<tr>
<td>8. Somnodent</td>
<td>Dr. Richard Palmisano Sydney, Australia</td>
<td></td>
</tr>
</tbody>
</table>
A. Appliance Design Variations
   1. Materials (patient comfort)
   2. Retention (clasps or other)
   3. Patient response (time to adapt)
   4. Adjustability (ability to change mandibular position--A-P/vertical)
   5. Position and type of adjustment mechanism
   6. Freedom of jaw movement
   7. Lab vs. in-office fabrication
   8. Chair time for insertion and adjustment
   9. Tongue space
   10. FDA acceptance

B. Appliance Selection Criteria
   1. OSA severity
   2. Number of teeth
   3. Nasal or oral breathing
   4. Occlusal scheme
      - Overbite and overjet
      - Angulation of teeth
   5. Bruxism
   6. Periodontal health
   7. Size of mouth
   8. Gag reflex
   9. Patient apprehension
   10. Mandibular range of motion (opening)
   11. Appliance needed ASAP

C. Who are Good Candidates for Oral Appliance Therapy?
   1. Clinical predictors
      - Younger age
      - Lower BMI (thinner)
      - Smaller neck size
      - Lower AHI (milder OSA)
      - < Moderate and severe OSA patients can have moderately good success
      - Positional OSA
      - Good ability to advance mandible

D. Contraindication for Mandibular Advancement Devices
   1. Patient unable to advance mandible more than 6 mm
   2. Active TMD symptoms
      - Painful opening or chewing
      - Painful TMJ noise or locking episodes
3. Insufficient teeth to support device
4. Periodontal disease and/or tooth mobility

**Note:** It is recommended that all restorative, periodontal, and TMD treatment be completed prior to appliance therapy

**IX. POTENTIAL SIDE EFFECTS AND COMPLICATIONS OF ORAL APPLIANCE THERAPY**

A. **Minor Side Effects**
   1. Excessive salivation or dry mouth
   2. Discomfort in teeth or jaw
   3. Temporary change in occlusion

B. **More Significant Side Effects**
   1. Jaw Pain
   2. Permanent occlusal changes
   3. TMJ noises

C. **Prevalence of Side Effects and Complications**
   3. Robertson, CJ: Dental and skeletal changes associated with long-term mandibular advancement. Sleep 2001; 24:531-537

D. **Understanding and Managing Side Effects**
   1. Why do TMD symptoms occur?
      - Inflammation in the TMJs
      - Muscle pain
   2. Causes of jaw pain
   3. Managing jaw pain
   4. Why do occlusal changes occur?
   5. Preventing occlusal changes
   6. Managing occlusal changes
X. INSURANCE REIMBURSEMENT

A. Guidelines for Insurance Reimbursement
   1. Polysomnogram confirming OSA diagnosis
   2. Letter or notes from MD recommending appliance
   3. Letter from treating dentist
   4. Medical insurance claim form
      • Diagnosis code for OSA (ICD# 327.23)
      • Oral appliance code (Custom appliance = E0486)
        (Non-custom appliance = E0485)
   5. Research articles

XI. MARKETING YOUR DENTAL SLEEP MEDICINE PRACTICE

A. Internal Marketing
   1. Educate your staff
   2. Identify and educate the patients currently in your dental practice
   3. Have educational information available in your office
   4. Send information with your billing statement

B. External Marketing
   1. Develop relationship with sleep medicine physicians and sleep centers
   2. Supply sleep physicians and sleep centers with information about oral appliance therapy and your practice
   3. Give a presentation to sleep medicine physicians and techs
   4. Place ad in newspaper (focus on patients who have failed CPAP)

XII. AMERICAN ACADEMY OF DENTAL SLEEP MEDICINE

A. American Academy of Dental Sleep Medicine
   One Westbrook Corporate Center, Suite 920
   Westchester, IL 60154
   P; (708) 273-9366
   Online: www.aadsm.org

B. Reasons to Consider Membership

C. American Board of Dental Sleep Medicine
   1. Board exam
   2. Diplomate status

XIII. SUMMARY